The Theory of Narrative Thought

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This book is dedicated to the Barbaras in our lives.

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PREFACE

We have been thinking about thinking for many years. The product of that effort is the Theory of Narrative Thought (TNT) which is a refinement of Image Theory (Beach & Mitchell, 1990) and was developed over the course of three previous books. The first of these books (Beach, 2010) contains the earliest, and in retrospect, the embarrassingly naïve, version of the theory, focusing on its implications for decision processes and schemes for helping people make decisions. The second book (Beach, Bissell, & Wise, 2016) contains a more developed version of the theory and further implications. The third book (Beach, 2019) expanded the theory's conceptual underpinning in terms of the narrative structuring of experience in general, which led to an improved statement of TNT. This fourth book retains the 2019 statement of the theory and focuses on recent refinements, its neurological, evolutionary, and mathematical roots, and on additional applications and implications.

We confess that the theory's name, the Theory of Narrative Thought, really isn't very accurate. Over the course of the three previous books, we tried different names but somehow fell into the habit of referring to it as 'TNT' in discussions between ourselves and with others, which has pretty much locked us in. Really, the theory is about cognition in general, with thought being something of a sub-category (called derived narratives). So, we'll apologize now for the confusion and hope you can look beyond it as you read. Perhaps this is a case of "...a rose by any other name...".

A warning to new readers, our use of the word "narrative" only coincides in part with the conventional use. Yes, we're referring to a story-like structure, but it isn't always a story and it isn't composed in the way an author or speaker might intentionally compose a tale—in fact, there's no intention involved at all. It merits being called a narrative simply because it is the past, present, and the future they imply, held together by causal rules. It is the structure, not the content, and "you" don't construct it. It simply is the way in which the brain structures experience. Narratives, in the conventional sense, derive from this structure, which we call the *prime narrative* to emphasize that it is conceptually different and more fundamental than the stories we all tell ourselves and others. That prime narrative structure of experience came first and conventional stories reflect it, not the other way around.

The format of this book differs from the others in that it is a collection of loosely linked essays. We hope you find them interesting enough to grant TNT further consideration and stimulating enough to merit research and application.

Two final things. First, we thank Ms. Pamela Sloughter for her hard work tracking down some of the rarer early documents discussed in this book. Second, unless you intend to be rude, we would very much like receiving an e-mail about your thoughts on TNT at leerbeach@aol.com and/or jamesawise@me.com.

PART I

THE THEORY

We begin with a description of TNT; a refresher for old friends and an introduction for new ones.

ESSAY #1:
THE THEORY OF NARRATIVE THOUGHT (TNT)

TNT posits that the brain structures experience as a narrative in which the past and present imply the future, allowing identification of potential threats in that future, and guiding action to prevent, avoid, or diminish them before they occur. In other words, cognition is primarily about what happens next and how to avoid or take advantage of it. In addition, narratively structured experience provides the shape and content of the narratives used to think and to communicate those thoughts to others.

We will return to this at the end of the essay, but it is best to understand from the beginning that TNT's central tenet, the prime narrative, replaces the traditional concept of "mind as agent" as the central feature of cognition.

The Theory

TNT begins with the proposition that a primary function of the brain is to synthesize elements into coherent wholes (e. g., Ivanitskii, 1994, 1996; Moon & Pae, 2019; Tononi, 2004, 2008; Kringelbach & Deco, 2021). Perception is the brain synthesizing sensations into coherent time and causally bound *events*. Memory is the brain synthesizing events into coherent *episodes*. And, of present interest, cognitive structuring is the brain synthesizing both episodes and their component events into coherent *narratives*. Which is to say, the brain creates events out of sensory experience, which are the visual, auditory, kinesthetic, olfactory, etc. sensations that herald changes in the internal and external environments (which we'll call, your *habitat*[1]). But events are useless by themselves, so the brain creates episodes out of events that occur together, bound in time or otherwise linked. And, because episodes are useless except in reference to what preceded and followed them, the brain indexes episodes by time (Reddy, Zoefel, et al, 2021). Doing this creates a logical structure, a narrative, about how the past led to the present and what that implies for the

[1] We share the environment with other people, animals, etc. But our unique bit of the environment is our habitat, and everyone's is slightly different.

future.[2] (Because it is awkward to have to speak of both events and episodes in tandem, and because events are causally the more basic of the two, we use the single word, event, to stand for both of them.

Narrative Constancy

A narrative, any narrative, is a sequence of events ordered by time and causality (Atkinson, 1978; Carroll, 2001; Polkinghorne, 1988). That is, narratives are not just about what events happened, they also are about the order in which they and other events happened and what caused them to happen (Atkinson, 1978).[3]

Narrative constancy refers to the observation that narratives can be presented in different ways without distorting the underlying story. For example, narrative order sometimes appears to violate temporality by interpolating earlier or later events, as in flashbacks and flashforwards in novels, movies, and TV or in the undulating flow of everyday conversation. But the recipient (reader, viewer, or other conversationalist) understands that the interpolated events took place earlier than the events in the main thrust of the narrative and are included because of their bearing on those events and thrust. Indeed, the ability to understand interpolations reveals that both the listener and the narrator recognize that events unfold over time and that earlier events have meaningful implications for later events.

In addition, a narrative can be recounted in numerous ways as long as each version includes the key events and respects their temporal and causal order. This is evident when two people describe the same series of events. Not only do they seldom tell exactly the same story, seldom do either of them tell it exactly the same way twice.

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[2] Lou (2021) presents a similar argument for the brain as a synthesizer, except instead of events, episodes, and narrative, he uses the terms letters, words, and sentences. He explores the architecture of neural circuits needed for this three-step synthesization and provides neuroscientific evidence suggesting that, indeed, the brain has such an architecture.

[3] See Mar (2004) for a review of the neuropsychological research related to story comprehension and story production, their common neural mechanisms, and the implications for cognition. Mullally & Maguire (2013) showed that memory, imagination, and prediction all use the same parts of the brain operating as a single system. And Reddy, Zoefel, et al (2021) report that temporality of events is represented in specific cells in the hippocampus.

The Prime Narrative

That different orders and different versions of events can be regarded as accurate recounting of the same story suggests that they reflect something more basic, an underlying temporal/causal structure from which the different versions derive. This basic structure is called the *prime narrative* (Beach, 2019); it provides the basic means of understanding of how one's life has progressed from the distant past up to the present. The stories you tell about yourself and others about what you want, believe, and find meaningful all derive from the prime narrative, but no story you can relate can fully encompass it. More to the point, the prime narrative is your foundation for dealing with your habitat and yourself.

Narrative Future

The foregoing is about the past and present, but what about the future? Clearly, you have some notion of what it will be. If you read a mystery novel, you can predict what is likely to happen next (although an accomplished author will ensure that you predict incorrectly—which is what makes it a mystery). If someone tells you something, you usually can see the implications for what will happen later. And when you think about your present circumstance, and how you reached it, you can imagine where it will lead.[4] In the latter case, you probably are right more frequently than you are wrong, especially in the short term. If you could not correctly anticipate what is going to happen in the next few moments, even the next few hours or days, you would not know what to do next; you would live in a state of suspension, anxiety, and constant surprise.

Of course, the future has not yet happened so no one can say with certainty what it will be. Humans have invented a variety of tools for dealing with this fact—fortune telling, divination, statistics, forecasting—most of which require the user to have special skills or the help of people who have those skills. But, lacking expertise or an expert, tools such as these are unavailable to most of us. Left to our own devices, we must rely upon our "intuitive" predictions about the future. And, because our predictions are all we have, we must treat them as accurate and act accordingly, hoping for the best.

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[4] We'll discuss imagination and TNT in Essay #14 but note that recent research (Lee, Parthasarthi, & Kabe, 2021) suggests that imagining the future and evaluating whether that imagined future is good or bad depends on two different parts of the brain, which fits well with TNT's separation of prediction of the future from evaluation of its threat.

There are many reasons for trying to predict the future but, in the long run, the primary reason is survival and its near-relatives, security and well-being. That is, prediction can reveal potential threats and suggest actions to avert them or soften the blow. Of course, not all threats are about survival, but expectations of distress, discomfort, or pain are sufficient to warrant mitigating action. Threats do not even have to be physical; potential aggravation and hassle, loss of esteem, or the possible failure of opportunities or expected benefits to materialize are all threats that require mitigation. But the point is, however serious, the most efficient way to handle threats is to anticipate them and deal with them before they can cause damage. Doing this requires use of the causal structure of the prime narrative about what has happened and how it led to what is happening now to infer what will happen next (and next, and next, etc.).

Causal Rules

Physicists may not be sure that the world is deterministic (Musser, 2017), but humans and other creatures behave as though it is (Cheng, 1997; Holyoak & Cheng, 2011; Lagnado & Solman, 2016; Sobel & Kirkham, 2006; Solman & Lagnado, 2015).[5] They operate as though every event that happens has been caused by an event that happened previously and will be the cause of an event (or events) that happen subsequently. Moreover, when a specific event(s) follows reliability from a previous specific event, they interpret the relationship between the two as a *causal rule*. Interpreting temporal relationships as causal rules turns what would otherwise merely be a list of events into a narrative about how events in the moderately distant past caused events in the immediate past, how this caused what is happening now and, most important, how it will cause what will happen next.[6]

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[5] Moreover, recent evidence suggests that the brain's operation is basically causal, i.e., assuming it is permits "capture [of] the causal flow of information, i.e., how activity in a given region can be shown to causally influence activity in another." (Kringelbach & Deco, 2021). Additionally, research (Duan, et al., 2021) suggests that detection of causal relationships between actions and their outcomes is mediated by the caudate nucleus and is enhanced by the anterior orbitofrontal region of the prefrontal cortex. See also, Danks (2009)

[6] Causal thinking may seem obvious and unremarkable because it is so familiar, but it is neither. For example, we could have evolved to think probabilistically instead of causally, but causality is much simpler and more efficient and, most of the time, it does a good job. In fact, probability, as a formal mathematical theory, was invented largely to describe the uncertainty we often feel about our causally derived expectations about the future (see Greenland, 2020 for related arguments).

Causal rules have direction and directness. Direction means that occurrence of an event influences, or at least implies, the occurrence of a specific subsequent event(s)—i.e., causality works forwards, not backwards. Directness, as the name implies, is how straightforwardly that influence is exerted. The most direct rules, are between a cause and its effect, A→Z. Slightly less direct rules are between effects that are the result of an intermediary event that was itself directly caused, A→(K)→Z. Even less direct rules operate through more intermediary events, A→(K→M)→Z. And so on. But, in all cases the rule is regarded as being between events A and Z; everything in-between is merely supportive of that rule.

Intermediate events have their own links (*lateral links*) with yet other events that are tangentially related to what is happening at the moment. Lateral links are enriching because they increase the interconnections among events, but they also introduce opportunities for things to go in unpredictable ways. Thus, with only direct links, everything would be simple (no lateral links) but highly determinant because every event would have only one cause and one effect. A mixture of direct and slightly less direct links would be richer yet (because of lateral links), but less determinant because the intermediate events may or may not be particularly determinant. Adding even less direct links, and more complex rules, would be even richer (even more lateral links) but even less determinant.[7] And so on. The longer the chain of events required to get from A to Z, the more opportunities there are for things to go wrong and for something instead of Z to occur. Which means that the less determinant the causal rule, the less reliable it is.[8]

Reliability can mean something like the proportion of times the rule actually produces (correctly predicts) Z. But, even though the rule's track record is important, so is its determinacy. Even without a track record, a more determinant rule stands a better chance of being right than a less determinant rule, if only because it is simpler and offers fewer opportunities for things to go wrong. Additionally, rule reliability reflects the degree to which the rule is *appropriate* to the current circumstance. The more closely the current conditions approximates conditions(s) in which the rule previously predicted Z, the more appropriate it is. (Of course, the broader the range of circumstances in which the rule has worked before, the more it is likely to be appropriate this time.) A third contributor to rule reliability is

[7] Complex causal rules also are known in the literature as causal mechanisms (see Johnson & Ahn, 2017; White, 2013).

[8] Meder, Mayrhofer, & Waldman (2014) have demonstrated that when acquiring and using causal rules, people take the lateral links into consideration rather than relying solely upon the main linkage.

the *credibility* of the source of the rule. Many rules are learned from experience, but as many, or more, are acquired from other people, textbooks, and the media. Together, determinacy, track record, appropriateness, and source credibility determine the rule's reliability—its dependability.

Actually, reliability is not a property of a rule. The rule is simply an "A→Z" proposition that is either true or false under particular circumstances. Reliability is an appraisal by a sentient being (e.g., you) of its certainty/uncertainty, its degree of belief that the rule's A actually will be followed by Z.

The Expected Future

Your prime narrative is the foundation for a causal tale that unfolded over time, ending with what is happening now; "This happened because of that, which caused something that resulted in something else that is happening right now." In principle, the tale ought to stop at the present because the future has yet to happen, so there are no events to add to the narrative. But it does not. Because past and present events are organized by time and causality in the prime narrative, the future always is implicit as yet-to-occur effects of past and present causes, the results of what is happening right now and what led up to it. Causality implies predictability; if, in the past, A caused Z, then if A is occurring now, the future occurrence of Z is implied. At the moment that A is occurring, Z is merely a causal implication because it has not yet happened, but it is the best prediction about what, in fact, will happen—this is called the *expected future*.

And this is where rule reliability matters. If the rules for producing expectations aren't wholly determinant, appropriate, and credible, you are uncertain about their implications for the future and therefore more hesitant about the future than you would otherwise be. Hesitancy translates into unwillingness to invest energy and other resources in that implied future.

Coherence and Certainty

When the prime narrative's constituent events are strongly linked by direct, reliable causal rules—when the story it tells is straightforward—it is coherent. Which also means that the brain's synthesizing processes have done their job; coherence is the degree to which it has brought efficient order to otherwise diverse elements.[9] Which also means that you feel confident

[9] Emotional negativity results from violation of one's standards for how the world should be, so a threat is the degree to which the events in the expected future fail to conform (violate) those standards. This is explained in Essays #5 and #9**.**

that you understand what is going on and that the (implied) expected future is what, in fact, will happen. And, because there is no way of telling if the prime narrative is or is not "true" until its predictions about the future prove accurate or inaccurate, coherence and confidence are surrogate for truth and, therefore, for believability. That is, if the prime narrative is coherent, you are inclined to believe that it and its implied future are true until proven otherwise.

Of course, it also works the other way; low coherence suggests the prime narrative is wrong, which means you do not really understand what is happening and why. And this results in uncertainty, not just about what is going on but also about what is going to happen as a result. It boils down to this: Uncertainty creates anxiety, which is emotionally negative. It is the potential for this negative emotion that prompts action to increase the prime narrative's coherence by revving up the brain's synthesizing processes in an attempt to clarify the path from the distant past to the present and into the future.[10] In this sense, low coherence, and the high uncertainty that it engenders, is a threat just like any other threat—something that must be mitigated.

Threats

Threats are expected events that, should they be allowed to occur, will significantly violate one's values or preferences, called one's *standards*. Appraisal of the degree of violation turns on the discrepancy between what one expects to happen and that which one's standards dictate *should* happen. The greater the discrepancy, the greater the anticipated emotional distress, hence the greater the potential threat.[11]

Presuming that the expected future is an accurate prediction of what will happen (and it is all you have to depend upon, so the presumption is efficient), your comfort, even survival, depends upon identifying and mitigating threats before the future becomes the present and the threatening events and their concomitant negative emotions become reality. This requires an evaluation of each event in the expected future and a decision about its potential for negative consequences and emotions as well as a decision about the overall negativity of the entire expected future. That is, the *usefulness* of the prime narratives' implied future is not that it provides a

[10] This will be explained more fully in Essay #5.

[11] Appraisal is modeled by the discrepancy test, about which more is said in Essay #11. Why threats are the focal point of TNT is explained in Essay #6. For a review of the nature of emotion see Tyng, et al. (2017),

glimpse of the future *per* se, it is that it provides a glimpse of the potential for that future violating one's standards and the emotional negativity that will follow. Few futures offer unalloyed joy but when the overall negative potential is significant, action must be taken to change the future before it happens.

Threats are not solely about the danger of bad things happening. They also are about the danger of losing existing good things or losing the opportunities to attain good things—both of which are forms of harm that prompt negative emotions (grief, disappointment). Too, not all threats are dire. Day to day life seldom presents extreme, life-threatening danger—except perhaps when you are driving your car. Most daily threats range from mild to modest potential discomfort and discontent that requires minor mitigating adjustment.

Rules and Actions

Actions are interactions with your habitat that are guided by the same causal rules that were discussed above. Acquired through both experience and instruction, these rules specify the results that your actions can be expected to cause, thereby telling you what to do to produce a particular result—specifically, threat mitigation. They also specify the results that other people's or natural forces' actions can be expected to cause, either spontaneously or in response to your actions, thereby telling you what to expect as repercussions of your actions.[12]

A sequence of contingent action rules is a *plan*; where contingency allows for doing either this or that depending upon the result of previous actions in the sequence or reactions to your actions by nature of others.

Implementation of a plan consists of the sequential execution of each causal rule in the plan. As each step produces a change in the internal or external environments, the change is sensed, perceived, synthesized as an event, and changes the prime narrative to represent what is going on right now (Essay # 5). Changes in the prime narrative cause changes in the implied future. Because action is primarily undertaken to mitigate threats, the resulting changes in the prime narrative and the implied future should, if successful, make the new implied future less threatening than its predecessor. Because actions in the sequences are contingent, if an action results in the implied future becoming less threatening, the next action(s) in the sequence is executed. If an action increases the threat, new action(s) is

[12] Language, too, is action (Austin, 1962: Searle, 1969) if only in that it causes both ourselves and other people to behave in ways that we otherwise would not have.

retrieved from procedural memory to correct for the setback and decrease the threat. In short, threat mitigation is a feedback loop in which the reference variable is perceived threat.

Failure

Of course, to expect is one thing, to actually have that expectation realized is another. When something other than what was implied, and therefore expected, happens instead, it is a sign that the expected future is an implication of an incomplete or incorrect prime narrative. Put another way, the discrepancy between what is expected and what actually happens is information that has two aspects. First is the size of the discrepancy, which is how far off the mark the expected future was. Second is the impact of the discrepancy, which is the degree to which incorporation of these unexpected events into the prime narrative will reduce its coherence. By definition, surprises don't fit, or they wouldn't be surprises. So, incorporating them, which must be done because, after all, they *did* happen, reduces the prime narrative's coherence. As we'll see directly, reduced coherence is a bad thing for a synthesizing brain. So, to restore coherence, the prime narrative must adjust (resynthesize) to accommodate the unexpected events. This does not require reflection or conscious effort on your part, it simply happens as a result of your brain's synthesizing principles for narrative structure, motivated by its (the brain's) requirement for coherence. As we'll see in Essay #5, this accommodation is how the prime narrative is updated to correct existing internal errors as well as how it incorporates new information about changes in the habitat that made its implied future wrong.[13]

[13] Establishment cognitive science works on the assumption that the brain evolved to receive sensory information about the environment with which it creates a model of that environment upon which reactive behavior is based. This is called the "outside-in" approach to cognition (Lyon, 2021). This is not the case for TNT; the prime narrative is not a model of the environment, although it contains information about the environment in the form of events and causal rules. But, the central role of standards in decisions about the future is decidedly "inside-out". The result is that TNT is both "outside-in" and 'inside-out". The focus is on the future and what to do about it. Any modeling of the environment is simply in aid of this focus, not an end in itself.

Derived Narratives: Narrative Thought and Communications

Private Derived Narratives

By the time you became an adult, the content of your prime narrative had two sources. One source was raw experience—commonly referred to as intuitive knowledge. The other was feedback from your own thinking and from what was communicated to you by others. The latter was afforded, in large part, by the acquisition of language, which allowed elements of the prime narrative that were pertinent to the situation to be synthesized into a "mini-narrative" related to that situation. That is, linguistically encoding cogent parts of the prime narrative produces a *derived narrative*, a sort of contextually delineated copy of a portion of the experiential prime narrative that can be used for thinking and communicating.

It is useful to classify derived narratives as being about raw and empathetic experience, called *chronicle derived narratives*, or about how to do things, called *procedural derived narratives*. (Beach, 2010; Gerrig, 1994). Chronicle derived narratives are what we tell ourselves (thinking) and others (communicating) about what is going on, how it came to be that way, what we expect to happen, and what the threats are. They also are the vehicle for extending the prime narrative's immediate predicted future by elaborating it into a longer-term story of what might possibly happen in a week, a month, a year, or even longer.

Procedural derived narratives are about action and are as important as chronical derived narratives—there is no point in knowing what is going on and what will happen if you can't do anything about it. Procedural derived narratives are the stepwise, detailed stories we tell ourselves and others about how what to do—they are the plans that guide action.

Like chronicle derived narratives, procedural derived narratives come from your own experience, such as trial and error learning, and procedures you are taught by others—parents, peers, teachers, and society in general. Part of the genius of humanity is the collective, cultural elaboration of procedural derived narratives into science, religion, government, etc., all of which, one way or another, exist to mitigate threat.

Chronicle and procedural derived narratives help you mitigate threats by changing your own and others' behavior and by guiding manipulation of physical objects and abstract concepts. But, they also serve the other functions—sort of by-products. Novels, TV, gossip are chronicle derived narratives that forestall unpleasant boredom but also are desirable as entertainment and instruction. Similarly, driving a car, building a bookcase,

texting a friend require procedural derived narratives to reach desirable ends (i.e., to avoid not reaching them) but the action itself can be positive. Indeed, everything studied by social scientists derives from chronicle and procedural derived narratives, from their fundamental function in threat mitigation to their being co-opted for broader purposes, such as education and entertainment. And both kinds of narratives reflect their origins in the prime narrative by being temporally/causally structured as past, present, and future.

Public Derived Narratives

When a private chronicle or procedural derived narrative is shared with other people, it becomes a public derived narrative. Then it frequently becomes more involved and abstract as other people contribute to it, hone it, and apply it more broadly. In some cases, this is the end of it. But, in other cases and with enough elaboration, it becomes something very elegant—mathematics, the basic and applied sciences, the arts, and all the rest. Or, it becomes something ugly—conspiracy theories, racism, hatefulness. Both elegant and ugly public narratives are part of humans' shared culture, and they all have their origins in the human ability to encode the prime narrative into language, to communicate it to ourselves and others, and to incorporate the results back into the prime narrative.

Finally, lest we become too focused on written or spoken language, derived narratives involve more than just words. Gestures, laughter, and facial expressions can be eloquent; "a kiss is a conversation without words". And laughter conveys a multitude of meanings (Glenn & Holt, 2013). Even so, words are a major part of it, the primary tool for expressing the multiplicity of narratives that people bring social interactions and that help them know their world and themselves through internal monologue. The key word in that last sentence is "tool," which is anything that helps us in our efforts to extend the future, identify threats, and formulate actions to deal with them before they overtake us.

Afterword

We have tried to keep this discussion of TNT short to ensure that the basic idea is not buried in detail or side issues. That basic idea, in case you missed it, is that avoidance of death, even discomfort, ultimately depends upon being able to anticipate threats and to act to eliminate or diminish them before they happen. Basically, TNT is about how this might take place.

TNT is a theory of the mind in which the usual concept of mind as an active agent is replaced by the prime narrative, which is both inactive and has no agency (see also, Gough, 2021). It merely is a self-organizing structure in which past, present, and expected future events are ordered by time and causality. Expectations are the causal implications of past and present events. They serve to identify potential future threats, triggering mitigating action. They also define surprises—discrepancies between what is expected and what actually happens—triggering corrective changes in the prime narrative that make subsequent surprises less likely.

Language supports abridged versions of the prime narrative, called derived narratives, which in turn support communication with oneself and others. Communication with oneself supports thinking. Communication with others supports social interaction and information exchange. The products of both thinking and social exchange are incorporated into the prime narrative as present (as they happen) and past events (subsequently), thus influencing expectations about future events.

Central to this is the characterization of the brain as a synthesizer. This doesn't merely move mind to the brain, because there is no agency in what the brain does. It simply synthesizes whatever is at hand according to its internal rules; primarily proximity in time and space. Much research has been done to identify the connections among functional units of the brain, but less has been said about what those connections are for—synthesizing, making larger bundles from smaller bundles.

Note that TNT does not attempt to explain consciousness. This is simply because consciousness is both the process and result of the brain synthesizing elements for the prime narrative as well as synthesizing derived narratives for thought and communication. It has no special status because it isn't special; it is merely verification that the brain and the prime narrative are functioning as they have evolved to function.

This position is consistent with research; a conscious decision to act does not lead to the brain being "fired up; to instigate the action" (Libet, 1985). Quite the opposite. The brain "fires up" about a half second *before* a conscious decision is made. This suggests that brain activity is a prior and necessary condition for consciousness, not something apart or something special.

Testing TNT

Suppose it were possible to assign all cognitive theories to different levels of a space in which those at the lower levels were narrowly focused on specific phenomena (e.g., a theory about the part of the brain involved in

some specific cognitive task) and the theories at higher levels are increasingly broad in their focus. Of course, higher level theories frequently have lower level theories imbedded within them. For example, TNT has a decision theory, called the discrepancy test, within it (Essay #11). So, TNT, including its discrepancy test, would be at a high level and the discrepancy test alone would also be at a lower level.

What constitutes evidence for or against a theory depends on its level. Evidence for lower level, focused theories is direct; experiments, case histories and the like. Evidence for higher level theories is less direct, starting with support for its component, lower level theories and proceeding to how reasonably it fits (is contextual) with other theories at its own and adjacent levels and with relevant parts of, brain physiology and neurology, evolutionary biology, and mathematics. That is, for a cognitive theory to be valuable, it must take its place in the context of the broader science of cognition, and allied disciplines. To the degree that it fits, support for these other areas is support for it. In short, support for a theory like TNT comes upward from its component lower level theories and laterally from its contextual fit with relevant higher-level theories in cognition and allied disciplines. And there is a third direction—how well the theory fits within the context of real-world issues. After all, cognition is about the world, so a theory of cognition should both fit and offer insights into the sorts of things that people actually think about, talk about, and form expectations about.

As you proceed through the following essays, you'll note the profusion of citations. These aren't there to show you we're learned or well read. Nor are they there simply to blame somebody else for our declarative sentences (as in "Don't blame us if we're wrong, blame them"). They're there to identify contextual links between TNT and lower level and lateral cognitive theories, other disciplines, and real-world issues. The same with the essays themselves; every one of them is about the contextual fit between TNT and other theories, disciplines, or real-world issues.

Two examples: Consider two papers we recently came across that provide the kind of lateral support discussed above. The first is about a concept in computational neurology called *predictive processing*. As described by Miller and White (2021), "Predictive processing casts the brain as a "prediction engine" – something that's constantly attempting to predict the sensory signals it encounters in the world, and to minimize the discrepancy (called the "prediction error") between those predictions and the incoming signal. Over time, such systems build up a "generative model", a structured understanding of the statistical regularities in the environment that's used to generate predictions. This generative model is essentially a mental model of the world, including both immediate, task-specific

information, as well as longer-term information that constitutes a narrative sense of self. [Prediction errors are minimized by updating] the generative model to more accurately reflect the world, or [by bringing] the world better in line with [the] prediction. In this way, the brain forms part of an embodied predictive system that's always moving from uncertainty to certainty. By reducing potentially harmful surprises, it keeps us alive and well."

The contextual fit with TNT is readily apparent:

- Predictive processing's (PP's) generative model is parallel to TNT's prime image, although it is not clear that the internal structure and the prediction mechanism for the former are as clearly defined as they are for TNT. But the two are largely the same.
- PP is about prediction of sensory signals. TNT is about prediction of events, bundles of sensory signals. Otherwise, the underlying idea is largely the same.
- PP uses the discrepancies between predicted signals and sensed signals to revise its generative model. TNT uses discrepancies between expectations and what actually happens to revise the prime narrative (see Essay #5 for details). Again, the ideas are largely the same.
- PP's generative model consists of the statistical regularities in the environment. TNT's prime narrative consists of events structured by time and causation and connected by causal rules. In TNT, probability is merely a way of measuring uncertainty about the reliability of the causal rules; how much one can rely upon the expectations that the rules engender. The underlying ideas are largely the same.

So, insofar as PP is a successful theory, its similarity to TNT could allow TNT to claim the same success (and vice versa).

The second of our two examples is about the neurological foundations of cognitive beliefs. Seitz and Angel (2020) examined the neurological bases and correlates of belief formation and conclude that there are three kinds of beliefs.

- Empirical beliefs form instantly and are about perceptions of objects and belief that those objects are real—TNT simply calls this perception which is about how sensations are synthesized into events and given meaning and emotional content through causal connections with past events.

- Relational beliefs, also are formed instantly and are about relationships among perceived objects—TNT calls these relationships causal rules—the predictability of one event given knowledge of another event.
- Conceptual beliefs are not formed instantly and require language. These beliefs are narratives that ... "pertain to human-unique events including the sequences of sensory signals such as music and language-based information ... Humans are used to telling stories about their own and other people's past, their origins, and their goals, and their future after physical death" (p. 3). TNT calls these derived narratives.

As with the first illustration, evidence supporting this classification of beliefs could be used as lateral evidence for TNT.

PART II

CONTEXT

The two essays in Part II follow from the discussion about how to test higher level psychological theories that was advanced at the end of Essay #1. Recall that the main idea is that lateral contextual ties with other disciplines are themselves a form of supporting evidence for a theory. In the case of TNT, three relevant disciplines are neuroscience, evolutionary biology, and the mathematical description of natural processes. The many citations of neuroscience research cited throughout Essay #1 and the remainder of this book establish the required links with that discipline. Essay #2 will examine contextual ties with evolutionary biology and Essay #3 will do so with the mathematics that best describes large parts of the physical (and social) sciences, called group theory. Space limitations dictate that both of these essays merely scratch the surface of their respective topics. They each could be expanded into books of their own. But, perhaps they will at least give the essence of our contention that they provide contextual support for TNT.

But context is but one goal of the following essays. They also describe the evolutionary and mathematical foundations of narrative and TNT. Evolution within an environment that can be described mathematically implies that the mathematical structure of that environment shaped and is reflected in the evolutionary outcome. That is, narrative thought is the way it is because humans evolved within a world that is structured the way it is.