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„How anticipation structures social reality“

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Stephan Berger

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1. What is anticipation?

„The End is Where We Start From” – it does no harm to start this thesis by quoting the subtitle of Mihai Nadins 2003 book on Anticipation, and it will hopefully not cause the reader any discomfort to find it iterated throughout the course of this work, as it is, in fact, a very concise description of what anticipation means.

Before we delve into the matter of elaborating various contemporary scientific accounts on the subject, allow me to first give a quick and somewhat biographical insight into why I chose to make anticipation the subject of my scientific endeavors.

Growing up in the 90s in the comfort zone of the rural Austrian middle-class life, I had the strong feeling that whatever was going on in the world, the slow but constant growth in social welfare was inevitable. Each year people surrounding me were able to afford that little extra luxury they could not get the year before, computers were getting cheaper, smaller and more potent on what seemed a monthly basis and so did the means of telecommunication. Although terrible things were certainly going on in the world (Iraq, Bosnia, Rwanda come to mind), at least in most of Europe things seemed to always be on the turn for the better. The European Union continued to expand, the Schengen agreement and the promise of a unified currency made it seem like a peaceful, unified and socially equal Europe was just around the corner. Without the intention of making a political statement in any direction, I consider it safe to say in hindsight, that the progress the world took since then was more troublesome than one was likely to predict in the mid-nineties. ¹

¹ Again, I do not want to advocate any political point of views in this thesis, nor do I take any satisfaction in the failure of any political measurements that are aimed towards global social welfare. In fact, methodologically speaking, I consider the history of mankind largely as one of trial and error, and as such, periods of failure and recession are a methodological necessity.
Of course periods of varying success are not restricted solely to domestic and foreign policies of nations around the world, such phases of fluctuation are no strangers to companies around the globe as well. One of the most prominent victims of this phenomenon is Apple. Certainly a very profitable company at this time, Apple was in quite some trouble in the mid-nineties\(^2\), facing the brink of bankruptcy. I remember my father saying to me in 2000, “If only I had known, I would have bought Apple stocks and be rich today. But I thought they would never recover.” Of course people around the world were in-line with him on that particular thought, as the rise of Apple was a surprise to many and certainly very profitable to those who had held on to their shares.

But I do not intend to praise the success of Apple as a company, nor the ingenuity of Steve Jobs, by bringing up this particular anecdote of computer history, in fact I want to focus on the statement my father made several years ago, articulating what probably millions of people around the world were thinking at that time: “If only I had known.”

This statement formsulates the absence of successful anticipation in a nutshell, and it is particularly interesting in its doing so, as it incorporates some of the basic ambiguity sentiment-wise that is so common in casual human communication. Let’s break it down:

\textit{If} – Perhaps the most potent combination of two letters in the English language, usually infers a conditional relation between two entities. We encounter it in logic, in the guise of argumentative figures like \textit{modus ponens}, and use it natural language to describe causal relations. In the statement above, \textit{If} refers to a conditional relation between a concrete current state in the present and a hypothetical state in the past, entailing a change in the present state, had the hypothetical state held true.

Only – While the word itself basically serves as a filler in the statement at hand (it provides no additional information on the causal relation between the states), it certainly infers an emotional attachment to the relational description, namely a feeling of regret. While this is largely irrelevant from a purely logical point of view, these kinds of emotional implications and attachments in natural language are vital to social communication, especially if the logical interrelation is hindered in one way or the other (think of non-verbal communication in the absence of a common spoken language between to individuals).

I – Depicting the subject in the statement at hand (my father referring to his past self) in this non-neutral fashion is another concession to the nature of natural language. Of course I could be replaced with X in this statement and it would still entail some meaning, while remaining subject-neutral and hence become viable in more abstract scenarios. Yet, while the purpose of self-reference in abstract settings (e.g. strict logical reasoning) is somewhat limited, it constitutes an important part of natural language.³

Had known – The use of past perfect in the above statement is crucial, as it infers a timeline into the causal relation, by referring to a state that could have entailed a certain cause, had it held true, while also implying the falsity of the state in question, but not its impossibility. On a semantic level the verb know implies the tangibility of a particular piece (or set of pieces) of information that was potentially available to the subject, but which it failed to ascertain at that particular point in time.

So let us sum up what information is entailed in this simple five word statement: There was a possible state in the past (my father knowing that Apple would overcome their problems) that,

³ Just think of the countless occasions each day when we refer to ourselves, say, in anecdotal evidence when illustrating something in every-day conversations.
had it been attained by the subject (the speaker of the sentence, i.e. my father), would cause the state of the subject in the present to differ (in this case, for the better) from its current state. The subject expresses regret over the failure to attain that particular state in the past.

Now, the reader may articulate dismay over the fact that this seems an awfully complicated way to express something quite simple, and there certainly is truth to that. But there is a reason why I want to break this statement down in such detail - because we want to try and pinpoint exactly the point at which anticipation happens.

At a first glance it might look like a pretty standard modus ponens inference:

If my father had known that Apple would turn profitable again (P), then he would be rich today (Q). (If P, then Q)

This works fine for the cases 1 and 4 in classical two-valued logic:

My father did know that Apple would turn profitable again and he is rich today (P and Q are true), so the statement is true. He did know, and he is rich today because of that.

Or: My father did not know that Apple would turn profitable again and he is not rich today (P and Q are false), so the statement holds true as well. He did not know and he is not rich today, because of that.

Now, the problem becomes more obvious in cases 2 and 3:

My father did know that Apple would turn profitable again and he is not rich today (P is true, Q is false), so the statement is false. He did know, but he is not rich today, therefore the implication is false.

Or: My father did not know that Apple would turn profitable again and he is rich today (P is false, Q is true), but the statement is still true. He did not know, but he is still rich, therefore the implication is true (he is still rich, right?).

While the last two statements are obvious non-sense, one might be tempted to think that the first two are still sensible inferences, but they too are unfit to deal with the matter at hand
satisfyingly. For instance, my father might have known that Apple stock would go up again, and he might be rich today, but for an entirely different reason - perhaps he did not invest despite his knowledge and won the lottery instead. Or he might not have known and still invested into Apple but lost it all again, so he is not rich now and did not know back then, in which case the statement is still true, but the entire purpose of the original statement is lost (he did not know, yet he invested and is not rich today).

So does this mean that there is no causal relation at all between the two initial statements? No, it just means that the relation is more complex than a simple modus ponens type causal relation. But that is not exactly what we set out for either, the goal was to try and pinpoint the moment anticipation enters the equation, so let’s give it another go.

As the reader certainly noticed, I referred to the statement (If only I had known) as the absence of successful anticipation in a nutshell, and by now we have elaborated two matters: a) that anticipation as a process is more complex than mere causal reasoning and b) that it is somewhat desirable to an individual to be able to anticipate events (as it in turn causes regret to fail to do so). But we have yet to establish how successful anticipation would pan out and how we can get to it. Obviously, in the example at hand, a successful anticipation would entail knowledge about the recovery of Apple in the future, while also being able to comprehend how to possibly profit from this knowledge individually. So, in our case, my mid-nineties father would have known that Apple would manage the turnaround, while he would also have known which measures to take to profit from that knowledge (e.g. knowledge about investing and how to accumulate the resources required). This is what successful anticipation would pan out to in this case, but it does not tell us how it actually came to work. We cannot derive how my fictional father knew that Apple would recover, just from the fact that he did know. The only thing we can do in order to ascertain that knowledge, besides asking him (and even then there is a decent chance that he himself will not know, or be able to articulate how he
knew), is to try and describe the circumstances under which he came to this particular anticipation.

This is the conclusion we have to work with for now: Any scientific discourse on the subject of anticipation must be *descriptive* in nature. Following this first conclusion and having provided a quick overview on how we experience anticipation in daily common practice, I shall sum up the contemporary scientific perspectives on the subject in the chapters to follow. By doing so, I intend to demonstrate that the various researchers (certainly more adept in the matter than I am) too seem very cautious to stay within the realm of the descriptive while expanding on the matter of anticipation.
1.2 Contemporary accounts of anticipation

In the section to follow we will familiarize ourselves with a variety of scientific accounts on the subject of anticipation. A common trait among the works we will look into is that the authors all acknowledge the importance of anticipation as a subject in scientific discourse, while also expressing some concern over the fact that the subject finds so little acknowledgement in the scientific community. None of the texts we will be dealing with are considered explicitly to be philosophical in nature – neither by their authors nor in the field of reception they receive – instead they stem from scientific fields such as theoretical biology (Rosen [1985] 2012 and Rosen 1991), semiotics (Nadin 2002) or computer science and artificial intelligence (Pezzulo et al. 2008). They are however highly interdisciplinary in nature, which is another common trait among publications dealing with anticipation.

It is the strong and heartfelt conviction of this author that there is a great deal of knowledge and merit to classic disciplines of philosophy, such as epistemology and the philosophy of mind, that can be extrapolated from these works and can indeed provide new and valuable perspectives to classic topoi of philosophical thinking.

The works we will deal with in specific detail in the section to follow are: *Anticipatory Systems* by Robert Rosen (Rosen 1985; with specific regard to the second edition published as recently as 2012)

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*Anticipation* by Mihai Nadin (Nadin 2002) and *The Challenge of Anticipation* by G. Pezzulo, M.V. Butz, C. Castelfranchi and R. Falcone (Pezzulo et al. 2008). The timeframe inside which these works have been published spans over 23 years (27 if the 2\(^{nd}\) edition of Anticipatory Systems is considered as an additional new effort), which is somewhat minuscule in terms of historical philosophy, but certainly quite significant in

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\[4\] It is indeed a very lucky coincidence that the conception of this thesis took long enough, so the second edition of *Anticipatory Systems* could be incorporated into it. Mihai Nadin and Judith Rosen who edited the second edition did a great job of making a very complex theory more accessible, well over 25 years after its initial publication.
consideration of the pace in which contemporary science works. This can be understood as another concession as to how small the role of anticipation in scientific discourse really is. Rosen (1991 and 2012) and even more so Nadin (2002) elaborate quite vividly on the fact that the very concept of anticipation is in strong opposition to traditional scientific points of view, particularly in regard to the primacy of reaction in physics (which they both trace back to Newton and Descartes). We will slightly scratch the surface of this debate in the coming sections, but clearly this cannot be our primary occupation, even though the subject itself is very intriguing and certainly merits an in-depth discussion of its own.

What we will look into more thoroughly, however, are the various definitions of anticipation and anticipatory processes that are presented in the aforementioned texts. We will progress through them in chronological order, starting with Robert Rosen’s *Anticipatory Systems*, which provided the initial conceptual framework for scientific discourse on anticipation and is referred to closely by both Nadin and Pezzulo et al.

Second, we will take an in depth look at Mihai Nadin’s conception of anticipation, which will also constitute the main tool upon which we will rely in the analysis to follow. Nadin’s account is a bit more general in nature and provides a concise and adequate picture of how anticipation works and how it can be applied in scientific reasoning.

Lastly, we will take a look at *The Challenge of Anticipation*, an ambitious project set out to create a *unifying framework for the analysis and design of artificial cognitive systems* (Pezzulo et al. 2008) and consider the definitions and perspectives offered in this work to see if and how we can apply them to the perspective we have gained at this point.

As the subject of anticipation is so very interdisciplinary to its very core, the author kindly asks the reader to bear with him, as we undertake this journey through various fields of science and considering various differing positions on anticipation that may or may not seem relevant to the cause at hand at all times, but are indeed vital in our process to get to the
conclusion – if it can be so called – offered in this particular piece of work. The author wholeheartedly assures that every step we take during the course of this process, as trivial or overly complex it may seem, constitutes – in his opinion – an integral necessity to better establish the very substance of the work at hand. Our conclusion, and the point of this entire practice, shall be that anticipation is indeed a very present phenomenon in every day human cognition, moreover that it is also a defining principle when it comes to the question as to how the structural qualities of society effectively come to be. This is a difficult task indeed and it is upon the reader to judge whether it can stand its ground or not, intimidation and fear of the unknown are certainly displaced in the ever-lasting quest to broaden one’s scientific horizon.
1.3 Robert Rosen’s account of anticipation

Rosen, a theoretical biologist, was (and still is) the central figure in advancing anticipation as a subject in scientific research. The main focus in our examination of Rosen’s theory will lie on his book *Anticipatory Systems: Philosophical, Mathematical, and Methodological Foundations* (Rosen 2012), which was originally published in 1985 but fortunately has seen a second, extended edition in 2012, due to the efforts of Mihai Nadin and Rosen’s daughter Judith Rosen – Robert Rosen himself died in 1998.

It is worth noting at this point that Rosen’s theory of anticipation within living systems is spread out over the course of a trilogy of publications, all dedicated to the exploration of a theory of life that goes beyond the scope of traditional reductionist thinking. In order to better comprehend the depth of the entire intellectual endeavor that Rosen had envisioned it is best to consider all three parts of the trilogy, just as Mihai Nadin passionately remarks in his Prolegomena to the second edition of *Anticipatory Systems* (Rosen 2012, p. xv). The trilogy consists of: *Fundamentals of Measurement and Representation in Natural Systems* (1978); *Anticipatory Systems. Philosophical, Methodological and Mathematical Foundations* (1985); and *Life Itself. A Comprehensive Inquiry into the Nature, Origin, and Fabrication of Life* (1991).

For the work at hand we will focus on *Anticipatory Systems* (Rosen 2012) and slightly touch on *Life Itself* (Rosen 1991), as an exploration of the theoretical framework in its entirety goes way beyond the scope of this text.

That being said, let us first take a quick look at Rosen’s preliminary remarks in order to see what he sets out to do with his theory of anticipation.

The present volume is intended as a contribution to the theory of those systems which contain internal predictive models of themselves and/or of their environment, and which utilize the predictions of their models to control their present behavior. Systems of this type have a variety of properties which are unique to them, just as “closed-loop” systems have properties which make them different from “open-loop” systems. It is most important to understand these properties, for many reasons. We shall argue that much, if not most, biological behavior is model-based in this sense. This is true at every level, from the molecular to the cellular to
the physiological to the behavioral. Moreover, model-based behavior is the essence of social and political activity. An understanding of the characteristics of model-based behavior is thus central to any technology we wish to develop to control such systems, or to modify their model-based behavior in new ways.

The essential novelty in our approach is that we consider such systems as single entities, and relate their overall properties to the character of the models they contain. There have, of course, been many approaches to planning, forecasting, and decision-making, but these tend to concentrate on tactical aspects of model synthesis and model deployment in specific circumstances; they do not deal with the behavioral correlates arising throughout a system simply from the fact that present behavior is generated in terms of a predicted future situation. For this reason, we shall not at all be concerned with tactical aspects of this type; we do not consider, for instance, the various procedures of extrapolation and correlation which dominate much of the literature concerned with decision-making in an uncertain or incompletely defined environment. We are concerned rather with global properties of model-based behavior, irrespective of how the model is generated, or indeed of whether it is a “good” model or not. (Rosen 2012, Preface to the First Edition)

These three paragraphs articulate quite concisely three of the main points we will have to deal with time and time again on our quest to apply anticipation in a social scope: 1. The presence of an internal predictive model; 2. That model-based behavior is the essence of social activity; and 3. That each system and the models it devised and processes is to be considered a single entity. These points will arise as well again later when we deal in detail with the conception of Mihai Nadin.

Rosen continues, acknowledging the basic epistemological nature of the study of anticipation at the very outset of his conception.

From the very outset, we shall find that the study of such global aspects of model-based behavior raises new questions of a basic epistemological character. Indeed, we shall see that the utilization of predictive models for purposes of present control confront us with problems relating to causality. It has long been axiomatic that system behavior in the present must never depend upon future states or future inputs; systems which violate this basic axiom are collectively called anticipatory, and are routinely excluded from science. On the other hand, the presence of a predictive model serves precisely to pull the future into the present; a system with a “good” model thus behaves in many ways like a true anticipatory system. We must thus reconsider what is meant by an anticipatory system; the suggestion arising from the present work is that model-based behavior requires an entirely new paradigm, which we call an “anticipatory paradigm”, to accommodate it. This paradigm extends (but does not replace) the “reactive paradigm” which has hitherto dominated the study of natural systems, and allows us a glimpse of new and important aspects of system behavior. (Rosen 2012, Preface to the First Edition)

As indicated earlier, one of the main intentions in Rosen’s work is to push the scientific discourse into a direction where it becomes indeed possible to question what he calls the “reactive paradigm”. In order to be able to deal with the insight and possibilities we can gain from the application of model-based behavior we need to able to transition towards the
“anticipatory paradigm”. This step was viewed as a necessity by Rosen in 1985 and it is far from being understood as such in 2012.

Let us take a look at the three main questions Rosen had in mind when he conceived *Anticipatory Systems*.

The main theoretical questions with which we deal in the present work are the following: (a) What is a model? (b) What is a predictive model? (c) How does a system which contains a predictive model differ in its behavior from one which does not? In the process of exploring these questions, starting from first principles, we are led to a re-examination of many basic concepts: time, measurement, language, complexity. Since the modeling relation plays a central role in the discussion, we provide numerous illustrations of it, starting from models arising entirely within symbolic systems (mathematics) through physics, chemistry and biology. Only when the modeling relation is thoroughly clarified can we begin to formulate the basic problems of model-based behavior, and develop some of the properties of systems of the kind with which we are concerned. (Rosen 2012, Preface to the First Edition)

In the spirit of our cause, we will not exhaust any extra effort to attend to the questions (a) and (b), but rather rely on knowledge that has already been put forth. We will however deal with question (c) in the course of our project, as it can prove quite rewarding to model the presence of a phenomenon (social anticipation in our case) against the very absence of the same phenomenon.

The various concepts that Rosen mentions in the next paragraph will be dealt with mostly implicitly on our part; of course they play a vital role in social anticipation, but in the spirit of working away from the reductionist principle instead of committing more into it, we shall acknowledge them only as a variety of factors in complex correlational framework.

In an effort to make Rosen’s definition of anticipation more tangible, let us take a look at his description of how his conception of anticipation came to be.

I proceeded by attempting to integrate these thoughts with my overall program, which as I noted above was to establish homologies between modes of social and biological organization. Accordingly, I cast about for possible biological instances of control of behavior through the utilization of predictive models. To my astonishment, I found them everywhere, at all levels of biological organization. Before going further, it may be helpful to consider a few of these examples.

At the highest level, it is of course clear that a prominent if not overwhelming part of our own everyday behavior is based on the tacit employment of predictive models. To take a transparent example: if I am walking in the woods, and I see a bear appear on the path ahead of me, I will immediately tend to vacate the premises. Why? I would argue: because I can foresee a variety of unpleasant consequences arising from failing to do so. The stimulus for my action is not just the sight of the bear, but rather the output of the model through which I predict the consequences of direct interaction with the bear. I thus change my present course of action, in accordance with my model’s prediction. Or, to put it another way, my present behavior is not simply reactive, but rather is anticipatory.
Similar examples of anticipatory behavior at the human level can be multiplied without end, and may seem fairly trivial. Perhaps more surprising is the manifestation of similar anticipatory behavior at lower levels, where there is no question of learning or of consciousness. For instance, many primitive organisms are negatively phototropic; they move towards darkness. Now darkness in itself has no physiological significance; in itself it is biologically neutral. However, darkness can be correlated with characteristics which are not physiologically neutral; e.g. with moisture, or with the absence of sighted predators. The relation between darkness and such positive features comprises a model through which the organism predicts that by moving towards darkness, it will gain an advantage. Of course this is not a conscious decision on the organism’s part; the organism has no real option, because the model is, in effect, “wired-in”. But the fact remains that a negatively phototropic organism changes state in the present in accord with a prediction about the future, made on the basis of a model which associates darkness (a neutral characteristic in itself) with some quality which favors survival. (Rosen 2012, p.7-8)

It becomes apparent here that anticipation can be understood as “knowledge” about an experience we have not made yet (or possibly will never make), as what holds true for the bear in this case is likely true for acquaintances with tigers, lions or even dinosaurs (to reference a species that is not currently present on our planet but can yet be apparent to us in fictive scenarios). Of course, this kind of knowledge also is the source of stereotypes (which we will elaborate more on when studying Nadin more thoroughly), as it is also the case in the bear-scenario. Our tendency to vacate the premises is based upon the preconceived (read: anticipated) notion that the bear will attack us; it is however not impossible that this specific bear is a particularly friendly individual on the lookout for a nice little get-together.

The example of the negatively phototropic microorganism is also quite intriguing, as the underlying anticipatory process is quite complex, yet it surfaces in a rather simple life form. The anticipation that moisture is more likely to be present in the absence of light serves as a predictor that correlates to a condition (the need of moisture to sustain life) that is entirely decoupled from the initial predictor (the absence of light).

Let us now - before we take a closer look at the definition of anticipatory systems Rosen has to offer - take a moment’s time to reflect on his perspective on the primate of causality in the sciences. He largely attributes this circumstance to the dominant role the reductionist view of the world has occupied in the sciences since the days of Newton and Descartes. Rosen elaborates quite vividly how this tendency towards causality and the reluctance to question
this dominance has in fact held the sciences back, particularly in efforts to explain behavioral phenomena in biology that we cannot fully explain otherwise.

In fact, the actual situation is somewhat worse than this. At its deepest level, the failure to recognize and understand the nature of anticipatory behavior has not simply been an oversight, but is the necessary consequence of the entire thrust of theoretical science since earliest times. For the basic cornerstone on which our entire scientific enterprise rests is the belief that events are not arbitrary, but obey definite laws which can be discovered. The search for such laws is an expression of our faith in causality. Above all, the development of theoretical physics, from Newton and Maxwell through the present, represents simultaneously the deepest expression and the most persuasive vindication of this faith. Even in quantum mechanics, where the discovery of the Uncertainty Principle of Heisenberg precipitated a deep re-appraisal of causality, there is no abandonment of the notion that microphysical events obey definite laws; the only real novelty is that the quantum laws describe the statistics of classes of events rather than individual elements of such classes.

This picture of causality and law, arising initially in physics, has been repeatedly generalized, modified and extended over the years, but the basic pattern remains identifiable throughout. And one fundamental feature of this picture has remained entirely intact; indeed itself elevated to the status of a natural law. That feature is the following: in any law governing a natural system, it is forbidden to allow present change of state to depend upon future states. Past states perhaps, in systems with “memory”; present state certainly; but never future states. It is perfectly clear from the above discussion why such a commandment is natural, and why its violation would appear tantamount to a denial of causality in the natural world.

A denial of causality thus appears as an attack on the ultimate basis on which science itself rests. This is also the reason why arguments from final causes have been excluded from science. In the Aristotelian parlance, a final cause is one which involves a purpose or goal; the explanation of system behavior in terms of final causes is the province of teleology. As we shall see abundantly, the concept of an anticipatory system has nothing much to do with teleology. Nevertheless, the imperative to avoid even the remotest appearance of telic explanation in science is so strong that all modes of system analysis conventionally exclude the possibility of anticipatory behavior from the very outset.

And yet, let us consider the behavior of a system which contains a predictive model, and which can utilize the predictions of its model to modify its present behavior. Let us suppose further that the model is a “good” model; that its predictions approximate future events with a sufficiently high degree of accuracy. It is clear that such a system will behave as if it were a true anticipatory system; i.e. a system in which present change of state does depend on future states. In the deepest sense, it is evident that this kind of system will not in fact violate our notions of causality in any way, nor need it involve any kind of teleology. But since we explicitly forbid present change of state to depend on future states, we will be driven to understand the behavior of such a system in a purely reactive mode; i.e. one in which present change of state depends only on present and past states.

This is indeed what has happened in attempting to come to grips theoretically and practically with biological behavior. Without exception (in my experience), all models and theories of biological systems are reactive in the above sense. As such, we have seen that they necessarily exclude all possibility of dealing directly with the properties of anticipatory behavior of the type we have been discussing. (Rosen 2012, p. 9-10)

To recap briefly: The main notion we have to take with us here is that it is by way of definition in the mode of the reactive paradigm that we cannot consider the reference to “future states” in any given system as an option in establishing a causal relation, even though such a relation can be established without a teleological motive, simply by implementing a predictive model that approximates with a high degree of certainty. Still, such is Rosens
conviction, anticipatory behaviors have been overlooked deliberately, and he proceeds to pose the question why.

How is it, then, that the ubiquity of anticipatory behaviors in biology could have been overlooked for so long? Should it not have been evident that the “reactive paradigm”, as we may call it, was grossly deficient in dealing with systems of this kind? To this question there are two answers. The first is that many scientists and philosophers have indeed repeatedly suggested that something fundamental may be missing if we adopt a purely reactive paradigm for consideration of biological phenomena. Unfortunately, these authors have generally been able only imperfectly to articulate their perception, couching it in terms as “will”, “Geist”, “élan”, “entelechy”, and others. This has made it easy to dismiss them as mystical, vitalistic, anthropomorphic, idealistic, or with similar unsavory epithets, and to confound them with teleology.

The other answer lies in the fact that the reactive paradigm is universal, in the following important sense. Given any mode of system behavior which can be described sufficiently accurately, regardless of the manner in which it is generated, there is a purely reactive system which exhibits precisely this behavior. In other words, any system behavior can be simulated by a purely reactive system. It thus might appear that this universality makes the reactive paradigm completely adequate for all scientific explanations, but this does not follow, and in fact is not the case.

(Rosen 2012, p. 10-11)

Put in other words, by being content with reactive paradigm (which is always a modeling in hindsight) and not asking the right questions in order to get to the notion of anticipatory systems, the predictive model was collectively put out of perspective, such that it did not occur for the most part to put phenomena to question, that lay beyond the realm of the cause-effect-relation.

Rosen also acknowledges that the discourse on anticipation inherently borders on the realm of the metaphysical (in his referencing the first of the “two answers”), which is usually quite quickly dismissed in the materialistically-driven “hard” sciences. Let us make note at this point that Rosen did not bother to refute this first answer while he certainly elaborated more thoroughly on the second. The reason for this, such is the conviction of the author of this text,
is that he simply does not attribute any kind of merit to this type of grounds for dismissal, and rightly so. The moment we encounter phenomena that we cannot fully comprehend, we have to be willing to go beyond the scope of our physical grasp, even if this implies stumbling through the woods of uncertainty and speculation.
1.4 Mihai Nadin’s Account of Anticipation

The scope of Mihai Nadin’s work is largely interdisciplinary and this very much holds true for his 2002 book *Anticipation. The end is where we start from*, which offers a broad perspective on anticipation and how it is present in various sciences, and where its presence is lacking respectively. Nadin is aware of and refers to the works of Robert Rosen, whom he greatly admired. Nadin also wrote compelling Prolegomena to the second edition of Anticipatory Systems (Rosen 2012), giving a perspective on how Rosen’s pioneering work in this field influenced and continues to influence the sciences.

As for now, we will delve into *Anticipation* (Nadin 2002) in quite some detail, as it provides a more general and more accessible account of anticipation as presented in *Anticipatory Systems* (Rosen 2012). Nadin is very committed to introduce anticipation into the equation as a principle of understanding and hence chose a more simple way to explain anticipation, providing many relatable examples and using a less mathematically-inclined language. Nadin starts off his introduction with an example, describing anticipation in an everyday scenario, namely the hammering of a nail into a piece of wood (Nadin 2002, p. 6). He then proceeds to describe the difference to hammering a nail into concrete and establishes that there is indeed a different frame of mind at work, depending on the situation.

There is no equation to describe how the mind prepares the body. The body seems to “know” the difference between hammering a nail into wood or concrete before the hand grips the hammer. The mind even compensates for unusual destabilizing factors: the handle can be slippery, the hammerer might not hit the nail exactly on the head, the nail comes to a denser section, and so on. Preparation for the task, under the mind’s guidance – that is, the effect – takes place before the cause, before the act, in anticipation of the hammering itself. In reality, the mind maps out everything we do – walking, working with tools, telling or listening to jokes, feeling pain, loving, learning. And it does this in advance, in anticipation of the event. As T.S. Elliot [sic] so aptly expressed, “The end is where we start from.” Some scientists speak of an internal model of potential action, as well as of a feedforward mechanism, that eventually guides performance of the task. (Nadin 2002, p. 7)

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5 This is by no means intended to put Rosen’s efforts to question, but a simple observation of the author’s experience while working closely with both texts for an extended period of time. The merit of Rosen’s work is beyond question, but when it comes to accessibility, it seems to the author that Nadin made a specific effort in his work, which should not go without notice.
This particular example is quite relatable, as there is indeed a strong notion of “feeling” the nail working into the concrete within us before actually hitting the nail. Some might even shrug their shoulders briefly at the thought of hammering a nail into such an unfit surface, as our ears may “hurt” in advance at the thought of someone scratching a nail against a blackboard (to bring up another relatable example). Anticipation when telling jokes is also quite commonly observed - we all know those moments when we start to giggle way before we actually deliver a punch line. And the recipient of the joke told may very well say “Oh, I see where this is going”, indicating anticipation on his part as well.

Now that anticipation has been brought up, let me give, by way of introduction, one of its possible definitions: the effect before the cause. Or, as the cybernetician Heinz von Foerster put it, “The cause lies in the future”. I know, this contradicts everything we are taught about the foundation of science. Moreover, anticipation contradicts everything we experience when we use technology. This is so because, after all, technology is physics made into tools and machines. This physical explanation of the world is known as determinism: something – the cause – determines, or leads to, something else – the effect. In 1633, Galileo defined cause as “That which, given, the effect is there; and, removed, the effect is taken away.” The physics of an act is no more than the realization of the deterministic sequence of cause and effect. Determinism requires that cause precede effect. In anticipation the opposite is true. (Nadin 2002, p. 10)

Nadin addresses an issue that will resurface throughout the text time and time again, namely the contradictory position anticipation takes in relation to the nature of science, and he certainly has a point there. The classic cause-effect-relation is something we hold quite dear in our everyday use of natural language. To bring up another example, think of how we react mostly, when we are confronted with dramatic and tragic situations, say someone running amok. We are immediately inclined to ask “What caused him/her to do it?”, whereas we will hardly ever say “If this person is being ridiculed in the workplace, he/she will run amok”. We (rightly) refuse to apply such statements because the cause-effect-relation does not really work very well in this kind of situation, as very few, if any, people who are ridiculed in the workplace run amok, but almost all serial killers have eaten bread throughout the course of their life. It is a given that the conclusion “Eating bread causes people to run amok” is nonsense, but on the other hand we have to attest that “Eating bread” did not prevent “running amok” either. The notion of anticipation cannot be viewed as a means to establish causality in
non-causal relations, but it can prove helpful by shedding light on situations that go beyond the scope of cause-effect-relations.

Nadin continues to elaborate how interwoven the deterministic and reductionist views have become with our perception of daily practice.

Cartesian reductionism did provide access to detailed knowledge of the world, from the microcosmos – elementary particles – to the macrocosmos – the planetary system, the universe, and beyond. It also lies at the foundation of scientific discovery and technological progress. (…)

As a description of the material world and as an expression of the laws governing its functioning, deterministic-based physics and Cartesian reductionism have proven to be extremely powerful instruments in the overall progress of humankind. (…)

To repeat, the fundamental premise of Cartesian determinism is easy to express: The past (cause) determines the future (effect). (…)

Heat transmission is a physical phenomenon of extreme importance. Stoves and furnaces are based on the physical law of heat propagation; heating systems incorporate it, and thermostats work according to it. But we human beings do not exactly put our hands in fire. We avoid it – not under the guidance of a pineal gland, but rather due to complex anticipatory processes. And it is in this respect that Descartes’ reduction of the world to the description of its materiality, that is, to physics, breaks down. Things are not only the collection of parts constituting them, but also the variety of ways in which these parts are assembled. Relations among parts are themselves as important as the parts and the whole. (Nadin 2002, 12-17)

This last example is particularly clever, as it is easy to comprehend (we all try not to get our hands burnt) but also quite insightful, because we don’t even need the reference of a past experience to know that our hand will burn, if we hold it into the flame; it may even suffice that our parents tell us in our childhood not to do that. While the cause-effect model arguably may be true for small children - “I won’t put my hand in the flame, because my parents told me not to do it” – in most cases we avoid the flame because we anticipate our hand being burnt in the fire.

Nadin proceeds to describe how the deterministic view entered our thinking, before he first shows us where it does not hold true, nowhere other than in the realm of life itself.

The deterministic model of the machine became so powerful that every thing and every being came to be considered one. Regardless of the mechanical contraption one conceives of, the thought of reducing everything to a machine is as disconcerting as it is, in many ways, promising. Such a reduction implies an objective view of the world – machines have no consciousness – and relates the purpose or function

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6 Nadin refers to Descartes theory that the pineal gland processes sensory data in human beings. Cf. Nadin 2002, p. 17
of the machine to whatever phenomenon might be under scrutiny. And it extends the Cartesian premise that everything is reducible to simpler parts in the description of reality that we call physics.

(...)

But while reductionism focuses on parts for the understanding of the whole – that is, for establishing the rationality of things – it discards the connections between parts and ignores their meaning. In the final analysis, complexity is sacrificed in favor of the deterministic causality expressed in the sequence of cause and effect.

(...) This explains the naïve hope, expressed in various ways in the history of the human obsession with mechanisms, that every living animal and plant could be explained through understanding how a machine works.

(...) Because life itself (by the way, the title of a pioneering work on anticipation by the late Robert Rosen) has proven to be impossible to synthesize from what does not have life, the only way to endow machines with “life” is to associate them with the living. The computer, as the union of hardware and software, made the human-machine analogy even more plausible. According to one theory (from among the many similar), the body corresponds to hardware, and the genetic code corresponds to software. (Nadin 2002, p. 21-25)

Again, Nadin remains very relatable, as machines have indeed entered our lives very invasively and are omnipresent – perhaps even more so in the 10 years since Anticipation went into publication – and it is also due to this fact that we have indeed come to think that everything can be broken down into more understandable theses and conceptions. But, as Nadin rightly points out, this works only when we sacrifice complexity, and as it turns out, complexity is a very present force in large parts of our daily lives – common daily life as well as scientific routine.

As pointed out before, Nadin is aware and appreciative of Rosen’s work, who also was a strong advocate of the appreciation of the complexity of life. The last analogy that is worked into that paragraph shall not concern us much at this point, but it is worth to note here that we can draw much from this analogy, in the sense that we can rely on the aid of computer simulations and learn from simulation and artificial intelligence theory, in order to gain knowledge on matters of life, both solipsistic and social in nature.

Nadin points out that there are two major fields of scientific activity from which we can draw noteworthy conclusions in the course of getting on top of the notion of anticipation, namely the fields of cognitive studies (particularly Benjamin Libet) and biology (Rosen) respectively. Let us first examine his perspective on the cognitive studies.
1) In the area of cognitive studies, Benjamin Libet was the first to demonstrate (in 1973), on the basis of clinical observations, that human actions – a simple movement of the hand or a more complex task, such as a physical exercise – take place in the mind before they take place as a real action. He raised the question of free will and formulated coherent rational explanations of how humans arrive at their decisions. Within this horizon, I have proposed (since 1983) my own hypotheses: Our interaction with the world to which we belong is not only physical; it unfolds through anticipation and is expressed in anticipations.

In particular, I posed the question: “How do we explain mind activity in anticipation of an act itself?” For example, how does the body “know” what it means to hammer, and how does it prepare for the activity? My answer was then, as it is now, that the source of anticipation is the interaction among minds.

It is through this interaction – in our doing things, in learning, in our biological functions, as well as in human functions pertinent to social and political life – that anticipation is made possible. Here the focus shifts from force associated with matter to information associated with cognitive states. Anticipation can be stimulated by training, by learning, and by facilitating new forms of interaction. If stimulated properly, anticipation enhances human abilities far beyond those of any other known species. In a way, the process is not dissimilar to the one triggered by the Newtonian model: Tools enhance our physical abilities; knowledge enhances our cognitive abilities. We do not reinvent the world in each of our actions; rather, we build on knowledge acquired on our own or from others. (Nadin 2002, p. 25-27)

This passage is particularly worth our thoughts as it introduces several concepts that we will rely on heavily in order to develop our own perspective on anticipation. Nadin speaks of an “interaction among minds” that serves as a “source of anticipation”, a notion that is specifically relevant, if we want to consider anticipation as factor in social interaction. Another point is the analogy he draws to the Newtonian model, comparing knowledge to tools, in the sense that knowledge enhances our cognitive abilities. In the mode of social interaction, knowledge (or as I will refer to it for the most part: information) is indeed a defining factor. We gain knowledge by interacting amongst each other and we apply this very knowledge to the modes and types of action we set in motion when interacting with one another. In other words, whenever we interact, we trade, give or hold back information, based on particular anticipations we hold about a particular course of action. We will work into this in more depth later on.

Everything we eventually do is spelled out through a number of conflicting models for future action. They are context sensitive. This is why I defined anticipation as our sixth sense – the sense of context – a definition with an anthropocentric flavor since the five known senses are related to human beings. The conflicting models that our minds generate as they process sense data and cognitive data depend upon the activities in which human are involved. Some models succeed. Others give way to a course of action promising a higher return. Examples include the evaluation of possibilities in playing chess or in military strategies (what moves are possible, which moves present tactical and strategic advantage, how might the opponent respond); or human utilization of tools (in particular soft tools such as computer programs). The increase in information does not result from more sense data, but from operations what we know and what is relevant in a given context. When one considers all these aspects, it becomes apparent that everything human beings do involves anticipation.
We discuss with one another, anticipating words, sounds, body language. We love, laugh, eat, sniff flowers, and do so many other things, voluntarily and involuntarily, consciously and unconsciously, not in reaction to something (associated with love, laughter, food, etc.) but in anticipation. Before we take the first bite of food, the digestive system is already set to process it. Before someone tickles us, laughter is triggered. And we are already walking before we actually take the next step. Indeed, the rational core of this statement was confirmed by data obtained from quantitative research of cerebral activity pertinent to tickling, gait, and digestive processes. Anticipation is also the mechanism behind forms of behavior that we still have problems understanding, such as addictions (alcohol, drugs, gambling). Newton’s forces cannot help here since addictions are far from being reducible to physical phenomena. Furthermore, anticipation drives inventors, hackers, and other individuals involved in creative activities – again, a subject for which physics and disciplines derived from it or working in its spirit are ill equipped to explain. Beauty itself, physically embodied, is in anticipation of, not in reaction to, aesthetic perception. (Nadin 2002, p. 27-29)

The concept of conflicting models (certainly inspired by Rosen) is again right on track for what we have in mind later on. Again, this picture is very relatable, many times we run situations countless times through our head before actually engaging in them or not engaging at all respectively. Visualizing this process using various models of ourselves (one might even say alter egos) we imagine how a particular action would pan out, and how it would change us and our surroundings. The fact that Nadin references playing chess is also quite fitting to our cause, as we will later refer to the game of poker as platform of interaction, where anticipation is an important mode of inter-individual cognition and interaction. Nadin acknowledges anticipation not only as a mode of interaction, but also as the driving principle behind irritating phenomena like addictions in human beings. In fact it becomes quite apparent, that the very nature of an addiction (basically: an individual deliberately causing harm to itself without any inclination of cause whatsoever) is inexplicable using only the methods of the cause-effect-reasoning.

Let us now look at the other major scientific field that Nadin sees as grounds for the application of anticipation, biology. Again it is Rosen who Nadin has in mind, directly referring to him:

… Rosen was the scientist who scrutinized in incredible detail the reductionist treatment of the living by proponents of determinism. He proposed a structural-relational theory of anticipation, in fact a broad theory of life. In his last interview, he spoke of anticipation’s enormous potential for humankind’s future welfare, but also for harm. (Nadin 2002, p. 30)
The break with the “reductionist treatment of the living” is obviously quite important to Nadin as well, and we too have extended on this particular matter above in some detail. While, as mentioned earlier, it is certainly beyond the scope of this particular piece of work, criticism of this view of the world is nothing less than a necessity if we want to conduct fruitful scientific discourse in this day and age. More relevant to our cause at hand is the tiny remark referring to Rosen’s last interview, where he stated that anticipation yields enormous potential for humankind. We can take this as a strong indicator for Rosen’s awareness of how much of social practice in fact takes place in anticipatory processes. We interact mostly based upon our expectations and in anticipation of particular events; this is the main point of this thesis and it is already articulated in its basic form in this minuscule remark.

Nadin continues with examples for anticipation, or lack of anticipation respectively, and this time he draws from the realm of the physical describing the fall of a stone, the bouncing of a ball and the jumping of a cat.

A more complex description, but still within the competence of physics, pertains to a ball’s bouncing. Here we start dealing with expectations and probabilities. It is a dynamic process. In a game like basketball, expectation is built into its rule. Factors of surprise and suspense make the game live entertainment: As the ball turns on the ring of the basket, the audience holds its breath until it falls in and scores, or falls out.

But here, in addition to reaction, we get into the complementary dynamics of anticipation. Indeed, catching a ball is far from being a clear-cut problem of physics. A person cannot determine the contact time to a ball (at what moment will it be within reach?) only on the basis of sensory information. We can see the ball; we can hear the sounds associated with its movement; and we can get a sense of its direction. In the final analysis, there is another element that makes catching the ball possible.

A ball is not caught or intercepted in reaction to its movement, but rather in anticipation. Recent experiments in the neuroscience of action suggest that implicit knowledge is also at work. An internal model, reflecting our experience in a world in which gravity is a given, supports anticipatory behavior. In Newton’s world, a force must explain the process. In our anticipatory model, it is information in the form of knowledge and its contextual organization that affects the successful catch.

Indeed, the catching of a ball is a more complex process than it might appear at first (think how small children usually have problems timing the moment right when they can actually snap at and hold the ball) but it is also a process that requires anticipatory action. Only if we are able to approximate where the ball will be at a time when it is inside the range of our grasp can we successfully catch the ball. And even with years of practice, it is not a sure thing
that one will catch the ball each and every time; instead, every catch attempt requires a separate cognitive effort in order to be successful. We will touch on this matter more later on, when we deal with the game of poker in more depth. Another element that we will encounter there is what Nadin called “factors of surprise and suspense” above. Such factors play a vital role in poker, not only in the sense that the cards are dealt randomly, therefore factoring in “luck”, but also in the more intriguing sense, that players can surprise one another given their ability to interact amongst each other.

The example from above continues with the description of the cat’s jump:

The cat has a body, that is, it has mass and weight like the stone and the ball. Yet the falling of a cat is anything like the falling of a stone. There is something that defies physics to come up with an accurate prediction of where, how, and when the cat will fall, and to express any expectation, such as a cat will always fall on its four legs. Catching the falling cat defies any deterministic explanation. The difference in the three examples is that characteristic of the living called anticipation.

(…)

There is no anticipation in the stone; the bouncing basketball, moving under the explicit influence of force and the implicit influence of anticipation, arouses expectation; anticipation is involved when a cat falls and when someone wants to catch it.

(…)

Then there is anticipation – in sports, as well as in the behavior of the living and in their particular performance. In this domain, physics cannot come up with a method that accurately and adequately explains all that goes on. (Nadin, p. 38-39)

To put it a bit differently: Physics and the cause-effect-relation may be able to describe when a falling stone will be at which point according to the rules of gravity, but they fail to explain why Michael Jordan is much better at playing basketball than the vast majority of humankind. The reason why exceptional professional athletes can surprise us in the way they do is because their body and mind corresponds exceptionally well to apparent tasks in specific situations, and they are able to do so not by reacting to a specific situation (which would be too slow), but by anticipating a future situation and adapting to it in advance. Because Jordan knew what his opponents were thinking (or in the process of thinking) before they actually acted upon those thoughts, he was able to outplay them in the impressive fashion that he did through the course of his career.

Moving back to the subject at hand, the presence of anticipation in biology:
After having introduced the notion of anticipation, I should probably reiterate that this characteristic of the living and of interactions involving the living has to be understood as being complementary to reaction. As a matter of fact, what I am suggesting here is that the physicality of the living cannot be overwritten by anticipation. It might well be, that energy is the underlying commonalty of both. In everything human beings do – and in every other living system, such as plants, animals, and living organisms too small for the naked human eye to see – reaction is co-present; it accompanies anticipation in ever-changing proportion. As the living organism proceeds towards its inevitable end – death – anticipation plays a progressively lesser role. (At senescence, anticipation ceases.) 
Anticipation characterizes the living from the most elementary level known – the monocellular – to the most complex. Rosen described the phototropic characteristic of primitive organisms – they move towards darkness correlated with moisture and the absence of predators – as an anticipatory behavior. This anticipation is complemented by the reaction to light. (Nadin 2002, p. 43)

The complementary nature of reaction and anticipation that Nadin points out in this specific passage is also vital to the cause of this work, specifically when we want to lay out even as much as an attempt at creating a framework for social anticipatory behavior. Of course being able to react (read: adapt) to changes in our surroundings is a defining and life assuring quality of human beings, but it does not suffice to view this as mere reactive process. More often than not we “react” to projections, potentialities that are situated in a (possible) future; in those cases, we anticipate.

Nadin finally raises the question whether a comprehensive theory of anticipation can be achieved:

A comprehensive theory of anticipation – if such a theory is indeed possible – is as difficult to formulate as awareness and understanding of the anticipations that are part of our existence are difficult to reach. One step in the direction of simulating and supporting such awareness is to reach an understanding of the various aspects of anticipation. This will eventually help us apply it as an instrument for simulating anticipatory processes in respect to certain tasks and function deemed important – learning, design and architecture, prevention of disease and crime, for example. (Nadin, p. 46)

This borders on what I alluded to in the introduction, when I stated that the scientific discourse about anticipation remains largely descriptive in nature. Nadin acknowledges this at this point, but also makes the strong case that, even if we only understand aspects of anticipation, it might still suffice to gain valuable knowledge in a variety of fields. It is in this spirit that we want to continue our examinations.
1.4.1 Nadin’s twelve definitions of anticipation

After his initial preliminary discussion of what anticipation amounts to, Nadin offers twelve concise definitions of anticipation, each accompanied by a specific example pertaining to the particular definition.

Quite in line with the realm of the descriptive so far, Nadin acknowledges that his definitions might very well be called “descriptions” (Nadin 2002, p. 46), hence again pointing out that it is almost impossible to speak in certainty when dealing with anticipation. While there is some empiric evidence of phenomena that imply a presence of anticipation, the sciences have not yet evolved to the point where we can nail down precisely when, where and how anticipation happens in the human brain.

We will go through these definitions in quite some detail, as they will form the basic framework of our understanding of anticipation that in turn will form the foundation upon which we will construct our theory of social anticipation.

Allow me to start out this undertaking by directly quoting Nadin’s preliminary words to the actual definitions:

These definitions certainly do not cover all the aspects of anticipation within a category; neither are they totally distinct from each other. The definitions should clarify the point that, as opposed to physics, we do not deal with one principle or force at a time, but with many incomplete descriptions. Whether a unified coherent theory of anticipation is possible is open to debate. These twelve definitions are no more than a set of possible explanations, some connected to a descriptive formalism (such as the formalism of logic or mathematics), which I will not attempt to apply in this text. Others are probably still empirical or even speculative. (Nadin 2002, p. 47)

It is indeed important to take note of and keep in mind the incompleteness we have to operate with here. Certainty is a quality that is best looked for elsewhere; in this particular endeavor we have to enter the realm of possibility and (to a lesser extent) probability. Just like Nadin, however, the author considers it a necessity and his obligation to lay out a nominal framework, such that at the very least the taxonomy of the subject at hand remains tangible. Mihai Nadin did a great job creating such an elementary basic framework and we will follow his path in the passages to come.
Definition 1. An anticipatory system is a system whose current state is determined by a future state.

As a wife’s delivery date draws near, the husband’s hormones change, as though “preparing” him for fatherhood. 

(...) 

The definition suggests that parallel to Descartes’ arrow of time corresponding to the deterministic sequence of cause and effect (that is, cause before effect, a cause in the past giving rise to a future effect), we have a time vector from future to present. The future state – expressed as a goal (of a design, plan, military strategy or sport maneuver) – can be real (the wife who will give birth) or virtual (the desired functioning of a new product). In order to be achieved, an anticipatory course of action is triggered. The time lapse between processes that prepare us for a task is only one aspect to be considered in this regard. Feedforward processes and forward models are good candidates for describing how future states might affect a current state. (Nadin 2002, p. 52)

At a first glance it might seem that the notion of a “future state” and a “current state” is somewhat arbitrary and just another way to express the reversal of the cause-effect-relation, but the notion of a “state” is very well worth a closer look. The concept of “state” goes well beyond that of “cause” and “effect” as - it becomes apparent implicitly in the definition provided by Nadin - it can serve to express internal states (the hormones of the husband changing) as well as external states (the delivery date drawing near) while still pertaining to the same individual (the states expressed are those of the husband). The concept of “state” does a better job describing the relational nature of the affair than a simple cause-effect-relation statement could do, because it offers tools to deal with the multiple layers on which the relation effectively takes place (e.g. the hormonal changes have causal relation to the delivery date, but they also anticipate a certain change of state in the environment for which the body has to prepare).

This definition also marks the first time that we encounter the concept of a “feedforward process” so far. Obviously a reconstruction of the word “feedback”, this notion describes processes that relate predictively to a certain future event in opposition to feedback processes which relate reactively to past events.

Let us now take a look at the second definition.

Definition 2. Anticipation is the generation of a multitude of dynamic models of human actions in a given practical situation and the resolution, through a reward or punishment mechanism, of their conflict is an action. The source of anticipation is the interaction of minds, in particular through directly or indirectly shared experiences.
The dynamics of world markets is one of conflicting models in which objective and subjective elements play their parts. The reward – profit – plays a decisive role in the choices made by persons involved in market transactions (buying and selling stock, portfolio management, risk tolerance). Each model is a description of the situation (e.g., which stock promises a higher return) and an action that affects market dynamics.

Reward mechanisms affect the selection of a certain course of action in a given practical situation (dieting, working overtime, working for a start-up company). In this sense, they are “driving anticipations.”

This definition suggests that actions are not predefined through one possible scenario, but through several. Anticipation is thus 1) the continuous generation of models of action and 2) selection, from among the models, of the model that is deemed better suited to obtaining the desired outcome. Computer implementations of this definition reveal that a reward mechanism – the winner gets the resources – is probably implicit in the process; otherwise selections seem random. More recent research reveals that punishment mechanisms – whipping vandals, high fines for speeding, chopping off the hand of a thief, and of course, everlasting punishment in hell for the irreligious – are even more effective. (Nadin 2002, p. 58-60)

This strongly resembles what we encountered earlier, when Nadin elaborated how anticipation serves as a process to create a multitude of possible models that is then processed into the best possible course of action as deemed by the individual. Now he introduces the notion of a reward/punishment system into the equation and gives us yet another handy tool for dealing with anticipatory processes in a social environment. Perhaps this is most tangible in the field of the stock market, where whoever can anticipate best which stocks are going to be most profitable obviously holds a significant advantage. As we will see in our excursion into the world of poker later on, the way through which we come to these very advantages is particularly interesting, namely by means of exchanging or trading information amongst individuals. Keep in mind that in the stock market, regulations are put into place to prevent insider deals which in their basic nature constitute anticipations (with a high degree of certainty).

Definition 3. An anticipatory system is a system containing a predictive model of itself and/or of its environment, which allows it to change state at an instant in accord with the model’s predictions pertaining to a later instant.

Every rocket launch procedure is simulated in faster than real time by a program that anticipates the flight director’s go-ahead decision.

A predator, such as an eagle or a lion, anticipates the trajectory of prey. The chameleon first takes additional distance before attacking its prey.

The predictive model is a blueprint (or several cf. Definition 2) for the action. In some cases the gene contains such a predictive model: Certain diseases (e.g., myotonic dystrophy, Crohn’s disease) are “pre-programmed”. In other cases, a complete new living entity (some plants, for instance) can grow from an existing part. Degeneration and regeneration are processes driven by an anticipatory script (probably involving a final cause). (Nadin 2002, p. 60-61)
Adding to the concept introduced in the second definition, we are reminded at this point of the instantaneous nature that anticipation has to fulfill in a variety of circumstances. While this may seem trivial at first – just think of the lion having to stop for a couple of minutes while he carefully considers the possible trajectory the antelope may follow on its escape route – this notion of instant availability is less transparent in the case of the diseases mentioned by Nadin. However it does seem plausible that the genetic structure of such diseases in fact amounts to what Nadin calls a “predictive model.”

Definition 4. Anticipation is the result of a correlation process. Correlations explain the functioning of the so-called auto-associative memory. This allows an organism to anticipate sensory data or, more precisely, to act even when data are only scarcely provided.

Although there is no immediate causal link between beauty and survival, anticipatory choices (e.g., pairing with attractive males) results in a female duck’s laying bigger eggs. A minute change in the heartbeat of newborns precedes infectious disease (neonatal sepsis) in newborns. Identifying the chance can save their lives.

First we need to realize the role of relations – i.e., descriptions of qualitative reciprocal dependencies: A is related to B, as in Peter is Mary’s brother. This can be written as ArelB and read as PeterBrotherMary. Relations are different from functions, which describe quantitative dependencies, as in A is a function of B (i.e. the speed of a car is the function of gasoline burned), written as A = f(B). Relations can be simple or complex.

Second, we need to realize that relations among relations can be established. Someone’s brother can be someone else’s father. This generates further relations. The relation between relations – their co-relation – and the extent to which one influences the other shed light on aspects otherwise ignored. Anticipatory behavior in bird migration, for instance, or anticipatory action in consolidating co-relations through agreements are an expression of co-relational causality.

DNA research focuses on even more refined co-relations and suggests that many genetic mechanisms are dependent upon them. Many co-relations, some very delicate, others rather robust, are established in the dynamic balance of the environment. Since interrelations are important, concentration on a certain aspect of the ecology, no matter how urgent it is deemed, is the wrong strategy. In some cases, the correlation is expressed in the form of a predictor, such as in the example of the change in heartbeat that precedes severe infectious disease in some newborns. (Nadin 2002, p. 64-65)

Correlation is one of the key features we will encounter when dealing with social anticipation, as we tend to face situations everyday where no immediate causal link can be established, yet a successful anticipation is possible. Falsely establishing such correlations leads to a phenomenon that will also become more meaningful when we make the transition to a social level, namely that of superstitions. Often times knowledge about correlations has to be passed on from individual to individual, as in the case of the newborn’s heartbeat, in which the detection of the change in heartbeat can only be of use if the person detecting it has prior knowledge of the relation between the change in heartbeat and neonatal sepsis. To pick up
Nadin’s terminology: the detector has to be aware of the correlation expressed by the predictor in order for anticipation to function.

Definition 5. Anticipation is an expression of the connectedness of the world, in particular of the quantum non-locality characteristic of many phenomena.

We anticipate the words to come in a conversation. We fill in the blanks in many communication situations (where noise interferes with the transmission, for instance).

“The same neurons fire when their owner watches someone else perform the same task” (the so-called “mirror neurons” model). Learning skills, experiencing empathy, and understanding others seem to be based on this anticipatory mechanism.

Quantum non-locality describes the quantum connectedness of the micro-world. The splitting of a particle results in two particles whose properties are dependent upon each other. Based on this experiment in quantum mechanics, the model was adopted and tested for a level of existence for which we do not yet have a quantum-like theory – the interaction of minds. The powerful model of non-locality proved to be appropriate for describing, at least in terms of analogy, anticipatory characteristics of human interaction. (Nadin 2002, p. 70)

“The connectedness of the world” is an apt description of a phenomenon that is indeed very present when dealing with anticipation in a social setting. The tears we shed when we see something tragic happen to someone we might not even remotely know (think televised news of horrible things going on in the world) are all too real in the sense that they express an actual emotional state that we experience although there is no local inclination to do so. Experiencing empathy is only an aspect of this phenomenon, when anticipation happens in a social setting we judge and draw conclusions based on what we experience through the minds of other people, based entirely upon non-local interaction.

Definition 6. Anticipation is the expression of natural entailment.

In the avian song control system, the volume of the brain regions that control song production increase in anticipation of the breeding season.

Deciduous trees lose leaves not as result of lower temperatures – which would be a cause-effect chain, but as a result of shorter days. The temperature/daylight duration correlation is expressed through the shedding of leaves in autumn. In the life cycle of flowers, a distinct moment occurs after which they no longer attract insects for pollination.

An animal’s fur thickens in anticipation of winter.

Robert Rosen dedicated quite an amount of work to defining entailment. It can be understood as the inner causation of the living. As long as the internal model prediction and the behavior of the system are related, the living expresses itself in anticipation. When the relation is affected – that is, when discrepancies occur – the living displays maladaptation to the world (senescence emerges). Hormonal control, for instance, can be seen as having the hormone as a predictor of an anticipated future state of the organism (e.g., waking up at a desired time). (Nadin 2002, p. 73-75)

We used the term *entailment* in similar fashion in the introduction to this work. If we take a close look at the issue through the examples provided by Nadin, we must conclude:
Entailment is a necessary condition for anticipation to take place in human beings. Why is it not the other way round? An answer can be articulated in the following way: Entailment is present regardless of the presence of anticipatory capability. It is only by way of entailment that anticipations gain meaning, in the sense that they become apparent to us and can lead to a variety of possible courses of action. Entailment corresponds to what we understand as “meaning” in natural language. Although it may look like a legitimate word a random combination of letters – say “erdfuijk” – may not have meaning in a given language, just like an anticipation of the form “P in anticipation of Q” may be without entailment in a given system.

Definition 7. Anticipation is a mechanism of synchronization and integration.

The retina synchronizes visual data and integrates them into a coherent image.
The performance of a musical score by an orchestra is the result of many anticipations reached through the integration of synchronism among musicians, orchestra, soloists, etc.
The dynamics of all known swarms (e.g. bees, birds, fish, automobiles in traffic) is based on anticipatory behavior resulting from synchronizations.
Anticipation is a characteristic of the dynamics of the living. Dynamics involves time and thus our understanding of it. Real time, slower or faster than real time, microstructures and macrostructures of time all come into the picture as we realize that nature does not have a universal clock, but actually runs a multitude of clocks. Whether at the level of a swarm or an orchestra, whether in the process of seeing, hearing, touching, or tasting, time is present as a rhythm, and anticipation proves to be an effective integrating factor. (Nadin 2002, p. 78)

Again, Nadin remains quite relatable, as the swarm-like nature of automobiles in traffic is something we can very easily catch on to. In those cases we are thrown into a situation where we are required to synchronize our actions with those of other active agents in an environment. Traffic regulations can be viewed as anticipations of possible sources of trouble that we circumvent by collectively agreeing upon a certain set of rules. In a sense we can view this as a premature agreement to anticipate events in a certain predicted fashion (e.g. we anticipate people not driving while they have red light).

Definition 8. Anticipation is an attractor within dynamic systems.

Forecasts (e.g. financial, medical, political) co-create the world they attempt to predict within the mathematics of dynamic systems.
Death is an attractor in living systems.
Attractors were identified within the mathematics of living systems. They can be described as the predefined configuration into which a dynamic system evolves. Simple dynamic systems tend towards
relatively simple attractors. An increase in a dynamic system’s complexity is reflected in the complexity of its attractor. In the realm of the living, anticipation means the realization of a certain kind of relational organization. It is a model of the living. Each model of the living eventually bifurcates from what it models (the death of the living). Genetic anticipation (hereditary diseases and other hereditary tendencies) is only one form through which the living is “attracted” to a certain condition. (Nadin 2002, p. 81)

It is important at this junction to distinguish between anticipation as an attractor and as a predictor (Def. 4). While a predictor surfaces in correlations, the concept of the attractor can be best understood as diffuse long-range goal, a general idea of a motive, so to speak. The possibility to bifurcate on the transition towards a particular attractor is an important aspect that is very much apparent to us in daily practice, say when someone decides to take another path in the course of his career. The attractor may remain intact as such (the goal to have a successful career that leads to fame and fortune) while the realization may be subject to change (e.g. a change in education).

Definition 9. Anticipation is a recursive process described through the functioning of a system whose past, present, and future states allow it to evolve from an initial to a final state that is implicitly embedded in it. To an observer from outside the system, this particular way of functioning appears as an evolution in which the system knows its own future.

The golden section, as well as the (mathematically equivalent) Fibonacci series, has a stabilizing function in the dynamic systems. They are an anticipation of a stable condition noticeable in human artifacts (e.g., paintings, buildings, musical scores), as well as in natural occurrences. Recursive processes in biological systems hold out promise for genetic engineering and ecologically based plant and animal disease prevention. Anticipation is “destiny” at work, causa finalis embodied in the process of being achieved. Aristotle distinguished among four categories of causation: material cause, formal cause, efficient cause, and final cause. In contemporary jargon, they correspond to different kinds of information. If we apply these categories to a house, it is evident that materials – cement, brick, wood, nails, etc. – pertain to material cause. Builders (think of the many types of workers involved in excavating, mixing and pouring concrete, bricklaying, etc.) make the efficient cause clear through their work, while the plans they go by (blueprints and various regulations) – represent the formal cause. The final cause is clear and simple: Someone needs or wants to live in such an edifice. Anticipations of this nature characterize art and literature, but also scientific and technological creativity in what is known as invention. (Nadin 2002, p. 85-87)

We can even prolong the example Nadin gives for a bit when we pose the question what the purpose of the “edifice someone wants to live in” is. Humans learned to build houses because the necessity arose to live in environments where it is not possible for human beings to live throughout the entire year. Hence, in anticipation of cold times to come, and possible dangers lurking in the night, houses were constructed and ever since considered somewhat desirable
edifices to live in. From an outside perspective it seems indeed like the living system (the human being) knows its future (being subject to mortal dangers of all sorts).

Definition 10. Anticipation is a realization within the domain of possibilities. The experiments mentioned above anticipate such a possible realization. But more modest applications are also possible.

The likelihood that someone owning a cellular phone with integrated GPS, which allows fast and precise localization in an emergency (such as an avalanche), be rescued is a matter of possibility, not probability.
The possible is very different from the probable: the impossible is also improbable, but the improbable can still be possible. They both have a degree of uncertainty. The possible can be more or less likely to happen. Anticipation, as a realization of a possibility, is thus the expression of its “likely to take place” quality.

Again, in the human body, possibilities (of a breakdown of a sort) make up a longer chain, each component of the chain appearing in retrospect as a kind of prediction. But it is not a cause-and-effect sequence, rather one in which what has to happen is signaled back in time. (Nadin 2002, p. 89)

The distinction between the possible and the probable is something that we will draw from a lot later on, let me therefore expand a few words in this regard at this point. When human beings interact amongst each other, uncertainty is an omnipresent viable. We can never really know in advance how people will react to a certain action (we cannot know because other human beings hold anticipations as well, and they may very well be in conflict to each other), but we can anticipate a reaction with a varying degree of certainty. In the social spectrum, we will see that there are various ways in which an individual agent can try to take influence on the degree of certainty, say by gathering information and keeping it from other agents. But some uncertainty always remains – this relates to what Nadin referred to as the factor of “surprise” and “suspense” above.

Definition 11. Feedback is a mechanism of anticipation.

Expectation of positive outcome is a type of feedback that influences anticipations in combat, sports, hunting, agriculture, and investing.

A brand name is an anticipation whose realization depends upon feedback mechanisms. Positive experience with a brand-name product prompts a consumer to buy the same and other products that the company produces.

Since Norbert Wiener introduced his cybernetic model, we have become aware of how, through feedback, some processes can be reinforced or weakened. Feedback controls grip force adjustments of handheld tools, learning processes, as well as such anticipatory manifestations as tickling expectation, incentive-based association learning, and sexual behavior. Anticipations can become weaker or stronger based on the nature of the feedback. Feedback and feedforward seem to complement each other. (Nadin 2002, p. 92)
Particularly the complementary relation between feedback and feedforward is something we will keep in mind and look into in more detail in the sections to come. In social anticipation, this correlation becomes quite tangible as we constantly deal with expectations (anticipatory processes) while simultaneously evoking expectations in other agents, taking impact on their behavior and then in turn again on our own.

This also one of the aspects where we can draw heavily from the progresses in the computer sciences, specifically in the realm of artificial intelligence research, where feedback-based learning processes that rely on reinforcement or weakening play a crucial role. This type of learning tries to imitate how human beings learn, and by looking at the simulations we try to put forth, we can gain deeper knowledge about our cognitive functions.

Definition 12. Power laws are helpful in describing interactions between systems whose components are correlated. In nonextensive situations, correlations do not decrease exponentially with distance, as they do in extensive cases. Described in terms of nonextensive thermodynamics, long-range interactions correspond to a particular description of entropy.

Human vision, for instance, seems to proceed along the path of the nonextensive case. That is, we “see” things before we see them, as in noticing a variation on a visual field. On a huge, uniformly colored wall, the smallest variation is immediately seen; it “jumps ahead” of the image as a whole. The scenario is similar for a predator hunting for prey (especially flying predators). The anticipatory behavior of the human body in a space laboratory, or subjected to short spikes of simulated zero-gravity, can serve as an example. It is clear that previous experiences are not available. Accordingly, here we have long-range interactions.

Probably the first thing to be mentioned is the repeating theme of correlation. What identifies anticipation as a long-range interaction is the interaction aspect between two apparently independent systems. Constantino Tsallis described the formation of a tornado as an interaction between such systems of air molecules. In the formation of a tornado, air molecules in a tornado system are highly correlated. The vortex is a very low-probability event regarding a field of possibilities. But it is quite captivating to notice how a similar mechanism describes anticipations of miniscule variations against a background of uniformity (a sound, a color, a light). The physics of perception (a subject for psychology) could not explain such anticipations short of placing them (like so-called parapsychological phenomena) under the Gaussian umbrella of probabilistic statistical distribution. (Nadin 2002, p. 96-97)

It is indeed a staggering quality of living systems that the anticipated perception can precede the actual visual (or sensorimotor) perception. This holds also true in social interaction when we finish each other’s sentences or give away punch lines we have already perceived before we actually received any kind of input. The input is created entirely within the realm of our own mind, and amazingly this happens in very long-range scenarios as well. We can
anticipate the laughter of a future crowd over a great joke we can tell them in a setting that is yet to come to be. The ability to deal with hypothetical scenarios by relating them to our active causation in the present is one of the defining qualities of human beings.

Now that we have dealt in some detail with the twelve definitions of anticipation as proposed by Mihai Nadin, we will have a quick look at perspectives and conclusions Nadin himself draws from his set of definitions.

1.4.2 A few examples and perspectives of Nadin’s conception

After having defined his framework of understanding anticipation, Nadin continues to give examples and discusses possible areas of application of anticipatory reasoning. In regard to the last definition and the tornado-example accompanying it, Nadin tells an interesting anecdote and reiterates on the importance of information in anticipatory processes.

In respect to this last hypothesis, a young scholar in particle physics (Michael Richter) challenged me: I understand the correlation of atoms leading to a tornado. But tell me what co-relates in an anticipation. I owe it to this provocative question that I can advance yet another thesis: Information is what co-relates an anticipation. And this prompts a strong statement (still subject to proof): Information is the ultimate substratum of anticipatory processes. Anticipatory systems are systems of information, themselves subject to interaction with other systems. Given this informational nature of anticipation, we can only be optimistic in regard to the possibility of computing anticipatory characteristics, even if in this respect the implementation processing will turn out to be more difficult than we would like to have it. (Nadin 2002, p. 100)

Particularly when dealing with living systems, it is all but obvious in our common thinking to attribute that kind of importance to information, but this statement is indeed very strong, even more so in the sense that it provides a challenging and rewarding perspective. The way we view life traditionally is in a constant involvement in material exchange: Living systems extract matter from the environment and give matter back in exchange. If we attribute a quality of vital necessity to information, we can make the transition to theorize about life in the realm of the immaterial.

From Descartes we inherited the view according to which the sensorial system of the living carries information from the outside world. This view is partially correct and reflects the physics of every instance of knowledge acquisition. However, our knowledge, moreover our awareness, and our action rely also on the ability of the living to generate “from inside”, from the mind, information of extreme
importance to what we do. We indeed have a forward channel – from the external world to the brain through our senses - and a backward channel – from our brain to our interacting minds, and thus to our actions. Accordingly we have a feedforward and a feedback mechanism of information control. An inverse model provides the command from inside based on information already available, not on information coming from the outside. Better known under the name associative memory, and used in computer-based handwriting recognition, for instance, associative memory is actually a powerful mechanism that allows us to work with less information than a machine might need in order to perform the same operation.

This is yet another way through which anticipation emerges as complementary to physics-based human activity. We can work using incomplete information because we “fill in the blanks” through our own experience. A common example of this is when a spouse or friend habitually interrupts mid-sentence because he/she anticipates what will be said.

Performance athletes involved in zero-sum games (Winner takes all!) also compete against each other’s anticipations. This is true in a game of chess or tennis, as it is in games in which teams compete. (Nadin 2002, p. 102)

We already touched on the ability to “fill in blanks” a bit in the sections above, but it does no harm at this point to think even more about the implications this ability actually entails. It is by way of this ability to generate information “from inside” that we are able to interact socially in the way that we do. Just think for a moment about what social interaction would come down to, were we not able to hold expectations about what our counterparts in society will do or intend to do. It is quite obvious that this would mean disaster; practically everything we have come to hold dear about social life (driving a car, taking a train, engaging in friendly conversation, practically all forms of ‘common courtesy’ and even trusting people not to kill us) would become impossible (or highly improbable, if one wants to weaken the claim a bit).

In fact, the point at hand can be attended in a different way as well: Think about our common conception of ‘disorders’ like autism or Asperger’s syndrome; the general idea behind interpreting these conditions is to think of the sufferers being unable to process expectations in the way that most people do, therefore evoking a sentiment of alienation or social awkwardness.

The ability to “fill in blanks” is an instance in which anticipation proves quite beneficial, but this does not have to be necessarily true.

However – and this deserves to be stated clearly – anticipation is not only an advantage, or a blessing (as the expression goes). As particular research on the mind has made clear, anticipation is based on our response to one situation at a time before sensory data arrives – and sometimes against incoming sense data. As a matter of fact, anticipation is most efficient when there is no sense data or only very little. This implies a selection mechanism regarding such data, which can become a habit of perception.
That at times we see or hear or smell or feel what we expect to see, hear, feel, or smell can affect our actions not only for the better, but also for the worse. We are preconditioned! We anticipate a stable, flat surface under our feet. Consequently, accidents can occur when this anticipation is not correct. The shift from the anticipated to acknowledging something that does not match the anticipated is difficult. Stand-up comedians, scientists, researchers, gamblers, stock market analysts, and athletes, among others, can testify to the difficulty with such a shift.

Instinct is yet another expression of anticipation; so are intuitions and the human propensity towards stereotyping and prejudice. Ethnic profiling, which has come into fashion since the end of September 2011, is intended to be an anticipatory defense mechanism. In reality it has been practiced for a long time, consciously or not. It has so much in common with stereotyping, and like stereotyping, it can lead to faulty anticipations. These and other mechanisms of the same nature allow us to rapidly anticipate in great detail and based on a minimum of information. But they can also result in mistaken reactions. We see here again the complementary nature of reaction – based on sense data – and anticipation – based on experience, i.e., mind interaction. As a matter of fact, anticipation is a process through which individuals are taken hostage by themselves. Our hypotheses – from very simple to complex scientific assumptions – anticipate our results. This applies to politics, religion, and ethics as well. Not unlike science and the arts, the moral code is an anticipation and also an interpretation of what it means to operate within the anticipation. It regulates and simultaneously co-creates relations among people.

Science is as difficult as any other human activity that starts from a hypothesis. We seem to be destined to circularity, and it takes a major effort to avoid it, or at least to become aware of it. (Nadin 2002, p. 105-107)

The fact that anticipation can work against incoming sense data is something we will encounter quite a bit in our discussion to follow about the nature of anticipatory processes in specifically competitive social settings. This failure (or reluctance) to let go of preconceived anticipations – to use Nadin’s words a failure to successfully perform the “shift” – is not only the source for stereotypes, but also the basis upon which another phenomenon rests, that we already touched on briefly, namely that of superstitions. Superstitions are assumptions about non-existent correlations that come to be by way of faulty anticipation.

Anticipation is the reason for our sense of being “destined to circularity” but it is also a tool – and quite possibly the only viable option at all – to work against this particular destiny, by successfully anticipating this very destiny and becoming as aware of it as we can possibly be.

Mihai Nadin continues exercising his definitions and, in consequence, raises the question of relevance in relation to his own hypotheses towards the end of his book.

Let us assume that anticipation is indeed a valid description of the world – a new physics, for those not willing to give up physics – or at least a valid description of the living. What besides awareness of anticipation can be gained from acknowledging it? If it is only a philosophic matter, why bother? The relevance, or appreciation, of philosophic speculation in today’s world is less than ever and will probably not increase. Alternatively, if anticipation is a valid research domain, what are its means of expression, its language? Moreover, what practical relevance can we await? To answer such questions presupposes more knowledge than is actually available. We would have to focus on fundamental questions at the borderline between many disciplines.

(...) That in our days science is undergoing an interesting shift from the focus on a very limited aspect
(specialization) to the richness of the overlapping border domains needs to be mentioned as encouragement for the type of research that anticipation makes necessary. Provided that interest can be stimulated, we can think of a number of applications.

(…)
Anticipatory medicine (not to be mistaken for prevention), learning, teaching, anticipatory politics (not the reactive mode it works in today), and the fields of human creativity and invention also belong to areas in which anticipation is essential.

(…)
In order to succeed, even modestly, we would have to modify our understanding of the world. Shaped for a long time by the successful but limiting description of physics, our understanding of the world, and thus of our own nature and condition, is burdened by experiences that have effectively lessened our anticipatory potential. Scientific predictions – some of extreme accuracy and with a high impact on human life and work – effectively eliminated the will to accept that there is a complementary dimension to reaction – anticipation – and furthermore, that the functional is complemented by the relational.

(…)
We have become experts in spare parts for the human body – an accomplishment that should never be undervalued, given the benefits to those who would be dead or only marginally operational. But we are far from even beginning to realize what anticipation could do for the living person who faces some form of physical handicap for which there is not yet a cure. Only in recent years, due to the spectacular advance in the study of the living, have some perspectives started to change, but not to the degree of making anticipation a goal of research. (Nadin 2002, p. 110-113)

As compelling as this passage may be – many scholars in the humanities around the world today will testify to the notion that philosophic speculation is indeed undervalued in social and scientific discourse – we have to attest that it is very hard to attribute the same category of utility to research on anticipation that we attribute to, for example, physics or chemistry, as we have to remain in the realm of the immaterial and the speculative for the most part when we deal with anticipation.

However, it is also true that we may not be shy to enter precisely this realm, if we want to study the living. Mihai Nadin acknowledges this, and it is largely due to the efforts of Robert Rosen that we know now that it is impossible to comprehend life to its fullest extent simply by way of the methodology provided by the “hard (empirical) sciences” (Cf. Rosen 1991, p. 11-24).

Before we close the lid on Nadin’s *Anticipation* and move on to examine another take on anticipation, allow me to quote the last paragraphs of his book, as they make once again a compelling statement.

As a matter of fact, the realization that the world is the unity of reaction and anticipation is not even new. What is new is the awareness of the limits of our understanding a dynamics of change that transcends the deterministic view. The necessary character of this understanding is probably best expressed in the spectacular development of the life sciences.
There might not be an icon to represent the name of the individual behind the revolution, but the revolution is under way and will, in the long run, impact the world no less than the Manhattan Project (to name a controversial undertaking) or the variety of scientific projects that the DNA model stimulated. Stem cell research is only a modest indicator of the impact of anticipation. The perspective of the world that anticipation opens justifies the descriptor “a second Cartesian Revolution.”

Instead of explaining complexity away, we will have to integrate it into our existence as the informational substratum of rich forms through which anticipatory processes take place. (Nadin 2002, p. 119)

We shall embrace this statement of his and try not to explain complexity away in the sections to follow, but take a close look at it and try to explain it, best we can.
The challenge of anticipation – anticipation and modern computation

The joint publication *The challenge of anticipation: a unifying framework for the analysis and design of artificial cognitive systems* (Pezzulo et al. 2008) offers an impressively dense overview on the subject of anticipatory cognition in computing artificial intelligence. The authors did an impressive job of putting together a broad variety of scientific endeavors that deal with the subject, and compressing those accounts into a unifying framework. Although the book is an exhausting read, more so if one is a layman to the field of artificial intelligence (as is the author of this text), it is also very rewarding in its complexity and depth. That being said I feel obligated to point out that we will only touch upon this intense piece of work in a very rudimentary way, as it goes way beyond the scope of the text at hand.

What we will do is take a look at the natural language definitions of anticipation the authors have to offer in this publication in order to try and fit them into our own understanding of anticipation.

Allow me to start this process out with a quotation from the book’s introduction.

What will artificial cognitive systems of the future look like? If we are asked to imagine robots, or intelligent software agents, several features come to our mind such as the capability to adapt to their environments and to satisfy their goals with only limited human intervention, to plan sequences of actions for realizing long-term objectives, to act collectively in view of complex objectives, to interact and cooperate with us, with and without natural language, to take decisions (also in our place), etc. Currently these capabilities are far beyond the possibilities of robots and other artificial systems. In the next years a huge effort will be required for scaling up the potentialities of the artificial systems that we are able to build nowadays. One way to overcome these limitations is to take inspiration form the functioning of living organisms. A large body of evidence, which we review in this chapter, indicates that natural cognitive systems are not reactive but essentially anticipatory systems. We do not think that this is a mere coincidence. On the contrary, we claim that anticipation is a crucial—and foundational—phenomenon in natural cognition. Individual behavior is guided by anticipatory mechanisms that are used for behavioral control, perceptual processing, goal-directed behavior, and learning. And also effective social behavior relies on the anticipation of the behavior of other agents. We argue that anticipation is a key ingredient for the design of autonomous, artificial cognitive agents of the future: Only cognitive systems with anticipation mechanisms can be credible, adaptive, and successful in interaction with both the environment and other autonomous systems and humans. This is the challenge that we anticipate for the future of cognitive systems research: the passage from reactive to anticipatory cognitive embodied systems. (Pezzulo et al. 2008, p. 3)

We see the authors proceed well along the lines that were laid out by Rosen (1985 and 1991) and Nadin (2002) illustrated in the preceding passages. They too start out by acknowledging the importance of anticipation as a principle of cognitive understanding and they even take it a
step further by stating that only cognitive systems with anticipation mechanisms can be “credible”, “adaptive” and “successful”. The notion of “goal-directed behavior” is something we have not yet encountered in this particular clarity, but rather had to deal with implicitly. This entails a very strong yet plausible claim, namely that goal-directed behavior in artificial systems corresponds to that of living systems. This holds quite some magnitude, as the thought that artificial creations might be able to navigate their intentions right along the same path humans take, seems troublesome from the very beginning (just think of the various science-fiction stories that deal with this type of subjects – they usually don’t end too well for humankind).

Also quite in line with Rosen and Nadin, they proceed to articulate dismay towards the reactive paradigm.

Reactive systems are those that produce behavior as a response or reaction to (sensed) environmental conditions and internal needs. They do not need to have a complex representation of their environment since it is sufficient for them to sense it. Take as an example a reactive driving rule: If you see the car in front of you stopping (e.g., you see the red lights indicating the stop), then press the brake. In normal traffic conditions, a reactive system endowed with this rule is able to avoid accidents most of the time. In artificial systems research, reactive rules (independently of how they are implemented) lead to efficient systems, since the computation they have to carry out is simple and cheap. However, these systems are not versatile, since they tend to have stereotyped responses, and they are not able to prepare for future conditions, but rather they have to wait for the conditions to occur first.

On the contrary, a system endowed with predictive capabilities can use the following rule: If the car in front of you is close to a crossing, then it is likely to stop, so stop in advance or at least get ready to stop when a crossing is ahead. Thus, a system endowed with predictive capabilities can take into account (possible) future events to decide on and prepare current behavior. Predictive capabilities permit even much more subtle behavior. Anticipatory systems can, for example, select an action whose anticipated effect is judged to be positive, prevent dangers before experiencing them, actively search for information that is expected to be relevant, etc. All these capabilities, that are based on processing information relative to the future, are the keys for passing from mere reactivity to proactivity and goal-oriented behavior. (Pezzulo et al., p. 6)

An additional category enters our vision at this point, namely that of “versatility”. It is indeed an astonishing quality of the human mind that it is able to function so well in a multitude of possible scenarios. But it is not humans that they have in mind specifically, but anticipatory systems in general, and from our position at this point, the question is what we can gain from looking at anything but human cognition?
The answer is quite simple: As we obviously fail to comprehend human cognition even remotely to the depth of its possible extent, we have to rely on methodological tools that are in fact available to us. Of such nature is the interest in trying to artificially reproduce defining human cognitive abilities.

There are two main reasons for conceiving cognitive minds as essentially anticipatory and future-oriented. First, cognition should be described as an active and productive activity rather than a passive stimuli-processing system. Second, representational and symbolic capabilities were only able to develop due to adaptive advantages of anticipating and dealing with the future. For this reason, the capability to form grounded representations and symbols depends on the capability to anticipate. (Pezzulo et al., p. 7)

We can extract two additional viable descriptions of human cognition from this short paragraph. First, that the human mind is active, rather than passive. This is quite relatable, as the well documented omnipresent drive towards gaining knowledge is indeed a defining quality of human beings. Secondly, they mention the ability to gain adaptive advantages by way of processing representational models. This notion is something that can be traced back to Rosen (1985) and is also very present in Nadin’s thinking (2002). And we have to admit that there is something to it: Whenever we experience empathy, it is through putting us in the position of whoever we are empathetic of, something that is best imagined as the creation of a representational model that we process and through which we “feel” as though it would indeed be ourselves.

Pezzulo et al. continue to provide us with a couple of very convincing descriptions of human anticipatory capabilities over the course of a few paragraphs within the limits of the very first chapter. We shall now take a look at these descriptions.

We humans are able to perform a plethora of anticipatory mechanisms that seem to go far beyond the capabilities of other species. We are the “symbolic species” (Deacon, 1997), which was able to develop language and rather complex social structures and cultures. Some interesting examples of these capabilities include:

We can formulate novel goals and plan in view of future needs (this includes abstract and distal ones such as having fun or becoming famous). The possibility to anticipate oneself could have lead to the capability to coordinate one’s own actions in the present and in the future, and to have a sense of ‘persisting self’.

We can formulate expectations at an increasingly high level of abstraction and can use these to regulate our actions. For example, we can decide whether or not to apply for a job depending on our expectations about the satisfaction it will provide us, the salary, the free time, the success, etc. Not only
can we formulate such abstract expectations, but we also can ‘match’ them with imaginary futures and select among them (albeit often only with a certain degree of success).

We are capable of substitution (Piaget, 1954), that is, to manipulate mentally our representations before or instead of acting in practice. Probably several animal species are able to use their internal models of phenomena for making mental manipulations, but we humans are able to use that ability systematically. A mechanic can assemble and dismantle a motor in his mind before doing it in practice. An architect can propose different plans for restructuring a house. Thanks to anticipation it is possible to deal with entities also when they are not present as stimuli: an ability that is crucial for defining an agent’s autonomy (Castelfranchi, 1995).

We can heavily modify and adapt the environment to ourselves, not only vice-versa. While other species adjust their representations to fit the actual world, we often act in the world in order to make it fit our representations of what we want, that is, our goals. Several animal species have the capability to adapt their environments, such as building a nest, but typically they do that in a very stereotypic way. We humans do not have this limitation and have heavily modified our environment to fit our present and especially future goals (Gardenfors and Orvath, 2005; Pezzulo and Castelfranchi, 2007).

(Pezzulo et al. 2008, p. 13-14)

A few notions that arise from this passage are worthy of specific note. The notion of the “persisting self” is quite interesting and also intriguing, as it seems really quite specific to the human existence that we have such strong notions of our past, present and future selves. We can become infuriated if someone misrepresents our past self in an anecdote, or become depressed when we realize that our present self is all but the future self we had conceived for ourselves. Although we certainly cannot tell exhaustively, there is a strong sense that this “timeline representation” of ourselves is quite unique to humankind.

The notion of substitution is another interesting thing to note. The ability to mentally deal with things that are not at all present physically is something that will occupy us time and time again throughout this text. It is via this ability that we are able to interact amongst each other based upon nothing more than a few intangible ideas.

We can imagine ourself [sic] in the future and reason about possible futures. Tulving (2005) has argued that the capability to engage in ‘mental time travel’ in the past and the future is a uniquely human capability. Although this view has been questioned, and it might be the case that this capability is also available to other animal species to a certain degree (see e.g. Hesslow, 2002), humans can use mental simulation with unchallenged flexibility. Moreover, recent neurobiological studies (see Schacter et al., 2007 for a review) indicate that the process of imagining future events involves the same brain structures that are necessary to form episodic memory traces. This suggests a novel view of memory, whose main adaptive advantage could be providing building blocks for mental simulation and not (only) remembering. This fact could explain the constructive nature of memory: what is needed to imagine the future is the capability to flexibly recombine information from the past rather than simply replaying the past. Although this view is quite novel in psychology and neuroscience, the relevance of mental simulation is highlighted by several research programs, including prospection (Buckner and Carroll,
Our highly sophisticated social life appears to rely on anticipatory capabilities as well, such as coordination and cooperation, perspective taking, imitation, theory of mind, and language (Knoblich et al., 2005; Frith and Frith, 2006; Gardenfors and Orvath, 2005; Iacoboni, 2003; Rizzolatti and Arbib, 1998).

We have developed symbols and a symbolic language. Various researchers (Ar-bib, 2002; Gardenfors, 2003; Gardenfors and Orvath, 2005; Swarup and Gasser, 2007) have recently discussed how anticipation is a precursor to symbolic communication and permits the evolution of symbols, and then the development of humans as the symbolic species (Deacon, 1997).


That our “highly sophisticated social life” is largely based upon processes that are anticipatory in nature or at the very least relate to anticipations will be the main focus of our project in chapter two, but we can easily invest a couple of thoughts into the subject right here.

Cooperation, imitation and language constitute three very puzzling qualities of inter-human interaction. We know that there is some form of mimicking in the animal kingdom, but the very thought of imitating another being of the same species based on some abstract quality (say, for example, idolization) seems absurd – or absurdly human, one might say. Cooperation is more relatable to the animal kingdom, but again it is something that humans really have evolved to perfection. Although it may not always show, the human ability to cooperate, to bond over the realization of a collective abstract goal, is something truly amazing. And then, there is language. We know that animals communicate and some of them may even use “words” of some kind. There might also be the possibility that animals communicate via the way of symbolic representation, but the sheer amount of representational, non-verbal devices the human species as brought forth is truly breath-taking if we think about it. Let alone the level of complexity that casual human-computer-interaction has reached is nothing less than centuries upon centuries of efforts in human thinking coming together. And yet we manage to make even more knowledge available to the following generations, decade upon decade.

The perspective that Pezzulo et al. bring to the discourse on anticipation is as fascinating as it is capacious. We have to limit ourselves in accordance with our scope (and the author has to
limit himself in accordance with the modest frame of his knowledge of computational science), hence the discussion of *The challenge of anticipation* cannot but fall short of what it would really be entitled to. It is the genuine hope of this author that this particular publication receives the attention it deserves in the years to come.
2. Social anticipation

2.1 An attempt at defining social anticipation

Now that we have familiarized ourselves with a variety of definitions of anticipation, we can move on to the very core of our undertaking, namely the attempt to establish a defining framework along the lines of the existing ones, upon which we can rest our theory of how anticipation serves to structure social reality.

Let us first start by reiterating the key features of anticipatory systems that we have learned so far, we will once more refer to Mihai Nadin’s twelve definitions, so let us review them quickly.

Definition 1. An anticipatory system is a system whose current state is determined by a future state.
Definition 2. Anticipation is the generation of a multitude of dynamic models of human actions in a given practical situation and the resolution, through a reward or punishment mechanism, of their conflict is an action. The source of anticipation is the interaction of minds, in particular through directly or indirectly shared experiences.
Definition 3. An anticipatory system is a system containing a predictive model of itself and/or of its environment, which allows it to change state at an instant in accord with the model’s predictions pertaining to a later instant.
Definition 4. Anticipation is the result of a correlation process.
Definition 5. Anticipation is an expression of the connectedness of the world, in particular of the quantum non-locality characteristic of many phenomena.
Definition 6. Anticipation is the expression of natural entailment.
Definition 7. Anticipation is a mechanism of synchronization and integration.
Definition 8. Anticipation is an attractor within dynamic systems.
Definition 9. Anticipation is a recursive process described through the functioning of a system whose past, present, and future states allow it to evolve from an initial to a final state that is implicitly embedded in it.
Definition 10. Anticipation is a realization within the domain of possibilities.
Definition 11. Feedback is a mechanism of anticipation.
Definition 12. Power laws are helpful in describing interactions between systems whose components are correlated. In nonextensive situations, correlations do not decrease exponentially with distance, as they do in extensive cases. Described in terms of nonextensive thermodynamics, long-range interactions correspond to a particular description of entropy. (Nadin 2002, p.53-96)

Our goal now is to create a methodological framework fit to the purpose of defining anticipatory processes in a social setting, so that we can identify them as such in a next step, before we eventually apply the knowledge we gained from this procedure in order to gain new perspectives on human social interaction phenomena.

In order to achieve this, we will go through each definition and alter it in a way that seems fit to our cause. As we are about to narrow down our field of exercise a bit, we can de-generalize
our vocabulary in an effort to create a more concrete terminology for the purpose at hand. We will refer to systems as individuals or agents.

Definition 1: Anticipation takes place in an individual if its current state is determined by a future state.

Definitions 2 and 3: An individual can process a variety of anticipations towards a particular future event simultaneously. A choice between conflicting anticipations is made through a mechanism of (perspective) reward and punishment reinforcement. Anticipations are gained internally or through interaction among agents.

Definitions 4, 5 and 12: Anticipations take place in correlation between the individual, its environment and interacting agents, none of which need to be physically tangible in order to trigger anticipation.

Definition 6 and 10: Each individual anticipation entails a multitude of possible realizations of which only few (if any) are transparent to the individual at any point in time.

Definition 7: Each individual - and therefore its beliefs, prospects and anticipations – is embedded in a structure consisting of other individuals and materially tangible and intangible objects, with which it is in constant interaction.

Definition 8: Individual perspective goals serve as an attractor in social anticipatory behavior. The realization of the specific goal may or may not be transparent to the particular individual.

Definition 9: Each individual holds a set of beliefs and expectations regarding its past, present and future state. These states may be subject to change at any point in time via any of the individual’s correlations.

Definition 11: Feedback-type input can occur to the individual at any point and from any source.

The reader may ask why we were able to group some of the definitions together. This is due to the narrower scope we applied to them, resulting in a de facto overlaps in meaning.
Now that we laid out the necessary conditions for social anticipation to take place, we can finally get around to exercising our framework through a variety of questions that surely have been itching us for some time now.

2.2 Anticipation and the individual embedded in society

From the very moment of our conception we are in constant interaction with the environment. It starts in the womb and ends on our deathbed. During the entire time of our lives, we interact, not only with other human beings, but with each and every being and thing that enters our mind. Amazingly enough it is completely irrelevant whether these things or beings are physically tangible or not; they don’t even need to be consciously tangible. We are constantly being influenced by a myriad of factors, while we ourselves in turn exercise impact on countless other factors. To give a simple and somewhat trivial example: The apple I buy and consequently eat can never be bought or eaten by anyone else ever again, so every potential buyer of this specific apple is influenced. Then there is the possibility that the apple was really good, and therefore causes me to visit the store it came from more regularly. Or perhaps I tell someone about my positive apple experience, eventually causing him to visit that particular store from then on and his friends in turn and so forth. We can exercise this little thought experiment indefinitely, but the conclusion will remain the same: each and every one of our actions inevitably alters the world, as slight as the change may be.

This, of course, is trivial, yet this knowledge will guide us through more complex endeavors. Consider the stock market. The influence an individual trader can take on the market certainly goes way beyond that of what my buying an apple entails for the worldwide stock market, yet it still yields only little impact. Now, let us assume our trader friend got together with nine other trader friends of his and they form a collective, say a company. By way of logical reasoning, the impact of the collective equals the added sum of each of the individual impacts,
and, for the sake of the thought experiment, we will also assume that in fact it is. Now our trader has already expanded his potential impact quite impressively, merely by grouping with other individuals. As it happens to be, one of his trader friends is really talented when it comes to lining up potent investors, while another of his trader friends has connections to higher ups in all sorts of governments. While the impact from the connections alone and the talent to locate investors respectively is not that great, the impact increases substantially if the two factors are combined. It is a safe assumption that the potential impact in this case rather multiplies than merely adds up. To round it all up, let’s assume that a third trader has access to some inside information by which he manages to acquire a well-known brand name that people know and trust. Now let’s put it all together: We have immense monetary resources, a well-established brand name, connections to influential people around the world and – last, but not least – the combined workforce of ten stock market traders. Our friend has done it; he has created a force that can change the world significantly at any point in time. He has drastically increased his initial force of impact, simply by joining forces with a group in a promising setting.

While this certainly was a neat little story, the reader may very well ask at this point why this should be considered an example for anticipatory behavior, rather than simply reactive tendencies combined with a sense of deduction. To answer this, let us try to take anticipation out of the equation.

Our trader friend still has all his initial qualities and abilities – knowledge about trading stocks, mathematical competence and an average investment potential – but he curiously lacks any ability to anticipate. Now he trades his stocks, based on what he learned and his reactive abilities, he invests in stocks that have risen for a while and gets out of those which keep falling for a while. He makes little to none net profit, when one of his colleagues asks him to join his start-up company, a collective of stock market traders. As our trader friend has no means of anticipation he finds himself puzzled over what the purpose of such a collective
could be. He looks at the facts that are immediately available to him and realizes, that by joining the collective he would lose money compared to not joining (all those costs related to starting a company) and therefore decides to stick by himself.

Because he has no sense of anticipation, he has no way of suspecting that joining the collective may prove beneficial to him even in a very short term. It is solely by way of anticipation that we can process possible future events in our mind and then conclude based upon those anticipations.

Anticipation is the principle that ties us together as interacting individuals, the principle that allows us to perform complex tasks that require sophisticated models of possible future events.

Now that we have elaborated how the individual is embedded structurally in society, let us now turn things around and take a look at the way in which individuals act as constitutive components in society.

2.3 The individual as a constitutive component in society

It has been illustrated now, that individuals are embedded in society and that their actions are largely based upon anticipations. While it may be intuitively transparent that society understood as an entity of its own is comprised by an unspecific amount of individuals, it is not quite as transparent that constitutive processes are responsible for this entity coming to be.

Let us again refer to the example of the stock market trader. While describing the transition of the trader collective the word “force” came up in an attempt to describe the amount of potential influence the collective had gained. The notion of “force” always has a rather crude sound to it, and specifically in social settings, it usually implies a sense of an overwhelmingly powerful drive that might be prone to exploitation. Having said that, and adding that we do
not want to extend on any moral inclinations at this point, let us examine for a bit, why the word “force” is adequate in this particular situation.

By grouping up and combining their ways of influence, the members of the collective were able to expand their collective impact way beyond what they could achieve individually. So much is certain, and we can safely assume that this perspective is likely to be held by the individual traders. However it seems also plausible that the collective created a force of its own, in the sense that the collective has access to a number of tools and that can serve to change the fabric of society quite substantially. If they were, for example, to focus their resources into one specific type of investment, it does seem quite plausible that this might cause other agents involved in the market to change their strategies (and hence behavior) accordingly. Doing so would not only be in reaction to the focus put out by our collective, but in anticipation of future changes in the market. In order to surprise their counterparts on the market our collective could then decide to shift their investment strategy in an entirely different direction, quite possibly causing severe fluctuation on the market and maybe even a crash of some sort - of course profiting again if they anticipate the potential crash correctly.

But we are drifting off into the realm of individual interaction; let us instead look at the bigger picture, the macrostructure in which our collective is embedded in, and how they correlate.

The market is an example for such a macrostructure; a specific nation would be another one and so forth. We can expand the picture until we reach the diffuse state where each and every individual relates to everyone and everything else, which we will call quite generally speaking society. Although there is indeed interconnectedness in such a broad sense, it is hardly ever that we refer to it, when we speak of society. For the sake of this argument, let us apply the notion “society” in this specific sense.

Individuals engage in interactive action within society. Individuals can form groups of individuals that engage in a way that differs from that which they would take as individuals without groups. Groups of individuals can in turn form clusters of their own (groups
consisting of groups, e.g. multinational institutions). The only way in which groups and clusters differ from individuals in their connectedness to society and their ability to interact within society, is the type of impact their interactions yield upon society. This impact has a quantitative dimension (the sheer amount of dealers of impact; the larger the group the larger the impact), as well as a qualitative dimension (individuals, groups and clusters are connected differently amongst each other; one may take more direct influence upon another). In regard to this qualitative dimension we have to introduce a new category of description, namely that of relevance. Relevance is to be understood as in a complementary relation to impact. Groups of little relevance may still have high impact (i.e. consist of many individuals) for example, while individuals may have little impact (being a single individual) still they may hold a disproportionate amount of relevance (think of kings, patriarchs or the pope). Actions by high-impact-high-relevance agents have a higher chance of changing the fabric of society in a substantial way. For instance, if the United States were to declare war on Iran, global policies would change drastically overnight. But the reverse can hold true as well: The 9/11 attacks are an example for a case in which a low-impact-low-relevance group (Al Qaida at that time) set actions in motion that affected society as a whole.

Individuals serve as constitutive components in society way beyond the scope of simple mono-causal inter-individual interaction. There are a variety of measures individuals can take to increase their potential influence within society, and the fact that we are sharing a world in which all agents are connected at all times, makes the fabric of society ever-changing in its very nature.
2.4 Information, surprise and superstition

Now that we have examined in quite some detail, the correlation between the world and the individual – in other words the materially tangible – we have yet to examine the functionality of the materially intangible in anticipatory processes - that is, the role of information. Information is a necessity in anticipatory behavior and we encounter it most prominently in our variations of the Nadin’s definitions two, three, four, five and twelve. Our variations were as such:

Definitions 2 and 3: An individual can process a variety of anticipations towards a particular future event simultaneously. A choice between conflicting anticipations is made through a mechanism of (perspective) reward and punishment reinforcement. Anticipations are gained internally or through interaction among agents.

And:

Definitions 4, 5 and 12: Anticipations take place in correlation between the individual, its environment and interacting agents, none of which need to be physically tangible in order to trigger anticipation.

For anticipation to happen internally, it seems quite clear that we need some mechanism of information processing, as the human brain usually does not seem work by creating something out of nothing but rather by transforming something into something else. It seems also plausible that interaction among agents requires information to be exchanged. So how do anticipation and information relate to one another?

The relation between the two is reciprocal in nature. We gather information with specific intentions (anticipations) in mind and the information we gain then triggers differing anticipations.

To illustrate our point, let us reiterate our example from above with the stock trader, who in this case is indeed quite capable of anticipation. Let us assume he has just received the invitation to join the other traders in the venture of starting up a company. Being the business man that he is, he gathers as much information as possible on the people involved and examines the premise of the business venture. He proceeds to learn that among the traders involved, there are at least two who can provide valuable assets to the group (connections and
investors), while the rest of the group consists of traders that are at the very least competent in their field of expertise. Based upon this information our trader anticipates that his joining the group will indeed prove profitable to him, despite a likely financial setback in the early stages and he decides to join the group. Not long after he learns, say from friend that also swears him to secrecy, that one of the two seemingly valuable members is in fact a fraud, but his friend cannot tell him who. Now our trader finds himself in a sticky situation, besides the obvious moral dilemma (he can only save himself and leave his colleagues to possible financial ruin, or he can stick with the group and hope for the best), there is another one embedded in this situation: Knowing that one of the two colleagues is a fraud, the success of the venture strongly depends on whom of the two his friend referred to. If the connection-trader is the fraud, the venture might still work out okay, as the showmanship and trickery the connection-trader brings to the group could in fact prove beneficial to the group rather than harmful. If, on the other hand, the investment-trader is the fraud, the entire venture might be at stake, as operating with funds that are not actually available will probably cause the company to fail. In other words, it holds little relevance whether the trader claiming to have great connections is lying, but it is highly relevant whether the investor promising trader is in fact a fraud. Our trader has to make anticipation with a high degree of uncertainty in this case.

There are more very interesting social phenomena that relate directly to the notion of information. One is that of surprise. We encountered it earlier, while elaborating on the works of Mihai Nadin, when he referred to the factors of surprise present in games such as basketball (Nadin 2002, p. 35). Indeed, surprise is also possible on a purely informational level, when we gain information that causes our anticipations to suddenly differ strongly from previous anticipations. The trader in our example surely felt a sense of surprise (among others) when he learned about the presence of a fraud within the group.
We experience surprise whenever either conflicting anticipations of which we had prior knowledge become manifest, or when we gain information that changes our perspective such that a previously anticipated goal becomes either impossible or unattractive. The fact that we experience such situations quite often in our daily routines can be understood as a concession to important role anticipations and expectations play in our existence. Every day while walking on the street, we are full of expectations and perspectives on a variety of matters; independent of whether we are aware of them consciously or whether they pertain to the realm of the subconscious.

Another phenomenon we want to look into at this point is that of superstitions. Superstitions are presumably exclusive to human beings and as such an even more attractive topic to expand thought at. Superstitions too come to be via a relation between anticipation and information – they are beliefs that are sustained purely on facts and expectations that are completely decoupled from the realm of the probable. We are careful at this point not to refer to the facts and expectations to be non-existent, as in a sense they do indeed exist. What does not exist however is a causal relation between the anticipation that is articulated in the belief and the fact that is attributed to it. Superstitions are a common phenomenon in various areas of human existence, but, surprisingly enough as the people involved are usually mathematically-inclined in one way or the other, they hold quite some presence among poker players. A common misconception in this case is that a specific card (among the deck of 52 cards used in poker) that has been dealt several times in succession is “less likely” to surface in hands to follow. While this particular superstition can actually be somewhat relatable – but still highly unlikely – in cases where cards are shuffled and dealt out manually, it becomes unfeasible in digital (online) poker, where each hand is actually created as a dedicated, separate event via computation through an algorithm.

However laughable they may seem, superstitions – just like stereotyping and prejudice, other information-related phenomena – constitute an important presence human interaction. Many
times we base our (inter-)actions upon our beliefs and quite possibly even more often, we base them upon false beliefs. I have stated in the very introduction to this work that I view the human existence as embedded in a constant mode of trial and error, and I strongly feel that anticipations – both faulty and correct – contribute a vital part to this mode of existence.
3. The game of Texas Hold’em as a playground for socialized anticipatory interaction

3.1 A short introduction to Texas Hold’em

While the game of poker has been a staple in European households throughout the last couple of decades, it is a rather recent development that it took its place in the guise of Texas Hold’em (commonly referred to as Hold’em). Other than the previously predominant variant Five-Card Draw, Hold’em relies on the concept of community cards – cards that are visible to all players and, combined with the player’s two private or “hole” cards, constitute the hands in play. In addition to the game’s betting format, which consists of four betting phases during different stages of the game, this ensures some strategic depth, while still maintaining the exciting nature of a game of chance (Brunson and Addington 2005, p. 75-84).

Arguably it is this strategic nature of the game that caused people to compare it to other high profile strategy games, such as chess or backgammon. Analogies like that often draw attention away from the fact that Hold’em is a game of chance, and lead some to the false conclusion that winning in poker is purely a matter of skill. Drawing this kind of conclusion can prove quite dangerous to a player’s bankroll, since the fluctuation in success – originating from the aspect of luck present in poker – is something a good player has to take into account at all times. The influence players may have on each other and their environment during a game is not to be underestimated, but it will never take the aspect of chance out of the game. Bad (or rather: unsuccessful) players will often draw wrong conclusions based on random events, and end up losing because of those. The ideal player is able to keep his emotions from interfering with his judgment at all times, while still being able to use other player’s emotional involvement to his advantage.

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Of course, even the most successful players are not able to keep their emotions out of the game consistently, which might be understood as a strong concession to the random nature of the game. There are bad beats, but also lucky draws, a fact that surely contributes to the popularity of poker throughout the world.

The rise in popularity of *Texas Hold’em* is synonymous with that of online poker sites, which have become a massively growing segment in the online gambling market in the past few years.\(^8\) This has also stirred up quite some controversy recently, be it the fact that online casinos were banned in large parts of the United States, or cases of cheating, alleged and confirmed.\(^9\)

Online casinos are relatively easy to run from a technical point of view, but, of course, usually subject to some legal controversy. Because of that, the big companies in the business usually operate from off-shore locations like Gibraltar (bwin.Party digital entertainment – the company behind *PartyPoker*) or Isle of Man (Pokerstars.com)\(^10\), which allows their websites to be operated practically unsanctioned.

Another major factor in the rise of popularity of poker is the growing media coverage of major tournaments like the *World Series of Poker*. Sport networks around the world have included broadcasts of poker tournaments in their regular schedules, some tournaments are even held and produced exclusively for television broadcasting.

With *Hold’em* becoming an ever growing public playground, poker is turning into an interesting environment for scientific research. Due to its accessible nature and popularity it

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offers a broad spectrum of player personalities, while still being complex enough to offer some strategic depth and room for expertise.

3.1.1 The rhetoric of poker

There is a certain type of rhetoric within the world of poker that has a history of its own (Thompson 2010, p. 241). Traditionally a game of the commoners (unlike Bridge or Baccarat)\(^{11}\), typical poker specific terms have a rather crude sound to them. People are “limping in” when they call an “unraised big blind”, as they barely seem to get themselves to it. An “inside straight draw” is often referred to as a “gutshot”, providing a rather martial sentiment. The player sitting directly to the left hand side of the big blind is referred to as being “under the gun”, a notion that seems to echo the times of the Old West, when gunslingers and bandits played poker in smoke-drenched saloons. The infamous legend of the dead man’s hand is another relic from this particular period of time, which has enjoyed a strong transition into popular culture and a firm place within it.

Other parts of the poker rhetoric draw prominently from references to the animal kingdom. Bad players who tend to make decisions, that other, more experienced, players would label “dumb”, are often called “donkeys”. An attempt to outplay such a player by luring him into a situation where he will play his cards for more than they are worth is subsequently called “baiting the donkey”.

Good players are called “sharks” as they feed on the plenty of “fish” that are in the sea, referring, of course, to the myriad of worse players that make poker profitable for “sharks” and casinos alike.

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Phil Hellmuth, one of the world’s most successful players and a somewhat iconic figure in the world of poker, also uses animal rhetoric to establish certain (stereo-)types of players in order to provide a tool for classifying certain players.

The mouse is like your old aunt Edna, a conservative type who probably wouldn’t even approve of your reading this book. […] The mouse hardly ever raises someone else’s bet; but if he does raise, look out, because he has the goods!

The lion is a tough competitor who plays fairly tight poker but doesn’t limit himself to the top ten hands. He bluffs with excellent timing and seems to know when the other players are trying to bluff him. Though he plays pretty tight, he’s occasionally out on a limb with a bluff or a semibluff. You could do worse than play like the lion.

The jackal is loose and wild, and some days it seems as though he’s just giving his money away. Because he’s involved in so many pots and raises so often, his play can take some pretty big swings. The jackal’s logic seems at odds with the logic of all the other players […] If a jackal runs hot by catching good cards for a while you may become convinced that he’s the best player in the world, but when his cards come back to earth, he can lose money as fast as he won it.

The elephant is fairly loose (which means he plays a lot of pots) and seems to be from Missouri, the “Show me” state. He’s what we refer to in poker as a “calling station”: he never folds when he is supposed to fold, because he doesn’t ever believe that you have the goods. […] The elephant isn’t very sharp and isn’t a very dangerous opponent for most players, but he seems to do well against the jackal, because the jackal keeps on trying to bluff the elephant.

The eagle is a rare bird, and you might not ever play with him, because he’s one of the top 100 poker players in the world. You’ll find the eagle wherever high-stakes poker is played. He flies around high in the sky and swoops down to eat other animals’ chips when he’s hungry! (Hellmuth 2003, p. 33-35)

This passage is filled with interesting bits for us to analyze in our quest to better understand the reciprocal nature of the relation between poker specific vocabulary and common practice language.

He gladly uses common anthropomorphic conceptions of animal stereotypes, like the shy
mouse, the dumb, slow-witted elephant, or the rare but deadly eagle. Those are familiar pictures we encounter time and time again, be it in children’s books, fairy tales or jokes. Our daily rhetoric is filled with these kinds of metaphors, so it seems to be a somewhat practical move to make use of them while theorizing poker. Hellmuth’s animal type metaphors are somewhat less martial than the rather grim image of sharks eating the fish in the sea of poker, as his eagle makes a point of eating the “other animal’s chips”, rather than the animals themselves.

The picture of the elephant being a “calling station” is another interesting thing to note. It stems from the act of putting up an equal amount of chips in order to stay in the hand, which is referred to as “calling a bet”. A calling station therefore is a player who is very reluctant to let go of his hand and hardly ever believes that he is really beaten. This kind of attitude is often looked down upon, particularly by good players, and often times the term “feeding” chips to another player comes up in this respect as well. Another term that is usually used relatively derogatively, certainly more derogatively than Hellmuth’s use to illustrate the jackal’s wild nature, is “giving away money”, which comes close to being an insult among poker players, as losing more money than necessary in a hand is considered rather bad play.

Another interesting point is raised by Hellmuth as he mentions that a jackal “running hot” may appear to be the “best player in the world”. Clearly, the jackal in that case is on a winning streak, a phenomenon that is both interesting and important to look at when we want to investigate the social nature of poker and gambling in general. Catching a couple of strong hands in a row will inflate the confidence of a player (more so that of inexperienced players) and simultaneously discourage other players from participating in hands, as they choose to disengage due to the presence of their seemingly unbeatable adversary. But overconfidence is a double-edged sword in the game of poker, as Hellmuth also implies, when he says that the jackal “can lose money as fast as he won it”.

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This also indicates another noteworthy aspect in the poker discourse, the honoring of long-term success. It is the single most important feature to a professional poker player’s confidence to be profitable in the long term. While luck may come and go, the notion upheld by virtually all pro players is that only skilled players can maintain a profitable long-term record. Hellmuth dedicates the first chapter in his 2003 book to debate the presence of skill versus luck in poker, the essence of his argumentation being, that skill becomes the predominant factor over the long haul the higher the stakes are.

Now that we have familiarized ourselves with the game of *Hold’em* and learned a few things about the mindset of professional poker players, we can move on to the key interest we shall pursue in the course of this study: what kind of insight can we gain from taking a close look at the game of poker as a social microcosm of interacting human beings.

### 3.1.2 Understanding poker games as a social microcosm

The necessary conditions under which a game of poker can take place are fairly easily achieved. It requires at least two players (up to ten per table), a deck of 52 playing cards and some representational vehicle to make bets with (predominately plastic chips of various colors). Apart from these physical requirements it is, obviously, integral that the players involved agree upon a predefined set of rules. In poker this mostly determines the possible methods of combining cards to form hands of different strengths, and how much players are allowed to bet and when.

These regulations mostly serve the purpose of ruling out some exploits like players being able to obviously give away their hands before their turn or being able to win by simply putting up (or having access to) more money than their opponents. Naturally the latter point still remains...
somewhat present, since the amount of disposable income a player has access to determines at what kind of stakes he can play. It will always be impossible for someone who earns minimum wage to play at a game which has an entry fee that is probably ten times the minimum wage, but if a player is putting up the amount in question he is guaranteed the same treatment as someone who can put up the amount multiple times, solely by the regulations of the game.

So by engaging in a game of poker, the players involved agree upon a certain set of rules that disengage them from a majority of entitlements in the reality outside the game, but also bind them to certain regulations and entitlements within the realm of the game, such that a player cannot gain advantages in the course of the game, based upon his situation in the outside world.

In the game of poker, the environment embedding the players is constantly changing since the players themselves can take influence by betting, and therefore manipulating the amount of money involved (and, of course, by verbal and non-verbal communication, but we will not take this fact into account for now), while the dealer is changing the environment by dealing additional cards, so in turn both provide information to the players and change their perspectives.
3.2 An example hand in Hold’em

In order to better illustrate these proceedings, let us take a close look at an example hand in a game of *Hold’em*.

The game is *No-limit Hold’em*, in which players can bet any amount up to the entire amount of chips they are currently holding. There are ten players involved numbered clockwise with player one (P1) being left to the big blind, while the big blind is player ten (P10). The blinds are 1$ (small) and 2$ (big), while the hole cards held by each player are as follows:

- P1: Ace of Spades and Ace of Hearts (AsAh)
- P2: Deuce of Clubs and Deuce of Diamonds (2c2d)
- P3: Ten of Hearts and Three of Hearts (Th3h)
- P4: King of Clubs and King of Diamonds (KcKd)
- P5: Seven of Spades and Seven of Clubs (7s7c)
- P6: Queen of Diamonds and Jack of Diamonds (QdJd)
- P7: Six of Hearts and Five of Hearts (6h5h)
- P8 (dealer): Ace of Clubs and Jack of Spades (AcJs)
- P9 (small blind): King of Hearts and Nine of Spades (Kh9s)
- P10 (big blind): Ten of Spades and Ten of Clubs (TsTc)

Each player holds 200$ in chips (100 times the big blind, a common limit for the starting amount of chips at a *No-limit Hold’em* table).

3.2.1 Before the flop

P1 is first to act, as the blinds are paid before the cards are dealt, meaning that P9 and P10 will be allowed to act only after the dealer (P8) has acted in this round of betting. P1 is holding the best possible hand at this point (two aces) in the worst possible position (first to
act), and in many instances he would bet at this point. However it is a somewhat common strategy to only call in this position, given that aces beat every other hand at this point and a strong bet would probably discourage players from entering this hand and limit possible winnings. So in this hand, let us assume P1 simply calls the 2$ to match the big blind. P2 is facing a somewhat easy decision as his pair of deuces is not too strong on its own, and the early call by P1 almost certainly indicates a stronger hand. If it was guaranteed that all other players would also join in before the flop for only the big blind, calling the 2$ could be cost-efficient, but in most cases P2 will fold in this situation, and we will assume that as well. P3’s hand is rather weak, as it has no connecting potential for a straight (3 and 10 can never be in the same straight) and it would only make a ten-high flush (if the community cards would provide 3 additional cards of the hearts suit). However, players often tend to overextend on suited cards (2 cards of the same suit) and we will therefore assume P3 calls. P4 is holding the second best possible hand (two kings) and has a position advantage over half of the field (P1, P2, P3, P9 and P10), so he has a variety of options at this point. He may simply decide to call as his kings are strong against a lot of possible hole cards and there are already two calls in front of him. However kings are vulnerable to basically any hole card combination that includes an ace if another ace comes up in the community cards to form a stronger pair. In order to protect his hand against such hands, P4 may contemplate a raise at this point. We will assume that P4 calls and raises by twice the minimum bet, making the bet to call 6$.

P5 holds an above average hand in a mediocre position and just witnessed a strong raise in front of him. Given the hands of the other players, his chances of winning the pot are limited, as he is up against stronger pairs already and even P3 can outrank him, if he hits a ten with the community cards. The best move in this position would be to fold, as the pot (13$) is only slightly more than double the amount he has to call. Even if his chances of winning are small, calling would be a good move, if he were guaranteed that more players will get involved in
the pot, therefore creating a large pot, multiple times the amount of what he has to contribute. We will assume that P5 is feeling lucky and calls the 6$.

P6 holds a weak hand against the two strong pocket pairs (meaning a pair in the hole cards) already involved, but has a good drawing hand for both a flush and a straight. If P5 had folded his hand, the decision would be easy, as the pot would be small enough to just fold this hand. But since P5 significantly beefed up the pot and the chances of winning with either a straight or a flush are very good, calling is actually a good move for P6. P6 calls bringing the pot to a total of 24$.

P7 also holds a drawing hand, but a much weaker one. The pot is big enough for him to consider a call, but neither his possible straight nor his possible flush is very strong. If, for example, he were to hit a 9-high straight, with his two hole cards forming the bottom part of the straight, he would be trailing against a hand like JT. We will assume that P7 folds his hand, even though he has a strong position advantage.

P8 holds a good drawing hand, simply because hitting an ace gives him the strongest single pair and the jack is a very valuable complimentary card. More importantly, however, he holds the best possible position in the game, as he is the last to act and can react to the other player’s moves. This makes a call in his position a good choice, as the pot is already 4 times what he has to put up. P8 calls, simply due to position advantage.

P9 holds an acceptable hand, but in a very weak position (he will be first to act after the flop and every subsequent round of betting). So, although he has already contributed to the pot, he will be best off folding his hand, more so if we take the other players hands into account (there is only one king left in the deck, for example). He would have to call for 5$ which at this point is roughly 1/6 of the amount in the pot, so a call isn’t the worst move on his part, as the decision to fold will be easy if his cards do not connect later on. The decision here mostly depends on whether the player thinks the pot will be raised again, as he definitely wants to get in cheap or not at all. We will assume that P9 folds his hand.
P10 holds the best non-figure card pair which is a very good hand in itself. He has already contributed 2$ to the pot and stands great chances of winning if he hits another ten with the community cards. He faces a rather easy decision as he has to bring up 4$ for a chance to win 31$.

As their bets were raised, P1 and P3 are still allowed to act in this round of betting. P1 could reraise the 6$ significantly at this point in an effort to thin out the field, which in fact would be a very good move, as he does not want to give drawing hands a chance to beat his aces and needs to try and force them out of the hand, by making a call unprofitable for them. However, looking at the flow of this betting round, many players might just want to call and look at the flop, trying not to overcommit by getting too much money in, if their aces might in fact be outdrawn. We will assume that P1 just calls, adding 4$ to his initial call.

P3 faces an easy decision. His hand is certainly not strong enough to merit a raise here, but the pot is already very large and he can see the flop for a relatively small amount. It’s a hit or miss situation for him, where he stands to win a lot if he in fact hits. P3 calls the 6$ bet.

So before the flop we have 7 players remaining in the hand and the pot has reached an amount of 43$ or 21.5 times the big blind.

3.2.2 After the flop

The flop comes down: Ace of Diamonds, Queen of Clubs and Seven of Diamonds (Ad Qc 7d) P10, the big blind in the initial round of betting, is first to act. These cards are bad news for him, since two cards came up that outrank his tens and potentially connect for a higher pair. With 6 other players in the hand his chances of winning are limited and folding his hand is the right move. However, since he is first to act, he has the possibility to check, passing the right to act to the next player, while still remaining in the hand. P10 will check at this point.

P1 holds the strongest possible hand at this point, three of a kind aces, since the cards on the
flop do not connect for either a straight or a flush. His strongest concern at this point is that someone might have two diamond hole cards (which P6 in fact does) and could possibly connect with the remaining community cards (the turn and the river) to complete a flush. P1 certainly wants to bet his hand, but has to be concerned about maximizing his gains, so he decides to just check, anticipating that at least one of the five remaining players will make a bet, which he in turn can raise.

P3 is in a worse spot than P10 and will certainly let his hand go. However, since he still can, he just checks.

P4 has encountered the treaded ace and is in a tight spot. He does hold the King of Diamonds, so if two more diamond suit cards were to come, he would hold the best possible flush. Since he bet out strongly before the flop, he may choose to bet again and represent having hit an ace. However he has virtually no chance of winning against P1, since he would need two more kings (one of which P9 folded earlier) to make four of a kind or two more diamonds to complete a flush. Still, if he wants to stand a chance at the pot, he has to make a bet here, which is a likely move since players are often reluctant to let go of very strong pocket pairs. P4 bets 20$, roughly half the size of the pot, trying to continue his display of strength and forcing players out of the hand.

P5 is in a particularly bad spot; he has connected and now holds three of a kind, but he is trailing badly to P1. He is virtually drawing dead (a circumstance under which no upcoming card can help against another player’s hand) as only the Seven of Hearts can save him. Both players do not have a diamond suit card in order to make a flush and both hold three of a kind, so any pairing of the board would give P1 the better full house. Of course P5 does not know that and three of a kind is a very strong hand, so he is likely to raise here. P5 raises the bet by 20$, making it 40$.

P6 has a strong draw, as any diamond suit coming up will give him the second best possible flush (a flush including Kd being the stronger one). He has to put up 40$ however, which is a
lot, as the pot is 103$ at this point. There is still the possibility that more players will call the bet, and if so, he stands to win a lot, should his flush connect. P6 calls the 40$ bet. P8 has hit his ace but he has every right to be cautious, as he is behind against many rather plausible hands at this point. Plus the bets and calls so far indicate strong hands involved. Folding his hand at this point would be a good and a smart move, however many players are likely to hold onto their hands in this position. We will assume P8 is a cautious player who folds at this point.

P10 will fold his hand as previously indicated.

P1 now faces a tough decision. He can decide to let the pot build up even more, by just calling the bet, not giving away the strength of his hand and luring players into paying off at the risk of allowing draws to hit, leaving him empty handed in the end. P1 will again just call, deciding to play his hand slowly.

P3 folds and P4 calls, not willing to let go of his kings just yet.

The hand goes on with four players remaining and 203$ (101,5 times the big blind) in the pot.

3.2.3 After the turn

The turn comes down: Three of Diamonds (3d)

P1 has been punished for his pretentiously cautious play, as the dreaded flush is now on the board. With four players remaining in the hand and a pot of considerable size, he has to assume that someone has in fact made a flush. But his three of a kind is still rather strong, and chances are that he still has the strongest hand. Plus, the board pairing (another queen, seven or three on the river) would give him the edge over a flush. He decides to finally throw some aggression into play and bets 60$, slightly less than a third of the pot.

The situation for P4 has not changed much. His only hope still lies in a flush, which he hasn’t made yet, and there is another player sporting aggression now. He has to assume he is beaten
at this point, and the bet is too large to make it worth for him to just look at the river. With a heavy heart, P4 lets go of his kings.

P5 is in a similar position to P1, but was the source of aggression in the previous round and has to wonder why P1 started out aggressively on his own now. His hand still beats any two pair hand but loses to a flush, which P1 clearly represented with his bet. As P5 has been rather reluctant to let go of his hand so far, he is consistent with this type of behavior and decides to call the 60$ bet.

P6 clearly is in a comfortable spot here. He has a very strong flush and has to wonder mostly how to get most out of this hand. He decides to just call thinking that P1 hit a weaker flush and will pay him off at the river.

We move on to the river with three players remaining and a pot of 383$ (191,5 times the big blind).

### 3.2.4 After the river

The river comes down: Seven of Hearts (7h)

P1 has been rewarded for his aggressive play at the turn, or so it would seem. Little does he know that P5 in fact hit the one possible card that could win him the hand. Of course the only way to play this hand now from the perspective of P1 is to gain as much as possible out of it. He can either bet an amount that is easy for the others to call due to the size of the pot or he can check, anticipating that whoever made the flush will place a bet, which he in turn can raise. As P1 was acting passively when he was in front before, we will assume that he checks his hand here.

P5 is in the best spot he could be in: as the last card has been drawn, he has the best possible hand and the pot as already grown to an exceptional size. His goal here is to make as much money as possible. He has to bet, there is no way around it: if he decides to only check, he risks that P6 also checks on his end, leaving him with just the money currently in the pot. He
has to size his bet such that it is hard for his opponents not to call it. His goal has to be to make them want to see his cards badly enough so they will pay his bet. We will assume that P5 bets 60$, the smallest amount he can bet at this point, but roughly two thirds of the remainder of his chips.

P6 still has a good flush, but has to be worried about the board being paired now; even a hand like Q7 would complete a full house, which beats his flush. Folding his hand here would be a very strong move, hardly ever will a player be able to let go of a strong flush in such a big pot.

We will assume that P6 calls the 60$ bet.

P1, still only concerned about how he will get the most out of this situation, gladly raises the bet by the remainder of his chips, 34$, putting him all-in (meaning he cannot bet anymore because he has no chips left) making the final bet 94$.

Given that all players started this hand with the same amount of chips (200$), P5 calls the bet (obviously, as he knows he has the best hand), and P6 folds his hand because he is certain his flush is beaten at this point. Actually P6 could call the 34$, as the pot size of 631$ provides enough justification to do so.

So P5 takes down a 631$ pot (315,5 big blinds), more than three times his commitment of 200$, with four of a kind sevens over P1’s full house aces and sevens.

3.2.5 Analyzing our example hand

Now that we have established an example hand to work with, let us take a look at the decision processes occurring in each of the individual agents during the course of the game. Admittedly, the hand fabricated here is a particularly drastic incident, and it should be noted that pots that size occur rather rarely, though it is certainly not impossible.

In our example hand there are a few decisive points that change the flow of the game significantly and in consequence cause the amount at stake to grow drastically.
• **P5’s decision to call P4’s bet before the flop**
  This move was the first really significant move of the game and weighed more than P4’s earlier raise. By calling the bet in this early position P5 increased the pot by almost 50% from 13$ to 19$, making it much more interesting for players with good drawing hands to get in for a relatively small amount. Had P5 not called, the decision would have been much harder for P6 and P10 later on. This call alone contributed to seven players staying in the hand before the flop and creating a large initial pot.

• **P1’s decision to check his hand on the flop and P4’s decision to bet half the size of the pot on the flop**
  Although the flop itself was certain to provide a lot of action, with two three of a kinds and a strong flush draw coming up, it was P4’s decision to carry over his aggression from before the flop that caused the pot to grow significantly there. His bet brought the minimum raise up to 20$, a raise P5 performed in the very next move. With P1 and P6 sporting very strong hands as well, the pot was destined to become massive from then on.

• **P5 calling P1’s bet on the turn**
  By calling P1’s strong bet, P5 committed himself irreversibly to the game, as he had put up too much to let go. This was a bad move statistically, although it was to be rewarded with him hitting the sole card that could help him on the river. Had P5 folded his hand there, P6 probably still would have called P1’s bet, but the pot would have turned out significantly smaller, lacking the 60$ from P5 at the turn, and the 94$ on the river.

Although the environment provided by the nature of the cards in this game certainly played some role, the key reasons as to why the pot grew so tremendously were given by the players involved and their decisions. Bad or illogical decisions by even a single individual player can cause the entire structure of the game to change, as moves that were not profitable before suddenly become reasonable options. This is why poker provides a fascinating framework to look at individual decision making because the components that contribute to these decisions are constantly subject to change, be it by chance, as a certain card may come up or not, or socially, as the behavior of an individual player significantly impacts that of other individuals involved.
The decisive moments throughout the course of our example hand can be traced back to a few individual errors, or rather incongruities, that caused the other individuals to reevaluate their situation and alter their decision making process. This is what we want to extrapolate from this example: that the game of poker is to be understood as a dynamic social structure, which is constantly fluctuating and reflecting the actions and decisions of its individual agents.

### 3.2.6 Anticipatory thought processes in a poker game

Now that we have established an example hand and analyzed it in quite some detail, we will once more refer to this example and take a specific focus at how anticipation functions in an individual player. In order to do this, we will take on a first person perspective of a specific player and examine his (potential) individual thought processes in respect to their anticipatory or reactive nature.

We will go through each stage of the game and take a look at the information that is presented to us at this specific point in time by the factual environment (cards dealt), the social environment (player interaction) and individual anticipations (probability evaluations, anticipated player behavior).

In order to do this, we will assume the role of P1 in an iteration of our example hand under the premise that the cards dealt and player actions are identical to those presented in the example hand, while the actions of P1 may be subject to change, based upon the reasoning we will encounter during our re-evaluation of the hand.

#### Before the flop

While we find ourselves in the strategically worst position possible at this point (being first to act), it is also the position in which anticipatory reasoning becomes most apparent in its usefulness. We hold two aces (AsAh), the best possible combination of hole cards in Hold’em. Since we are already holding two of the four aces available in the deck, it is quite
unlikely that another player is holding an ace, and even more unlikely that there is another player holding two aces in the player field. We can also deduce from our hand that it is less likely that another ace turns up in the community cards, which limits our chances of hitting another ace, but also significantly lessens the chance of an ace-high flush or straight to appear in the course of the game.

So, to sum it up: We know that there is no hand that can beat us at this point, and we know that there is only one (very unlikely) hand that can tie with us. We also know that there are nine more players to act in front of us, and that it is very likely that among those nine, someone is holding a strong enough hand to be willing to go up against us, which is exactly what we want, simply due to the fact that we are likely to be ahead of anyone. However, as implied in the example, our biggest worry at this point is how to get the most out of this situation, which is obviously very much in our favor. At this point we are left with no other option than to deal with unapparent information, expectations and anticipations. This also marks a point where we have exhausted what we can gain from the factual environment (we only know about our two aces at this point) and are limited to information we can extract from the social environment and our individual anticipations. As for the social environment, the amount of information is also somewhat limited as we are first to act and no other players were yet able to interact with one another in the domain of the game. If we assume that this is the first hand we ever play at this particular table and that we do not know anything about our opponents (other than their names or physical appearances) – which is quite common in online games where people are usually represented by mere nicknames that they choose themselves – we are indeed left with very little information to work with, as there is hardly anything we can deduct from the social environment. Of course we can look at the individual facial expressions, body language and other conscious or unconscious gestures, but those kinds of deductions may prove unrevealing (hence the common language expression ‘poker face’) or even misleading (‘bluffing’, another expression that found its way well into common
language). In other words, they lead to anticipations with a certain degree of uncertainty and it is precisely this operating with uncertainty and (false) information that makes poker a game, in the sense that people enjoy playing with one another in the form of a positively experienced pastime.

But, to move back to the example at hand, we are indeed faced with a variety of options and an extensive amount of anticipations coupled to those very options. For one we may consider betting a significant amount of chips at this point, anticipating that only players with sufficiently strong hands will call our bet, therefore causing a decrease in the amount of players involved before the flop and increasing our chances of winning the pot, as we are currently winning against any other possible hand. Another option worth considering is to only bet the minimum amount in an effort to “lure” more opponents into playing their (possibly weak) hands, by increasing the size of the pot, while not representing as strong a hand as we would represent by placing a larger bet. In this case we anticipate that more players involved will lead to a larger pot size while also limiting our chances of winning the pot (the more players are involved, the higher the chance that our pair of aces eventually gets beaten). Our anticipations at this point are not only based upon our own hand, but even more so upon the perspective actions of other players and our interpretation of information that is available to us at this specific point. If we know, say by way of past experience or gesture interpretation, that the field consists mostly of conservative players who are very likely to fold against an early bet, our anticipation might be that a strong bet will eventually cause us to lose money we could have won, had we not ‘scared’ our opponents out of playing the hand. On the other hand, if we can assume that the other players are more likely to play weaker hands, we can anticipate that betting out strongly may be the better move, as it serves to reduce the number of players involved, potentially creating few but highly advantageous match-ups against players with strong hands that are still losing to our aces.
So it becomes apparent that there is no single right move at this point but rather a variety of options which correspond to our anticipations. There is one definitively bad move at this point, which is to fold the hand. The conclusion that this is a bad decision can however be reached via strictly reactive reasoning: From the fact that there are only four aces among the fifty-two cards in the deck, we can deduce that two aces are the best possible hand before community cards are dealt, hence, in reaction to us having the best possible hand, we have to conclude that getting involved before the flop is necessarily a profitable move. It is only by anticipatory reasoning however that we can come to a decision whether calling the bet or raising it is a better move.

For the proceedings of this example we will assume that we just call the bet in P1’s place, as he did in the initial instantiation of our example hand.

**Before the flop, second betting phase**

[player actions so far: P2 fold; P3 call; P4 raise to 6$; P5 call; P6 call; P7 fold; P8 call; P9 fold; P10 call]

At this stage the factual environment has not yet changed (two aces are still the best possible hand) while there has been some significant action in the social environment that in turn influences our individual anticipations.

From the action so far we can draw several conclusions with a varying degree of certainty. We know that P3 holds a hand with which he wants to see the flop which can either be a pair of some sort or a drawing hand that becomes strong if it connects with the flop. We know for a fact that he cannot possibly hold a stronger pair than we do, and we can assume that he would have raised the bet, if he was holding a strong pair. So, with a relatively high degree of certainty, we can anticipate that he will fold his hand if he does not hit matching cards on the flop and call or raise if he does so in turn.
We also know that P4 likely holds a hand that is stronger than that of P3, as his raise indicates that he is indeed holding a strong hand in which he wants to invest. The fact that he raised from an early position leads us to the assumption that he is not bluffing as there are still six players to act in line behind him (who can potentially raise his bet) and the amount he could win from a possible bluff (two bets and the blinds – 7$) seems too small in order to warrant the sum he put in (6$). So our anticipation, still with a relatively high degree of certainty, is that P4 is on a strong hand and will likely call if we were to raise his bet before the flop.

P5’s call is an action that entails quite a bit of uncertainty; in other words: we cannot quite know what to make of it. It could be the case that he is indeed on a strong hand (a figure-card pair) or a strong drawing hand, or it might very well be the case that he is just willing to gamble for the fun of it at this point. He is obviously willing to invest in his hand in order to see the flop, but his call does not point us into any direction as to how strong a hand he is holding. Those situations, in which we have to operate with a high degree of uncertainty, are interesting showcases for anticipation, as we have to rely on information that goes beyond the realm of the factual (for example, in this case preconceived behavior-patterns) in order to successfully deal with the situation at hand.

P6’s call points into a similar direction, but with an even broader spectrum of possible hands, as the growing pot contributes to hands with smaller expectation value (e.g. drawing hands and small pairs that are only strong if they connect with the community cards) becoming profitable to call with. We can assume that neither P5 nor P6 are a threat to us at this point (this can be done purely reactively), but we anticipate that either of them sporting aggressive play after the flop does indeed indicate a threat, in the guise of a potential drawing hand coming to fruition.

What held true for P6 also holds true for P8, even more so as he is in the best possible position (last to act in every consecutive round of betting) which extends the amount of profitably playable hands even further. We can anticipate that he is very likely to call with any
half-decent hand and that he is likely to bet or raise if he holds a strong hand, as he will be aiming to get as many players out of the hand as possible. As he only called, we have to assume that his threat is only of potential nature, as was the case with anyone else yet (as we are holding the strongest hand at this point).

That P10 calls from the big blind is something we could also anticipate with a high degree of certainty, considering the size of the pot and the fact that he was already forced to invest into the hand by way of the big blind. His call indicates that he has at least an average hand, one with which he does want to see the flop, but which he does not consider strong enough to merit a raise in his position (which will be first to act in every consecutive round, as P9 already folded his hand). Calls from the big blind usually infer the highest degree of uncertainty, and information can usually only be gathered by means outside the factual environment. As the big blind is also in a pre-conceived position towards the game (he has a mandatory commitment to the pot before he is allowed to view his cards), the player has the opportunity to somewhat conceal the motivation behind his game-internal actions, as it remains open to the players’ interpretations whether his pre-commitment was a factor in his decision or not. In a sense the blinds are another element of surprise and uncertainty that is integrated into the game (alongside the element of chance in the dealing of the cards) in order to produce fluctuation in player resources (chips) that in turn stimulates interaction and forces players to face decisions (creating a sentiment we usually refer to as excitement or even thrill).

Now that it is our turn again, and having witnessed a variety of player moves since our initial call, it is time to re-evaluate the situation and adjust our anticipations accordingly. We know that at least P4 holds a very strong hand and that we are facing many players with potentially strong hands once the flop has come down. As folding the hand is not an option (as explained above) we are left with the possibility to either call P4’s bet, which would mean a rather small investment compared to the sum we are to win possibly, or to raise the bet further potentially
driving players out of the hand and therefore increasing our chances of winning. The situation we find ourselves in can be understood as a trade-off between either increasing our chances of winning at the expense of our possible earnings, or increasing our potential gain by also decreasing our chances of winning (simply calling, leaving the field of players as it is). Our anticipation here is that we cannot force enough players out of the hand to further our chances of winning - which are already the highest possible at this point – so substantially that a deeper commitment to the pot is worth the potential risk of losing to a weaker hand after the flop. For example if the flop offers no connectivity for us and at least two players remain aggressive at the flop, that constitutes a strong indication that our aces are in fact beaten and with slim to none chance of winning later on. If we commit to the pot strongly now, our loss will be more substantial if this scenario came indeed to be, while our potential winnings if we remain passive (not indicating as strong a hand as we in fact hold towards other players) may even increase as players might be tempted to try and force us out of the hand.

While it is certainly not the only possible move, but the most plausible, based upon our anticipatory reasoning, we will simply call the 6$ bet (as P1 did in our initial example). With P3 also calling we move on to the flop.

**After the flop**

[The flop is: Ad Qc 7d]

P10, the big blind, checks, passing his right to act first to us. The flop has produced another ace, giving us the strongest possible hand (three of a kind aces) once more and definitely ruling out the possibility of another player holding the two remaining aces (the one hand that would be tied with us pre-flop). This situation is particularly great for us, since we chose to remain passive before the flop and have therefore not indicated the strength of our hand towards our opponents, while our chances of winning have increased substantially. There is some threat from a possible flush (another diamond suit card, one of which – Qd – would give
us a full house, effectively rendering the flush worthless), but our chances of winning are still very high. From the factual environment we can conclude that ten out of thirteen diamond suit cards can complete a flush, and even then two of those cards would have to be held by a player, so the chances for another diamond suit to come up are not too big as only 8 out of 52 cards meet the requirements. From the social environment we can conclude that it is rather likely that at least one out of the remaining five players will place a bet, given that they did bet and call respectively before the flop and that we did not imply any strength on our part. Anticipating that there will be at least one more bet coming up in this stage, we decide to simply check our hand, giving us the possibility to either raise or call the bet in consequence. P4 indeed places a strong bet and P5 raises it even further, indicating a very strong hand on his part. In addition P6 calls and makes the pot even bigger, and with P8 and P10 folding, we are left with a lot of new information from the social environment to deal with. We know for a fact that our hand is the strongest at this point and have to contemplate what we have to gain by making that kind of strength apparent (by re-raising P5’s bet). It is very unlikely that all three remaining players will fold to a potential raise from us, so there seems to be no way around letting the turn and the river come to be, which are the only possible threats to us at this point. So the question is whether we want to try and maximize our gains at this point, or whether we still want to preserve the potential to cut our losses if the flush indeed comes up and ends up beating our three of a kind. Anticipating that it is impossible for us to win this hand right here, we decide to just call (as was the case in our initial example) in an effort to try and keep our potential losses at bay at this stage of the game where uncertainty (towards the appearance of additional community cards and the hole cards of the other players respectively) is still a very present factor. With P3 folding and P4 calling we move on to the next stage of betting.
After the turn

[The turn: 3d]

This card yields trouble for us, as we no longer hold the strongest possible hand. Any combination of two diamond suits as hole cards beats us now and among the three other players it is quite likely that at least one of them holds a flush now. However we have already committed too much to the pot in order to simply let go of our hand, so an informed decision has to be made. From the factual environment we draw the conclusion that our hand is no longer the best possible hand, and from the social environment we know that it is quite likely that at least one of our opponents was speculating on a flush to come around. So the knowledge we really need at this point is whether someone in fact made a flush or not, and we have to formulate a strategy in order to ascertain this particular knowledge. If we merely check at this point, we stay quite in ‘character’ with what we represented so far but we also open up ourselves for the possibility to be bluffed out of this hand. It is still quite possible that a player holding a weaker flush may be forced out of the hand by a strong bet at this point and besides that, our three of a kind aces still beats most other possible hands. Plus there is still the possibility for the board to pair, giving us a full house and the edge over any flush. Anticipating that a strong bet on our part will cause our opponents to think we hold a strong flush and possibly forcing them to let go of a weak flush, we decide to place a bet of 60$ definitely representing strength while also leaving us some room to let go of the hand if we are indeed beaten.

P4 folds, while P5 and P6 call our bet.

After the river

[The river: 7h]

The river card gives us a full house – aces and sevens – putting us beyond any possible flush. As neither a straight flush nor a royal flush is possible, the only hand that can possibly beat us
at this point is four of a kind sevens. Judging from the factual environment, it is very unlikely that a player indeed holds two sevens while the other two sevens are on the board and from the social environment, the main aggressor through the early betting rounds was P4 who already folded his hand, so it seems likely that both P5 and P6 are sitting on flushes or even just flush draws. However P5 went over the top of P4’s bet after the flop, which does indicate either three of a kind or a strong draw on his part, as a bluff from his position at that point seems rather unlikely. Anticipating that we hold the strongest hand (judging from the mere mathematical improbability of someone holding four of a kind) our goal must be to get as much out of this hand as possible. In order to achieve that, we can either check at this point, anticipating that one of the two remaining players will place a bet, or we can place a bet on our own, sized such that it is mathematically intriguing to the other players to call on their part. We will check at this point (again in line with the initial example) as it seems likely that either of the two players will place a bet, at the very least to try and bluff his way into winning the immense pot.

The rest of the story plays out as illustrated earlier, P5 bets out the minimum bet, P6 calls and under the impression that we still hold the strongest hand we raise the bet for the remainder of our chips, eventually losing our entire initial buy-in.

Now the question is: Did anticipation fail? In a way, it did. The majority of decision we made in the course of this example were “good” decisions, and they largely were the result of anticipatory reasoning. However it would have also been by anticipation that we could have avoided the substantial loss in the end. P5 did give us clues as to which hand he was holding, his call after early aggression by P4 indicated that he was holding a hand that needed to connect with the community cards, and the fact that he went over the top of P4 on the flop was an indicator that he hit something stronger than a mere flush draw (two pairs or three of a kind, either queens or sevens). So the anticipation that could have eventually saved us at least
some of our losses at the hand was that the board pairing with a queen or a seven would indicate the danger of P5 possibly holding four of a kind.

However, this potentially beneficial anticipation was in conflict with another anticipation, stemming from the realm of probability, namely that it was quite unlikely for P5 in terms of mathematical probability to actually hit the last remaining seven to complete his four of a kind. So in a sense it was a very justifiable mistake, yet again one that had its foundation in a faulty anticipation.

In conclusion, my hope is that I was able to better illustrate to the reader in this example how anticipatory reasoning functions in a very concise, dedicated environment that offers only a very limited amount of possible courses of actions. If we expand our understanding of to the larger scope of social reality, we have to conclude that the amount of factors involved is immensely more capacious and that the potential impact of our anticipations is ever so much more drastic.

As a means to better understand the world, it does good – such is the opinion of this author – to look at the phenomenon in question at a smaller scale and in a well-defined, more stable environment. Such was the purpose of this excursus and it is my hope that it served to provide the reader with more insight on the matter of anticipatory thought processes in man-made and man-driven surroundings.

3.3 Mirroring aspects of present day social reality

Now that we have grown to accept the game of poker as a platform that serves both to display and observe elements of behavior and decision making in agents in social environments, it is natural for us to look at the conclusions we can draw from this for our judgment of proceedings in present day societies.
The key question of course is whether it is the game that borrows from reality, in the sense that agents are influenced by their experiences and traditional modes of behavior that are passed on through generations; or is the case such that certain inherent traits of thought processes form the underlying foundation of both, the social reality of present day societies and the social reality created in a game of poker? Of course, as it is so often the case in the sciences, the answer is diffuse, rather than distinct.

The logical instinct that most scientists are brought up with is to first look at the less complex environment (meaning that which relies on the smaller amount of necessary premises in order to function) first and then, consequently, try to apply the gained perspective on the larger scale.

The moment a player enters a game of poker, he gives up vital aspects of his social existence for the sake of participating in a game following a certain set of rules. Most prominently, as elaborated earlier, this means giving up being embedded in the possessive structure provided by our social surroundings. In a game of poker, your only means of possession are chips, which are usually distributed equally at the beginning of a game. A player cannot buy himself into winning a game of poker by simply being able to put up more money than other players involved. (Hellmuth 2003, p. 137-138)

This is a necessary condition in order to warrant a sense of fairness in the game, a fact that certainly does not translate into present day society. The small business owner will always be trailing in comparison to the bigger business owner, purely due to the fact that he is not able to compete financially. While there may be some political effort to create a sense of balance here, the essence of the problem in this case is that an agreement between the two parties that ensures competitive fairness is unlikely achieved, as the conflict of individual interests will always supersede potentially mutual interests.

Another aspect that is given up when participating in a game of poker is the right to act freely. The possible actions in a game of poker (as far as the game is concerned, players are of course
allowed to communicate and act freely outside of the game – another interesting duality which we will look into more thoroughly soon) are very limited, as to what can be done and when. A player may only act following a previously declared sequence of actions and even then he may only perform a limited amount of actions. Of course these limitations are integral to the functionality of poker as a game; were the options unlimited, the game would grow incomprehensible and could have never gained as much popularity. It is easy to grasp the actions possible at a certain point in a game of poker, yet it is equally possible for players to surprise one another, which is a strong indicator that choice still is an important factor in the game.

Another aspect of society that can be observed as a reflection in poker games is the mindset of beliefs and projections individual agents hold internally. This reflects in the attitude they bring to the table when they enter a game of poker.

Aaron Brown depicts the middle-class in present day society as such:

If you can tolerate what life offers in low- and calculable-risk opportunities, you should take it. That is the defining strategy of the middle class, but it can be adopted by anyone, rich or poor. Choose a career in a low-risk field, and get plenty of good training. Be nice to everyone. Select sound investments; make conventional choices; pay your taxes; obey the law. Do a little better every year than the year before, and raise children who will do a little better than you. For many people, this is the American Dream. For others, it’s the only sensible choice, the only kind of life that allows happiness without achieving it at the expense of someone else.

(...) For most of history, there wasn’t a big middle class. There were rich and poor, life was risky for both, and everyone gambled. The growth of the middle class began in seventeenth-century Holland. Europeans who achieved middle-class security generally stopped gambling and soon afterward tried to get everyone else to stop. But in the United States, the middle class grew so large by the nineteenth century that a sizeable population began to try to escape it. Europeans were shocked to see the western frontier populated not only by drifters and refugees, but also by prosperous eastern farmers who wanted more land, who risked ruin and death for the chance to get rich. Other successful people moved west to escape conformity—social, religious, or otherwise. Traditionally in world history, mines were worked by slaves or oppressed peasants. In the United States, college graduates, clerks, and men with property flocked to mining camps all over North America (to dig and play poker). Even more surprising, these same kinds of people often volunteered to serve as foot soldiers in wars (to fight and play poker). All of them threw away middle-class security to bet their lives and fortunes for wealth or freedom, and many of them found both. This unprecedented combination of opportunity and anarchy produced both poker and modern finance. (Brown 2006, p. 2-3)

His account illustrates the thought outlined earlier: The moment a player stops playing poker as a low-risk pastime with minor stakes and starts to adopt it as a means to accumulate wealth, his attitude changes drastically. The mindset the player enters the game with has direct
influence on his decisions and this mindset in turn is subjected to the attitude the individual adepts from interaction in society. An individual who adopts the **defining strategy of the middle class**, as Brown puts it, cannot rely on an incalculable risk source of income like stock trading or poker.

Brown raises another interesting point, namely that the middle class strategy tries to achieve personal gain while avoiding causing harm to others. This cannot be achieved in a game of poker, as the very mechanic of the game is designed such that it constantly incentivizes players to force each other to give up money they invested previously, thereby inflicting harm upon each other. Even if players were to reach an agreement to not bet against one another, this would still mean a loss to each individual player by means of the house edge (the casino keeping a fraction of the pot).

In its nature, the house edge resembles taxes in societies, as they form a token investment that must be put up in order to be able to participate in society. Such requirements constitute a trade-off that must offer some kind of merit; in the case of taxes, this usually means social security. In the game of poker, much like on the finance market, the merit consists of the chance to win big amounts under certain circumstances that are in part subjected to the outcome of player interaction.

### 3.3.1 The duality of existence in the poker player

During the course of a game of poker, a player is constantly involved in a discourse between two competing personae, his game persona, the image he is trying to portrait against his opponents, and his individual persona that he is trying to portrait against the other players on the table. The game persona calls, bets and folds the cards without necessarily being involved in the decision making process (which mostly occurs within the individual persona). This persona draws from the characteristics the player show as a human being in day-to-day life, his education, experiences, thoughts and perspectives. The game persona, however, is a highly
logically organized structure that totally succumbs to the regulations of the game and its proceedings. So, in a sense, a player showcases both personae in an instant when he talks with other players on the table about whatever people may choose to talk about at a poker table, and bets, raises and folds on the other hand, sporting his game persona, which communicates solely within the measures of the game.

We can find a similar duality in social reality when we look at how human beings organize themselves in social structures. There is a duality between the individual, narcissistically driven persona and the socially embedded persona that often times is the cause for dispute. For example someone may serve who strongly holds a particular believe individually, but has to reject the same belief due to their engagement in a social environment, as in a political party for instance. In such a case, there is a strong sense of dualism, where one aspect may supersede at some point, but both sentiments exist simultaneously within the same human being.

Another example for what constitutes basically a game persona is found in how the state of being a citizen of a particular nation relates to the individual. A particular individual belongs to a specific group of people, i.e. a nation, by way of citizenship, but this does not entail a commitment of the individual persona to this state. For example a person may be a citizen of a particular state, but choose to live abroad and be emotionally detached from the on-goings in his nation of origin, in which case the individual persona remains detached of the game persona. Yet, the state of citizenship can reflect in the individual persona as well, if, for example, a person has a strong emotional attachment to the state of being part of a specific nation (i.e. patriotism/nationalism). In such a case what previously constituted a game persona supersedes the individual persona. The moment a state can no longer be omitted from an individual by way of internal reflection it becomes a constitutive part of the individual persona.
3.3.2 Risk taking and player personality

Because the environmental factors (i.e. the cards dealt) in a poker game are somewhat miniscule in comparison to the influence factored in by player behavior, the question arises which personality traits lead to a certain type of player behavior. As the reader will most likely have noticed, I refrained from including player personality descriptions while introducing the players and hands involved in our example hand, but hinted at some player personality traits while elaborating certain player moves throughout the proceedings. While this was also for the sake of simplicity, the main motivation was to put the focus on the influence the environmental proceedings take on the players. It is worth noting however that the psychological component of the game, i.e. analyzing player personalities (Cf. Chapter 3.1.1) and adapting accordingly, is equally important and perhaps more important at the highest level of play, as the player pool usually shrinks the higher the stakes are. (Cf. Greenstein 2005, p. 129-131)

The individual player personalities come into play whenever decisions are being made and, perhaps, most prominently when risky moves are undertaken. Risk is an omnipresent factor in the game of poker as there are hardly ever situations in which a player has enough information in order to determine a move as being completely safe. In every other case any move constitutes a risk, as it means a potential loss of money.

During each stage of a hand players have to calculate their risks and chances and make decisions accordingly. While there are strategies that may be considered more safe than others, the game of poker is structured such that it encourages risk taking and rewards balanced but daring play in the long run.

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13 Obviously an in-depth characterization of the players involved would have extended the length of the example significantly, while only adding information that has limited relevance to the point I am trying to make here.
In his book *The Poker Face of Wall Street* Aaron Brown establishes a strong analogy between the world of poker and the finance market, whereas in both worlds risk is a determining factor:

Finance can only be understood as a gambling game, and gambling games can only be understood as a form of finance.

(…)

However, I mean something different from the superficial comparison that you can make or lose money in Las Vegas or on the New York Stock Exchange. I mean that financial products have additional risk embedded in them, the same negative-sum, pure-random risk that underlies roulette and craps. It’s true that a long-term buy-and-hold investor of a diversified portfolio of stocks is taking real economic risk, but that’s a tiny fraction of what goes on in the stock market. No one gets paid a lot of money to sit around worrying about what the average return on equity will be over the next 20 years; no one screams and shouts about it. People do get paid a lot of money, and scream and shout, to trade one stock versus another or buy a stock and sell it five seconds later. The average investor in the stock market gets the average return; everything else is just gambling. Anything you win comes from someone else who loses, all relative to the average return. The bets are negative sum because there are taxes and transaction costs from the exchanges, just like the house edge in a casino. And at least in the stock market there is some underlying economic risk; it’s not all one person winning from another. All other markets except commodity markets are zero sum. Every loan or bond has a borrower and a lender; every foreign currency transaction has a buyer and a seller; every derivative contract has one party paying another. For anyone actually working in the markets, all the excitement and opportunity come from these kinds of bets. (Brown 2006, 6-7)

While this analogy certainly is not too far out to grasp, Brown offers a solid account and a very sound argumentation for how deep this analogy really goes. Just like in a game of poker, participants at the stock market agree upon a defined set of rules and conditions, that limit the amount of actions they can perform and when they may act. And - again the analogy remains sound - the element of chance is a key factor in both surroundings as the interaction between agents is always based upon (absent) information. In a game of poker, a player is constantly out on a quest to gather information in order to be able to make the most informed decision he
can. This also holds true in the stock market where any information about possible fluctuation on the market must be valued and asserted accordingly.

In an effort to balance out these interactions between players, rules are put in place as a regulation: Actions like throwing away one’s cards out of turn or showing them face up while the hand is still in progress can be penalized in a game of poker. Similarly on the stock market regulations are present to prevent insider deals, in which information is traded such that it creates inequalities on the market.

In a sense risk is put in place in order to ensure a certain amount of balance. Brown argues similarly as he establishes his four reasons why risk is present in the market:

1. Risk makes products more attractive to investors. People like to gamble, so financial institutions add risk the way a fast-food company sneaks extra fat, sugar, and salt into its offerings. This is the first reason that occurs to most people, and it’s true, but it’s the least of the reasons.
2. Risk is essential for capital formation. People have to be persuaded to take assets that could be used for consumption and think of them as sources of future income. You need risk for this the way you need heat for cooking.
3. Risk creates winners and losers, and a dynamic economy needs both. Everyone is born with a lot of options in life, and volatility increases the value of options. The concentrated capital of winners is a force for change, and losses have freed many a loser to exploit the value of options a comfortable person would ignore.
4. Risk attracts traders. Traders are not passive order takers, but a hugely important dynamic force in the economy. There is a reason the successful ones make so much money. Without enough risk, the right kind of people don’t show up. (Brown 2006, 8)

Both, the finance market as well as the game of poker, constitute highly dynamic fields of interaction, wherein agents interact with each other and the environment. Risk as a factor serves as an incentive to keep agents from stopping to interact, which in turn prevents the system from being stagnant. This also implies a certain trade-off for the individual, as neither of the environments in question is very protective of its protagonist: There is no mechanic in
poker that prevents players from betting more than they can actually afford, and neither is there a mechanic on the finance market that keeps traders from sinking their money into seemingly hopeless stocks. As Brown points out, the existence of both winners and losers is of integral importance to the functionality of the system.

3.3.3 The rights of a poker player
As we established earlier, the act of entering a game of poker constitutes a break from the outside world and puts the individual in a new state of commitment and entitlement within a particular instance, in this case a framework of rules and stipulations that make up a specific game.

The act of buying into a game of poker by providing a previously indicated sum that forms a necessary condition for players in order to be able to participate is also an act of establishing equality among players. All players hold the same amount of resources (chips) at the beginning of a game and have to commit equally to the rules of the game. Pre-game entitlements such as individual wealth are not carried over into the game environment. This decoupling from explicit and implicit environmental surroundings is the first and most basic right of a poker player, a guarantee to be treated equally and a chance to participate once a certain set of criteria is met.

During the process of a game, a player’s individual success depends exclusively on his individual ability to adapt to a fluctuating environment and to compensate for set-backs caused by the presence of chance within the game. In order for this concept to function, players must commit to a neutral instance, in this case the dealer, who gives out cards, thereby altering the environment and impacting on player decisions, gains and losses. The state of neutrality of the environment (most prominently the cards and the dealer) and uniqueness of each hand as an isolated event is another defining basic right a poker player is granted upon
entrance. This regulation serves to ensure that no player can gain an advantage by fraternizing with the dealer or another player.

One of the major advantages the game of poker has to offer is that its rules are relatively concise and simple, and can hence be enforced rather effectively with relatively little administrative effort. This warrants that players are treated equally and makes for a genuinely fair competitive environment.

If we take a look at present day society in this regard, we must note that many current issues of inequality stem from the opacity and exploitability of regulations within society that in turn is a result of the level of complexity the structure of present day society has reached. Society does not offer an initial reset of means and resources (like the buy-in does in a game of poker), but instead offers a variety of possibilities to preserve gained advantages and transfer them into the various stages of social interaction.

In this sense, poker can very well serve as a subject of observation for how agents fare in equalized environments.

3.4 Linking Hold’em to the realm of social anticipation

The purpose of this chapter was to illustrate how anticipatory thought processes take place in a specific, well defined environment which pertains to a limited amount of rules and possible actions such that it makes for more concise environment for our analysis. During each stage of a poker game, different factors come into play. The environment changes, the expectations of the players change as does the influence the players infer upon each other by placing bets according to the factual or perspective value of their cards. By taking a close look at a specific player in an example hand, we were able to create an image of possible anticipatory thought processes taking place within that particular individual player. Although these thought processes are immediately linked to the proceedings in the game they are inspired by, we can extrapolate a specific kind of reasoning from these processes, that we in turn can find to be
mirrored in a larger scope, namely in the very fabric of society. Many of the factors that occur in the thought process in interactive environments are also present in the larger scale model of present-day societies: individuals try to anticipate possible moves from others and they react to changes in the environment as well as to predictions of changes in the environment. Knowledge about the weather forecast predicting there will be rain tomorrow may be enough to cause me to bring an umbrella to work, although there might not be any rain as I leave on the next day. The reason we are able to come to such conclusions is by way of anticipation, the ability adjust actions in the present according to events located in a possible future.

This third chapter served to illustrate that we are in a persistent mode of anticipatory thought, not even in the mere solipistic sense that we create possible futures for ourselves, but in a more sophisticated, social sense that causes us to reflect upon the possible actions of other agents in a field of interaction. The game of Hold’em is one example of such a field of interaction, and it is the hope of this author that this chapter served to prove that it is also a worthwhile field of observation for the scientific research on anticipation.
4. Conclusion

What is anticipation? The initial question posed at the very beginning of this venture may very well still be ringing in the ears of the reader. The answer provided here may not be all we hoped for, but truth be told, it is the strong conviction of the author that the scientific - specifically the philosophical – discourse on the subject of anticipation is only at the very beginning of its path.

We progressed through a wide variety of scientific disciplines – biology, semiotics, computational theory, to name just a few – on our quest to attain knowledge on a subject that seems quite elusive from the outset of its very conception. But, in a way, I like to think that we did succeed, as we were able to evoke at the very least awareness on a matter that incorporates tremendous scientific potential.

Our journey began with handful of definitions and descriptions of anticipatory systems and their capabilities. We came to understand how anticipation functions on varying levels of complexity and within different kinds of systems, from living systems to realizations in the realms of physics and within the world of artificial intelligence.

With those definitions in mind we went on to undertake an attempt at defining an explanatory framework as to how anticipation works, if we indeed understand it as a highly social phenomenon. It was there that we saw that among the multitude of living systems that can be found on this planet, human beings really prove to be quite exceptional, in the sense that they constantly engage amongst themselves and their surroundings and that they do so – as well – in anticipation. Anticipation is the driving principle behind a variety of emergences in the realm of social interaction. It is via anticipation that we are able to tell jokes, dream, smell flowers, and even live through future scenarios before we actually experience them. It is also anticipation that enables us to engage in goal-oriented interaction in fairly sophisticated artificial contraptions, a phenomenon that we commonly refer to as playing games. We then
proceeded by making such a game – the game of *Texas Hold’em* – the focus of our undertaking, in an attempt to apply the framework of social anticipation that we established earlier onto a concrete scenario of human interaction. Our excursus did indeed help to shed light upon a variety of issues that emerged from our integration of anticipation as a principle into our reasoning about social interaction.

What holds true in the fictive reality that is created in a game of *Hold’em*, holds true as well as an application in real life: Agents that are able to anticipate changes in the environment as well as possible courses of action by other agents, hold a significant advantage over agents that are not able to do so. The merit of the specific advantage for the individual is depended upon which kind of correlation is entailed in the anticipatory process: While the successful anticipation of rain may entail something minor like the conservation of dry cloths, a faulty anticipation of the behavior of a wild animal may very well prove deadly.

Anticipation is a driving principle in life; that, we have ascertained from our journey into the depths of scientific literature on anticipation. But we have also grown to understand that anticipation is a driving force in *social* life and that it is indeed by way of anticipation, that society itself is conceived in its very fabric.

Allow me now to close by saying: If knowledge is indeed power, then anticipation is knowledge before it is *known*. 
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Abstract

The goal of this thesis is to encourage a philosophical debate on the subject of anticipation, which so far found its place predominantly in other scientific disciplines – such as theoretical biology (Robert Rosen) or computational sciences (Mihai Nadin among others). A dedicated philosophical debate on the matter is yet to take place, although the authors mentioned in this piece of work all allude to the implicit nature of philosophical and ethical questions while dealing with the matter of anticipation.

The study at hand is to be understood as an attempt at formulating an introduction to the interdisciplinary discourse on anticipation and attempts to establish a theoretical framework in order to make anticipation apparent as a social phenomenon. Based upon the various definitions and examples provided in the scientific literature on the subject, the question is raised how projected (potential) future outcomes are incorporated into inter-subjective social interaction and reasoning. Without doubt it is one of the key cognitive capabilities of human beings to extend thought along the scale of time beyond the realm of the present and the primacy of the moment. The acknowledgement for and the dealing with this meta-temporal dimension of human cognition from the perspective of a broad spectrum of scientific disciplines constitutes the first core section of this thesis. Based on a variety of texts from different scientific backgrounds the question is raised as to which qualities define anticipation as an individual phenomenon and how it serves as a constitutive component in individual human cognition.

Continuing from this first, initial range of examples and definitions, an attempt at applying this framework of definitions on a social scale is made in the following section. Based upon the 12 definitions of anticipation presented by Mihai Nadin in his book Anticipation. The end is where we start from a fundamental methodological framework is formulated in an effort to create a set of tools that is fit to examine anticipation as a phenomenon in a social setting.
Referring to this very framework, several questions are raised in the context of social anticipation: How do individuals function as agents that are embedded in a social environment, how do the individual and its specific actions serve as a constitutive component in the fabric of society, and how can anticipation serve as means to explain highly social phenomena such as information, expectation, surprise or superstition. While this thesis certainly does not offer definitive answers to this questions, nor can it be its purpose to offer such answers, the point of this particular study is to establish these questions as a subject in a philosophical discourse, in order to raise awareness on the matter and help encourage acceptance towards scientific dialogue on anticipation as a category in the quest to better understand the cognitive means of human existence.

In the third core section of this thesis an attempt is made at putting the theoretical framework of social anticipation to work in a concrete, structurally defined environment, in order to provide a more practical perspective on the matter at hand. The environment chosen in order to illustrate this idea is that provided by a popular, man-made setting, namely the game of Texas Hold’em, a variety of the traditional card game poker. A short introduction to the game, its rules and its history is given before a closer look at the individual anticipatory reasoning and behavior of players within the dynamic structure of a game of Hold’em is investigated. By extrapolating the knowledge we gain from observing the actions of individual agents in this specific setting to a larger scale (the scope of modern societies), it is examined whether this knowledge can indeed serve to better understand phenomena in the reality of social interaction. The conclusion to this undertaking is that the interaction between human beings and the environment they are embedded in takes place based upon a multitude of pre-conceived assumptions and expectations, which are to a significant extent the results of individual anticipatory reasoning.

The premise of this thesis is to shed some light on the subject of anticipation and to help establish its place as a key component in a philosophical debate, which in its fruition may
even serve to deliver veritable knowledge in the progress on the fundamental question: “what is a human being?”
Zusammenfassung


Auf Basis dieses ersten, grundlegenden Rahmens an Definitionen und Beschreibungen von Antizipation und antizipativen Systemen wird in der Folge erarbeitet, wie eben diese Definitionen in einem sozialen Kontext angewandt werden könnten. Auf Basis der 12


Im Lichte der Arbeit, so ihre Prämisse, soll es gelingen, die soziale Dimension des Phänomens Antizipation in den Fokus einer philosophischen Debatte zustellen, an deren Ende
wertvolle Erkenntnisse zur Beantwortung jener ursprünglichen Frage „Was ist der Mensch?“ stehen könnten.
Curriculum Vitae

Name: Stephan Johannes Berger

Geburtsdatum: 25. August 1986 in Linz (Oberösterreich)

Ausbildung:


1997 – 2005 Europagymnasium Auhof, Linz

Besuch der Schulform „Realgymnasium mit Französisch ab der 3. Klasse (7. Schulstufe)“

Abgeschlossen mit der Matura (mit Auszeichnung)

2005-2012 Studium der Philosophie an der Universität Wien (Institut für Philosophie und Bildungswissenschaft)

Daneben Tätigkeit im IT-Bereich (vor allem Netzwerkherstellung und –wartung), als Tutor an der Abteilung für Vergleichende Literaturwissenschaft an der Universität Wien, sowie als Mitarbeiter beim Verein Società – Forum für Ethik, Kunst und Recht.