THE MIND'S I

Fantasies and Reflections on Self and Soul

COMPOSED AND ARRANGED BY

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AND

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DOUGLAS R. HOFSTADTER

A Conversation with Einstein's Brain

The Tortoise and Achilles bump into each other accidentally at the edge of one of the large octagonal ponds in the Jardin du Luxembourg in Paris, where young lads and lasses often take their small sailboats—and, in this day and age, even motorized and radio-controlled boats. But this is beside the point. It is a pleasant fall day.

ACHILLES: Why, Mr. Tortoise! I thought you were back in the fifth century B.C.!

TORTOISE: What about yourself? As for me, I often stroll through the centuries. It's good for the spleen, and besides, I find it refreshing on a pleasant fall day to meander among the bushes and trees, watching children grow old and die, only to be supplanted by a new generation of equally brainless, but generally rambunctious, human beings. Ah, what a harried existence it must be, to be a member of that feeble-minded species. Oh—pardon me! Indeed, I totally forgot I was addressing a member of that noble race. Why, you, Achilles, of course are an exception to the rule (thereby proving it, as the common human "logic" has it). You have been known, on occasion, to come out with truly insightful comments about the human condition (even if they were, to some extent, more or less accidental and unintended!). I feel very privileged to have known you, of all the human race, Achilles.

ACHILLES: Why, how kind of you to say those things about me. I'm sure I hardly deserve them. But, getting back to our chance meeting, I happen to be here today to have some footraces with a friend. However, he did not show up, so I am led to guess that he had sized up his chances and decided to spend his day some more profitable way. So here I am with nothing particular to occupy me, a leisurely day ahead of me to stroll about, watching the people (and Tortoises), and musing on philosophical matters, which, as you know, is a hobby of mine.

TORTOISE: Ah, yes. As a matter of fact, I too have been musing somewhat over some somewhat amusing ideas. Perhaps you'd like me to share them with you?

ACHILLES: Oh, I should be delighted. That is, I should be delighted as long as you're not going to try to snare me in one of your wicked traps of logic, Mr. T.

TORTOISE: Wicked traps? Oh, you do me wrong. Would I do anything wicked? I'm a peaceful soul, bothering nobody and leading a gentle, herbivorous life. And my thoughts merely drift among the oddities and quirks of how things are (as I see them). I, humble observer of phenomena, plod along and puff my silly words into the air rather unspectacularly, I am afraid. But to reassure you about my intentions, I was only planning to speak of brains and minds this fine day —and as you know, of course those things have nothing—nothing whatsoever—to do with logic!

ACHILLES: Your words *do* reassure me, Mr. T. And, in fact, my curiosity is quite piqued; I would certainly like to listen to what you have to say, even if it is unspectacular.

TORTOISE: You're a tolerant soul, Achilles—a praiseworthy way to be. Well, we're about to broach a difficult subject, so I will ease us gently into the waters by means of an analogy. You *are* familiar with "playing-records," aren't you—the kind of grooved plastic platters upon which are imprinted fine, near-microscopic patterns?

ACHILLES: Indeed I am. *Music* is stored upon them.

TORTOISE: Music? I thought music was something to listen to.

ACHILLES: Yes, it is, to be sure. But one can listen to playing-records.

TORTOISE: I suppose. If you put them up next to your ear. But they must make awfully silent music.

ACHILLES: Oh, surely, Mr. T, you are joking. Haven't you ever listened to the music stored upon a playing-record?

TORTOISE: To tell the truth, I have been inspired, at times, upon glancing at some playing-records, to hum tunes. Is that it?

ACHILLES: Hardly. You see, you put them on a rotating turntable and place a thin needle, which is affixed within a long arm, in the outermost groove, and—well, the details are too much for me, but the end result is that you hear the glorious sounds of music coming out of a device called a loudspeaker.

TORTOISE: I see, yet I don't see; why don't you just use the loudspeaker and dispense with the other paraphernalia?

ACHILLES: No—you see, the music is not stored in the loudspeaker; it is in the *record.*

TORTOISE: In the record? But the record is there *all at once;* music, as I know it, comes slowly, a bit at a time. Isn't that so?

ACHILLES: You are right on both counts. But even though the record is there "all at once," as you put it, we can draw sounds out of it bit by bit. The idea behind this is that the grooves pass slowly under the needle, and as they pass, the needle vibrates slightly in response to those very fine designs you earlier referred to. Somehow, in those designs are coded musical sounds, which are processed and passed on to the loudspeaker, to dispense to our waiting ears. Thus we manage to *hear* the music just as you said, "a bit at a time." The whole process is quite marvelous, I should say.

TORTOISE: Well, it *is* marvelously complicated, I'll grant you *that.* But why don't you do as I do—just hang the record up on your wall and enjoy its beauty all at once, instead of in small pieces doled out over a period of time? Is it that somehow there is a masochistic pleasure in the pain of doling out its beauties so slowly? I am always against masochism.

ACHILLES: Oh, you have totally misunderstood the nature of music, I am afraid. You see, it is in the *nature* of music to be spread out over a period of time. One doesn't just enjoy it in one sudden burst of sound—it can't be done, you see.

TORTOISE: Well, I suppose one wouldn't like hearing one large piercing noise—the sum of all the parts—in one short blow. But why can't you humans do as I do—it's such a simple, obvious idea—hang the playing-record up on your wall and, with your eyes, take in all its pleasures at a glance! After all, they are all there, aren't they?

ACHILLES: I am astonished to hear that you find the surface of one playing-record any different from that of any other. They all look alike to me—much as Tortoises do.

TORTOISE: Well! I hardly need dignify *that* comment with an answer. You know very well that they are just as different as, say, two pieces of music, one by Bach and the other by Beethoven.

ACHILLES: They look very similar to *me.*

TORTOISE: Well, it was *you* who allowed as how the very surfaces of the record contain all the music—thus if the two pieces of music differ so must the record surfaces differ—and to exactly the *same* amount as do the pieces, moreover.

ACHILLES: I guess you've got a point there.

TORTOISE: I'm glad you'll grant me *that.* So, since all of the music is on the *face* of the record, why don't you take it in at a glance, or at most a cursory once-over? It would certainly provide a much more intense pleasure. And you'll have to grant that each part of the musical selection is in its proper place; the relationship of the parts is not lost, as it would be if all the *sounds* were to be heard at once.

ACHILLES: Well, in the first place, Mr. T, I don't happen to have very good eyes, and—

TORTOISE: Aha! I've got another solution! Why don't you paste all the pages of the written score of some selection upon your wall and regard its beauties from time to time, as you would a painting? Sure you'll have to admit that the music is all there, in every last respect.

ACHILLES: Well, to tell the truth, Mr. T, I must confess to a shortcoming in my aesthetic capacities: I doubt that I would know how to visually interpret the printed symbols in front of me in such a way as to give me the same pleasure as I gain from the actual hearing.

TORTOISE: I am sorry indeed to hear that. Why, it could save you so much time! For imagine, instead of wasting a full hour listening to a Beethoven symphony, on waking up some morning you could simply open your eyes and take it all in, hanging there on your wall, in ten seconds or less, and be refreshed and ready for a fine, fulfilling day?

ACHILLES: Oh, you do poor Beethoven an injustice, Mr. T, a sorry injustice.

TORTOISE: Why, not at all. Beethoven is my second favorite composer. I have spent many long minutes gazing at his beautiful works, both in score and on playing record. The sculpted forms in some of his playing records are so exquisite, you have no idea.

ACHILLES: I must admit, you have floored me. That is an odd way, to put it mildly, to enjoy music. But I suppose you *are* an odd character, and

this idiosyncracy makes as much sense, given what I know of you, as any of the rest.

TORTOISE: A condescending view. How would *you* like it, if some friend "revealed" to you that you'd never correctly understood a Leonardo painting—in reality, it should be *listened* to, not looked at, and is sixty-two minutes long, in eight movements, and contains long passages with nothing but the loud ringing of many different-sized bells?

ACHILLES: That is an odd way to think of paintings. But . . .

TORTOISE: Did I ever tell you about my friend the alligator, who enjoys music while lying on his back in the sun?

ACHILLES: Not that I recall.

TORTOISE: He has the advantage of having no shell covering his belly. So whenever he wants to "hear" a lovely piece, he picks out the appropriate disk and slaps it sharply for an instant against his flat stomach. The ecstasy of absorbing so many luscious patterns all at once, he tells me, is indescribable. So just think—his experience is as novel to me as mine is to you!

ACHILLES: But how can he tell the difference between one record and another?

TORTOISE: To *him*, slapping Bach and Beethoven against his belly are as different as to *you* slapping a waffle iron and a velvet pad against your bare back would be!

ACHILLES: In so turning the tables on me, Mr. T, you *have* shown me one thing—*your* point of view must be just as valid as *mine*—and if I did not admit it, I should be an auditory chauvinist pig.

TORTOISE: Well put—admirably put! Now that we have gone over our relative points of view, I will have to confess to being familiar with your way of listening to playing records, rather than looking at them, odd though it does seem to me. The comparison between the two types of experience was what inspired me to exploit this example as an analogy to what I wish to present to you now, Achilles.

ACHILLES: More of your usual trickery, I see. Well, go on with it—I'm all eyes.

TORTOISE: All right. Let's suppose that I came to you one morning with a very big book. You'd say, "Hullo, Mr. Tortoise—what's in that big book you're carrying with you?" (if I'm not mistaken); and I'd reply, "It's a schematic description of Albert Einstein's brain, down to the cellular level, made by some painstaking and slightly crazy neurologist after Einstein died. You know he bequeathed his brain to science, don't you?" And you'd say, "What in the world are you talking about, 'a schematic description of Albert Einstein's brain, down to the cellular level'?" would you not?

ACHILLES: I certainly would! The notion sounds preposterous. I suppose you'd go on roughly as follows: "Probably you're aware, Achilles, that a brain—any brain—is composed of neurons, or nerve cells, linked together by fibers called 'axons' to form a highly interconnected network." I'd say interestedly, "Go on." So you would.

TORTOISE: Bravo! You're doing very well! You took the words right out of my mouth! So I would indeed go on, as you suggested. I'd continue, "The details are beside the point here, but a little knowledge is essential. These neurons are known to *fire*, which means that a minuscule electric current (regulated by the resistance of the axon) passes down an axon into an adjoining neuron, where it may join other signals in a combined effort to 'trigger' this neighbor-neuron to fire in turn. The neighbor, however, will cooperate only if the sum of the incoming currents has reached a threshold value (which is determined by its internal structure); otherwise it will refuse to fire at all." At this point, you might say, "Hmm."

ACHILLES: So how would you go on, Mr. T?

TORTOISE: A good question. I suppose I might say something like this: "The foregoing is a peanut-sized summary of the goings-on in a brain, but I suppose it's sufficient background for an explanation of what this heavy book is that I'm carrying about with me today." If I know you at all, you'd say, "Oh, I'm eager to hear about it, but perhaps I should be warier, lest it contain one of your infamous schemes, whereby you lure poor little unsuspecting me into one of your inescapable absurdities." But I'd reassure you that no such prospect was in store, and thus reassured, you'd urge me to divulge the contents of the book, about which you, having taken a peek in it, might say, "It just looks like a lot of numbers and letters and little abbreviations and things!" And I'd say, "What did you expect? Little pictures of stars and galaxies and atoms, whirling about with formula such as '$E = mc^2$' scattered hither and thither?"

ACHILLES: At that swipe, I might take offense. I'd say indignantly, "Certainly not."

TORTOISE: Of course you would—rightly so. And then you'd say, "Well, what *are* all those numbers and things? What do they stand for?"

ACHILLES: Let *me* go on. I can anticipate, I believe, just how you'd reply: "Each page of this book—and there are around a hundred billion numbered pages in it—corresponds to one neuron and contains numbers recording such aspects relevant to that neuron as: which other neurons its axons lead to, what its threshold current is for firing, and so on. However, I forgot to tell you certain further important facts about the functioning of brains in general—in particular, what happens, or is believed to happen (from all we know from neurological research), when thoughts occur in the brain, and especially conscious thoughts." I might object with some vaguely worded complaint about thoughts occurring in the *mind,* not the *brain,* but you'd hastily dismiss *that* remark and say, "We can talk about that some other time—say, for example, if we meet by chance in the Jardin du Luxembourg someday. But for now my goal is to explain the contents of this book to you." I'd be placated, I suppose, as I usually am, so you'd press on with a comment in this vein: "A thought occurs (in the mind *or* the brain, whichever you prefer—*for now!*) when a series of connected neurons fire in succession—mind you, it may not be a long string of *individual* neurons firing like a chain of dominoes falling down one after another—it may be more like *several* neurons at a time tending to trigger another few, and so forth. More likely than not, some stray neural chains will get started along the side of the mainstream but soon will peter out, as threshold currents are not attained. Thus, one will have, in sum, a broad or narrow squad of firing neurons, transmitting their energy to others in turn, thus forming a dynamic chain that meanders within the brain —its course determined by the various resistances in the axons that are encountered along the way. It would not be out of place to say that 'the path of least resistance is followed,' if you follow me." At this point, I'd be sure to comment, "You've surely said a mouthful —let me have a moment to digest it." After mulling over this food for thought you'd so far provided me with, and asking you a few clarifying questions on it, I'd be satisfied that I'd gotten the general picture. Of course you'd probably tell me that if I wanted more information on the subject, I could easily go look it up in almost any popular book about the brain. So then you'd say, "Let me wind up this description of neural activity by briefly describing what accounts for *memory,* at least as well as has been so far established. Think of the 'flashing spot of activity' careening around within the brain ('where all the action is,' so to speak) as a boat traveling across the surface of a pond, such as those toy sailboats that children sometimes bring to the octagonal ponds in the Jardin du Luxembourg, the site

of our hypothetical mind-brain encounter; every boat leaves a disturbance behind it, its wake, as it travels through its medium. The 'hot spot' within the brain, just like the boat, leaves its own kind of disturbance, or wake, behind: the neurons that just fired as the signal came through continue to undergo some kind of internal activity—perhaps chemical in nature—for a few seconds. A permanent change in the neuron is thereby effected. The change is reflected in some of the numbers we have already spoken of, such as the threshold value for firing, the axon resistances, and so forth. The exact way in which those numbers are modified is, of course, dependent on certain aspects of the internal structure in question—and these aspects themselves are susceptible to numerical encoding." *I* might well chime in at this point, I imagine, saying "Hence it would be of utmost importance to record *those* numbers for every neuron, as well as the already-mentioned resistances and thresholds." You would no doubt reply, "An astute remark, Achilles; I had not anticipated you'd see that necessity so quickly. And we might do well to give those numbers a name too: the 'structure-altering numbers' seems adequate to me." To conclude this exchange, I might make the following sort of remark: "The structure-altering numbers are quite remarkable in that they not only describe how *other* numbers on the page are to change, but also how they themselves are to change, next time the neural flash comes passing through!"

TORTOISE: Oh, you have captured quite well the essence of what might go on between the two of us in an admittedly hypothetical dialogue. I might well say all the words you attributed to me; and I have every reason to believe that you too could come forth with such utterances as you have just proposed. Thus, what have we come to? Ah, yes, I recall—in the hypothetical situation set up, I was in possession of a book, wherein were numerically recorded all the relevant data, neuron by neuron, taken from the brain of Albert Einstein the day of his death. On each page, we have: (1) a threshold value; (2) a set of page numbers, to indicate neurons linked to the present one; (3) the values of resistance of the linking axons; and (4) a set of numbers indicating how the wakelike "reverberations" of the neuron, which occur as a result of its firing, will alter any of the numbers on the page.

ACHILLES: By telling me what you have just said, you would have completed your aim of explaining to me the nature of the heavy tome in your possession. So we would probably have come to the end of our hypothetical dialogue, and I can imagine that we would soon

thereafter bid each other adieu. Yet I cannot help making the observation that the reference you made in that hypothetical dialogue to some possible future conversation in these gardens between the pair of us strikingly suggests the circumstances in which we find ourselves today!

TORTOISE: How coincidental! It surely is by pure chance.

ACHILLES: If you don't mind, Mr. T, I'd like to know how this fictitious Einstein book could conceivably shed any light on the "mind-brain" problem. Could you oblige me in that respect?

TORTOISE: Willingly, Achilles, willingly. *Would* you mind, though, if I added a few extra features to the book, since it *is* hypothetical, anyway?

ACHILLES: I can't see why I should object at *this* point. If it's already got a hundred billion pages or so, a few more can't hurt.

TORTOISE: A sporting attitude. The features are as follows. When sound hits the ear, the oscillations set up within the drum are relayed to delicate structures within the middle and inner ear; these eventually connect to neurons whose duty it is to process such auditory information—thus we could call them "auditory neurons." Likewise, there exist neurons whose duty it is to convey coded directions to any given set of muscles; thus, hand motions are caused by the firing of specific neurons in the brain linked indirectly to the muscles in the hand. The same can be said of the mouth and vocal cords. As our additional information, then, for the book, we'd like to have whatever set of data is required to know precisely how the auditory neurons will be excited by a given incoming tone, if we supply its pitch and loudness. And the other essential chapter in the book is the one that tells in what way the firing of any "mouth-directing neuron" or "vocal-cord-directing neuron" will affect the muscles of the organ in question.

ACHILLES: I see what you mean. We'd like to know how the internal structure of neurons was affected by any auditory input signal; and also how the firing of certain key neurons, linked to speech organs, would affect those organs.

TORTOISE: Precisely. You know, sometimes, Achilles, it's good to have you around to bounce my ideas off of—they come back at me considerably cleaner than when I came out with them. Your naive simplicity somehow complements my learned verbosity.

ACHILLES: I'd like to bounce that one off on you, Mr. T.

TORTOISE: How's that? What do you mean? Did I say something untoward?

ACHILLES: Now, Mr. T, I assume that in the heavy tome under discussion, there would be numerical conversion tables, which accomplish precisely the tasks just set forth. They would give the neural response of each auditory neuron to any tone; and they would give the changes in mouth shape and vocal-cord tension as a function of the neurons linked to them by nerves in Einstein's body.

TORTOISE: Right you are.

ACHILLES: How could such an extensive documentation of Einstein do anybody any good?

TORTOISE: Why, it could do no good for anyone, except conceivably some starving neurologist.

ACHILLES: So why have you proposed this stupendous volume, this prodigious opus?

TORTOISE: Why, only to tickle my fancy as I mused on mind and brain. But it may serve as a lesson to novices in the field.

ACHILLES: Am I one?

TORTOISE: Doubtless. You'll do very well as a test subject in illustrating the merits of such a book.

ACHILLES: I somehow can't help wondering what old Einstein would think of it all.

TORTOISE: Why, given the book, you could find out.

ACHILLES: I could? I would not know where to begin.

TORTOISE: You would begin by introducing yourself.

ACHILLES: To whom? To the book?

TORTOISE: Yes—it's Einstein, isn't it?

ACHILLES: No, Einstein was a *person,* not a *book.*

TORTOISE: Well, that's a matter for some consideration, I'd say. Didn't you say that there is music stored in playing-records?

ACHILLES: I did, and what's more, I described to you how to get at it. Instead of a playing-record being there "all at once," we can use an appropriate needle and other apparatus and extract real, living music from it, which emerges "a bit at a time"—just like *real* music.

TORTOISE: Are you implying that it is only some kind of synthetic imitation?

ACHILLES: Well, the sounds are genuine enough. . . . They *did* come off plastic, but the music is made of real sounds.

TORTOISE: And yet it's there "all at once" too, isn't it—as a disk?

ACHILLES: As you pointed out to me earlier, yes, it is.

TORTOISE: Now you might at first say that music is *sounds,* not a record, mightn't you?

ACHILLES: Well, yes, I would; yes.

TORTOISE: Then you are very forgetful! Let me recall to you that *to me,* music is the record itself, which I can sit and tranquilly admire. *I* don't presume to tell *you* that to see Leonardo's Madonna of the Rocks as a *painting* is to miss the point, do I? Do I go around claiming that that painting is only a storage place for long, droning bassoon blasts, melodious piccolo runs, and stately harp dances?

ACHILLES: Why, no, you don't. I guess that either way, we respond to some of the same features of playing-records, even if you like their *visual* aspect, while I prefer their *auditory* aspect. At least, I *hope* that what you like in Beethoven's music corresponds to what *I* like.

TORTOISE: May or may not. Personally, I don't care. Now, as to whether Einstein was a person, or is in the book. . . . You should introduce yourself and see.

ACHILLES: But a *book* can't *respond* to a statement—it's like a black piece of plastic: It's there "all at once."

TORTOISE: Perhaps that little phrase will serve as a clue to you. Consider what we just said on the subject of music and playing-records.

ACHILLES: You mean, I should try to experience it "a bit at a time"? What bit should I begin at? Should I start at page 1 and read straight on through, to the end?

TORTOISE: Unlikely. Suppose you were going to introduce yourself to Einstein—what would you say?

ACHILLES: Ah . . . "Hullo, Dr. Einstein. My name is Achilles."

TORTOISE: Splendid. Now there are some fine tones of sound for you.

ACHILLES: Tones . . . hmmm. Are you planning to use those conversion tables?

TORTOISE: Good gracious, what a brilliant thought. Why didn't it occur to me?

ACHILLES: Well, everybody has inspirations once in a while, you know. Don't feel too bad.

TORTOISE: Well, you came up with a good thought. That's just what we'd try to implement, had we the book.

ACHILLES: So, you mean, we'd look up the possible changes in Einstein's auditory neuron structure resulting from each tone of the utterance?

TORTOISE: Well, roughly. You see, we'd have to do it *very* carefully. We'd take the first tone, as you suggested, and see which cells it would make fire, and how. That is, we'd see precisely how each number on each page would change. Then we'd go through the book painstakingly page by page, and actually *effect* those changes. You might call that "round one."

ACHILLES: Would round two be a similar process occasioned by the second tone?

TORTOISE: Not quite. You see, we haven't completed the response to the first tone yet. We've gone through the book once, neuron by neuron. But there is the fact that some of the neurons are firing, you know, so we have to take that into account. Which means we have to proceed to the pages where their axons lead and modify *those* pages in the way that is directed by the "structure-changing numbers." *That* is round two. And those neurons, in turn, will lead us to still others, and lo and behold, we're off on a merry loop around the brain.

ACHILLES: Well, when do we ever come to the second tone?

TORTOISE: Good point. It's something I neglected to say earlier. We need to establish a kind of time scale. Perhaps on each page the time taken for the neuron in question to fire is specified—the time it took to fire in real life, in Einstein's brain—a quantity best measured, probably, in thousandths of a second. As the rounds progress, we sum up all the firing times, and when the times add up to the length of the first tone, we start in on the second tone. That way, we can proceed to feed in tone after tone of your self-introductory utterance, modifying the neurons that would respond to that utterance at every step along the way.

ACHILLES: An interesting procedure. But surely a very lengthy one.

TORTOISE: Well, as long as it is all hypothetical, that should not bother us in the least. It would probably take millennia, but let's just say five seconds, for the sake of argument.

ACHILLES: Five seconds required to feed in that utterance? All right. So right now, my picture is that we have altered scores, if not myriads, of pages in that book, changing numbers on page after page after

page, wherever we were led, either by the previous pages or by the tones that we were feeding in, via the auditory conversion tables.

TORTOISE: Right. And now, once the utterance is finished, neurons continue to fire—from one to the next, the cascade continues—so we perform a strange and elaborate "dance," shuffling back and forth between pages, round after round, without having any auditory input to bother with.

ACHILLES: I can see that something strange is about to happen. After another few "seconds" (if we are to stick to that somewhat ridiculous underestimate) of page turning and number changing, certain of the "speech neurons" will begin to fire. And we would then do well to consult the tables indicating shape of mouth or tension in vocal cords.

TORTOISE: You have caught wind of what is happening, Achilles. The way to read the book is not from page 1, but according to the directions in the preface, which tell about all the changes that must be effected and give all the rules for how to proceed.

ACHILLES: I suppose that given mouth shape and condition of vocal cords, it would be within grasp to determine what Einstein is "saying," wouldn't it? Especially given the level of technical advancement we've presupposed, that seems only a minor task. So I suppose he would say something to me.

TORTOISE: I presume so—such as, "Oh, hello. Did you come to visit me? Have I died?"

ACHILLES: That is a strange question. Of course he did.

TORTOISE: Well, then who's asking you the question?

ACHILLES: Oh, just some silly book. It's not *Einstein,* of course! You can't trap me into saying *that!*

TORTOISE: I wouldn't dream of it. But perhaps you'd like to address some more questions to the book. You could conduct a whole conversation, if you had the patience.

ACHILLES: That is an exciting prospect—I could see just what Einstein *would* have said in conversations with me, if I'd ever *really* met him!

TORTOISE: Yes, you could begin by asking how he felt; then proceeding to a description of how glad you were to meet him, since you'd never had the chance during his lifetime—proceeding just as if he were the "real" Einstein, which, of course, you've already decided was out of the question. How do you suppose he would react, when you told him he's not the *real* Einstein?

ACHILLES: Now, hold on a minute—you're employing the pronoun "he" about a *process* combined with a huge *book.* That's no "he"—it's something else. You're prejudicing the question.

TORTOISE: Well, you *would* address him as Einstein as you fed in questions, wouldn't you? Or would you say, "Hullo, book-of-Einstein's-brain-mechanisms, my name is Achilles"? I think you would catch Einstein off guard if you did that. He'd certainly be puzzled.

ACHILLES: There *is* no "he." I wish you'd quit using that pronoun.

TORTOISE: The reason I'm using it is that I'm simply imagining what you *would* have said to him, had you actually met him in his hospital bed in Princeton. Certainly you *should* address questions and comments to the book in the same fashion as you *would* have to the *person* Einstein, shouldn't you? After all, the book initially reflects how his brain was on the last day of his life—and he regarded himself as a person then, not a book, didn't he?

ACHILLES: Well, yes. I should direct questions at the book as I would have to the real person had I been there.

TORTOISE: You could explain to him that he had, unfortunately, died, but that his brain had been encoded in a mammoth catalogue after his death, which you are now in possession of, and that you are conducting your conversation by means of that catalogue and its conversion tables for speech.

ACHILLES: He'd probably be most astonished to hear *that!*

TORTOISE: Who? I thought there was no "he"!

ACHILLES: There is no "he" if I'm talking to the book—but if I told it to the *real* Einstein, *he'd* be surprised.

TORTOISE: Why would you be telling a live person to his face that he had already died, that his brain had been encoded in a catalogue, and that you were conducting your conversation with him through that catalogue?

ACHILLES: Well, I *wouldn't* tell it to a *live* person, I'd tell it to the book, and find out what the live person's reactions *would* have been. So, in a way, "he" *is* there. I am beginning to be puzzled . . . who am I talking to in that book? Is there somebody alive because it exists? Where are those thoughts coming from?

TORTOISE: From the book. You know that very well.

ACHILLES: Well, then, how can he say how he's feeling? How does a *book* feel?

TORTOISE: A book doesn't feel any way. A book just *is*. It's like a chair. It's just there.

ACHILLES: Well, this isn't just a book—it's a book plus a whole *process*. How does a book plus a process feel?

TORTOISE: How should I know? But you can ask it that question yourself.

ACHILLES: And I know what it'll say: "I'm feeling very weak and my legs ache," or some such thing. And a book, or a book-plus-process, *has* no legs!

TORTOISE: But its neural structure has incorporated a very strong *memory* of legs and leg-aching. Why don't you *tell* it that it's now no longer a person, but a book-plus-process? Maybe after you've explained that fact in about as much detail as you know it, it would start to understand that and forget about its leg-aching, or what it took for leg-aching. After all, it has no vested interest in feeling its leg, which it doesn't have, aching. It might as well ignore such things and concentrate on what it *does* have, such as the ability to communicate with you, Achilles, and to think.

ACHILLES: There is something frightfully sad about this whole process. One of the sadder things is that it would take so much *time* to get messages in and out of the brain, that before I'd completed many exchanges, I'd be an old man.

TORTOISE: Well, you could be turned into a catalogue too.

ACHILLES: Ugh! And not have any *legs* left, to run footraces? No thank you!

TORTOISE: You could be turned into a catalogue and continue your thought-provoking conversation with Einstein, as long as someone were managing your book, flipping pages and writing numbers in it. Even better, you could conduct several conversations at once. All we need do is make several copies of the Achilles catalogue, including directions for use, and send it around to whomever you desired. You'd enjoy that.

ACHILLES: Ah, now, that's more exciting. Let's see—Homer, Zeno, Lewis Carroll . . . provided that catalogues had been made of *their* brains, as well. But wait a minute. How am I going to keep track of all those conversations at once?

TORTOISE: No trouble—each one's independent of the others.

ACHILLES: Yes, I know—but I've still got to keep them in my head all at once.

TORTOISE: Your head? You would have no head, remember.

ACHILLES: No head? Then where would *I* be? What is going on here?

TORTOISE: You'd be at all those different places at once, conducting fine conversations with all those people.

ACHILLES: How would it feel to be conducting conversations with several people at a time?

TORTOISE: Why don't you just imagine what it would be like to ask Einstein, presuming, of course, that you had made several copies of *his* catalogue, and shipped them about to various of your friends, or anyone, for that matter, and they too were talking with him.

ACHILLES: Well, if I didn't tell the Einstein in my possession about it, he'd have no way to know of the other catalogues or conversations. After all, each catalogue has no way of being influenced by any of the other catalogues. So I guess he'd just say that *he* certainly didn't feel like he was engaging in more than one discussion at a time.

TORTOISE: So that's how *you'd* feel too, if several of *you* were engaging in simultaneous conversations.

ACHILLES: *I*? Which one would be me?

TORTOISE: Any of them; all of them; or perhaps, none of them.

ACHILLES: This is eerie. I don't know where I would be—if anywhere. And all of those weird catalogues would be claiming to be me.

TORTOISE: Well, you should expect as much; you do it yourself, don't you? Why, I could even introduce a pair of you—or all of you—to each other.

ACHILLES: Uh-oh. I was waiting for this moment. Every time I see you, you spring something like this on me.

TORTOISE: There just might ensue a teeny scrap over which one was the real one, don't you think so?

ACHILLES: Oh, this is a diabolical scheme to squeeze the juice out of the human soul. I'm losing a clear sight of who "I" is. Is "I" a person? A process? A structure in my brain? Or is "I" some uncapturable essence that *feels* what goes on in my brain?

TORTOISE: An interesting question. Let us go back to Einstein, to examine it. Did Einstein die, or was he kept on living by the creation of the catalogue?

ACHILLES: Well, to all appearances, some part of his spirit was kept alive by the fact that the data were recorded.

TORTOISE: Even if the book never was used? Would he be alive then?

ACHILLES: Oh, that's a difficult one. I guess I'd have to say "no." Clearly what made him live on was the fact that we "brought him to life" from out of the sterile book, "a bit at a time." It was the *process*, above and beyond the mere data book. He was conversing with us, that's what made him alive. His neurons were firing, in a somewhat figurative way, albeit rather slowly compared to their usual speed—but that's of no consequence, as long as they were firing.

TORTOISE: Supposing it took you ten seconds to do round one, a hundred seconds to do round two, a thousand seconds to accomplish round three, and so forth. Of course, the *book* would not know how long all this took, because its only contact with the outside world is through its auditory conversion tables—and in particular, it can never know anything that you don't choose to tell it. Would it still be as alive, despite the enormous sluggishness of its firing after a few rounds?

ACHILLES: I don't see why not. If I too had been catalogued in the same way and my pages were being flipped equally lethargically, our rates of conversation would be matched. Neither he nor I would have cause to feel any abnormality in the conversation, even if, in the outer world, our mere exchange of greetings lasted millennia.

TORTOISE: You at first spoke of this process that brings out the structure "a bit at a time" as being so important, yet now it seems it doesn't matter if it's constantly slowing down. Eventually the rate of exchange of thoughts would be a syllable a century. And after a while, one neuron would fire every trillion years. Not exactly a sparkling conversation!

ACHILLES: Not in the outer world, no. But to the two of us, who are unaware of the passage of time in the outer world, all is well and normal, as long as someone does our internal bookwork—no matter how slowly. Einstein and I are serenely oblivious to the fast-changing world outside our flipping pages.

TORTOISE: Suppose this faithful neural clerk—let's call him A-kill-ease, just for fun (no relation to present company, of course)—just suppose he slipped off one afternoon for a little nip, and forgot to come back. . . .

ACHILLES: Foul play! Double homicide! Or do I mean bibliocide?

TORTOISE: Is it all that bad? Both of you are still there, "all at once."

ACHILLES: "All at once," bah! What's the fun of life if we're not being processed?

TORTOISE: Was it any better at an ever-slowing snail's pace?

ACHILLES: At *any* pace, it's better. Even a Tortoise's. But say—what's the point of calling the book-tender "A-kill-ease"?

TORTOISE: I just thought I'd let you think about how it would feel if your brain were not only encoded in a book, but also you were *minding* that very brain-book (no pun intended, to be sure!).

ACHILLES: I suppose I would have to ask my own book. Or no—wait a minute. My book would have to ask *me*! Oh, I'm so befuddled by these confounded and compounded *level*-confusions you always hit me with out of the blue! Ah! I have a grand idea. Suppose there was a machine that came along with the books, a machine that does the page turning, the little calculations, and the clerical work. This way we would avoid the problem of human unreliability, as well as your strange twisty loop.

TORTOISE: Suppose so—an ingenious plan. And suppose the machine broke.

ACHILLES: Oh, you have a morbid imagination! What recherché tortures you would put me through!

TORTOISE: Not at all. Unless somebody told you of it, you wouldn't even be aware of the machine's existence, much less that the machine had broken.

ACHILLES: I don't like this isolation from the outer world. I'd rather have some way of sensing what's going on around me than be dependent upon people telling me things of their own choice. Why not take advantage of the neurons which, in life, processed visual input? Just like the auditory conversion tables, we could have *optical* conversion tables. These will be used to create changes in the book according to the signals from a television camera. Then I could watch the world about me, and react to its events. In particular, I'd soon become aware of the page-turning machine, the book full of so many pages and numbers, and so on. . . .

TORTOISE: Oh, you are determined to suffer. So now you'll perceive the fate that is to befall you: You'll "see," by means of input fed into you via the television camera and the conversion tables, that the mechanical page-turner that has served you so well has a loose part that is just about to slip. *That*'ll scare you, all right. And what good is that? If you had no optical scanning device, you'd have no way of knowing

what's going on in the world about you, not even with respect to your page-turner. Your thoughts proceed calmly and coolly, unaffected by the cares of the outside world, blithely unaware that they may soon come to a forced end, since the page-turner may break. An idyllic existence! Up until the very end, not a worry!

ACHILLES: But when it breaks, I would be dead and gone.

TORTOISE: You would?

ACHILLES: I'd be a lifeless, motionless heap of number-covered sheets.

TORTOISE: A pity, I'm sure. But maybe old A-kill-ease would somehow find his way back to his familiar haunts, and take up where the broken machine left off.

ACHILLES: Oh! So I'd be resuscitated. I was dead for a while, and then returned to life!

TORTOISE: If you insist on making these strange distinctions. What makes you any "deader" when the machine breaks than you are when A-kill-ease leaves you unattended for a few minutes or a few years, to play a game of backgammon, to take a trip around the world, or to go get *his* brain copied into a book?

ACHILLES: I'm obviously deader when the machine breaks, because there is no expectation that I will ever resume functioning . . . whereas when A-kill-ease takes off on his sprees, he will eventually return to his duty.

TORTOISE: You mean, if you have been abandoned, you are still alive, just because A-kill-ease has the *intention* of returning? But when the machine breaks, you are dead?

ACHILLES: That would be a very silly way of defining "aliveness" and "deadness." Certainly such concepts should have nothing to do with the mere intentions of other beings. It would be as silly as saying that a light bulb is "dead" if its owner has no intention of turning it on again. Intrinsically, the light bulb is the same as ever—and that's what counts. In my case, what counts is that that book should be kept intact.

TORTOISE: You mean, that it should all be there, all at once? Its mere *presence* there is what guarantees your aliveness? Just as the existence of a playing-record is tantamount to the existence of its music?

ACHILLES: A funny image comes into my head. The earth is destroyed, but one record of Bach's music somehow escapes and goes sailing out into the void of space. Does the music still exist? It would be silly

to make the answer depend upon whether it is ever found and played by some humanlike creature—wouldn't it? To *you,* Mr. T, the music exists *as the record itself.* Similarly, when we come back to that book, I feel that if the book merely sits there, all at once, *I'm* still there. But if that book is destroyed, I'm gone.

TORTOISE: You maintain that as long as those numbers and conversion tables are in existence, *you* are essentially, potentially alive?

ACHILLES: Yes; that's it. That's what's all important—the integrity of my brain structure.

TORTOISE: Do you mind if I just ask, "Suppose someone absconded with the *instructions* in the preface, telling how to use the book?"

ACHILLES: Well, they'd better bring them back, is all I can say. My goose would be cooked if they weren't going to return those instructions. What good's the book without its instructions?

TORTOISE: Once again you are saying that the question as to whether you are alive depends on whether the filcher has good intentions or bad. It could just as well have been the capricious wind, blowing about, which caught hold of those few pages of preface and wafted them into the air. Now there's no question of *intention.* Would "you" be less alive for that?

ACHILLES: This is a little tricky. Let me go over the question slowly. I die; my brain is transcribed into a book; the book has a set of instructions telling how to process the book's pages in a way that parallels how my neurons fire in my actual brain right now.

TORTOISE: And the book, together with its instructions, lies on a dusty shelf in a far corner of a used book store. A chap comes in and chances upon the oddity. "Egads!" he exclaims, "An Achilles-book! What on earth could that be? I'll buy it and try it!"

ACHILLES: He should be sure to buy the instructions too! It is essential that the book and instructions remain together.

TORTOISE: How close? In the same binding? In the same bag? In the same house? Within a mile of each other? Is *your* existence somehow diminished if the pages are scattered hither and thither by a breeze? At what precise point would you feel the book had lost its structural integrity? You know, I appreciate a warped playing-record fully as much as a flat one. In fact, it's got an extra bit of charm, to the cultured eye. Why, I have a friend who considers broken records more stylish than the originals! You should see his walls—they're plastered with broken Bach—fragmented fugues, crushed canons,

ruptured ricercari. He delights in it. Structural integrity is in the eye of the beholder, my friend.

ACHILLES: Well, as long as you're asking *me* to be the beholder, I'd say that if the pages are to be reunited, there is still hope for my survival.

TORTOISE: Reunited *in whose eyes?* Once you're dead, you the beholder remain only in book form (if at all). Once the book's pages start being scattered, will you feel yourself losing structural integrity? Or, from the outside, once *I* feel that the structure is irretrievably gone, should I conclude that *you* no longer exist? Or does some "essence" of you exist still, in scattered form? Who will judge?

ACHILLES: Oh, goodness. I have totally lost track of the progress of that poor soul inside the book. And as to what he himself—or I myself —would be feeling, I am even more unsure.

TORTOISE: "That poor soul inside the book"? Oh, Achilles! Are you still clinging to that old notion that it's "you" somehow there, inside that book? If I am correct in my memory, you were so reluctant at first to accept that kind of idea when I suggested that you really *were* talking to Einstein himself.

ACHILLES: Well, I was reluctant until I saw that it—the book—seemed to feel, or at least to express, all his—Einstein's—emotions, or what *seemed* like emotions. But maybe you're right to chide me—maybe I should just trust the old, familiar commonsense view that the only *real* "I" is right here, inside my very own living, organic brain.

TORTOISE: You mean, the old, familiar "ghost-inside-the-machine" theory, is that it? What is it, inside there, that this "you" is?

ACHILLES: It's whatever *feels* all these emotions that I express.

TORTOISE: Maybe the *feeling* of those emotions is the sheer physical event of having a shower of electrochemical activity come flying through some one of the various neural pathways inside your brain. Maybe you use the word "feeling" to describe such an event.

ACHILLES: That sounds wrong, because the *book* uses the word "feeling," if *I* do, and yet it can feel no electrochemical activity surging. All that the book "feels" is its numbers changing. Perhaps "feeling" is synonymous with the existence of any kind of neural activity, simulated or otherwise.

TORTOISE: Such a view would place undue stress on the unfolding of feeling "a bit at a time." While the time development of a neural structure undoubtedly seems to us like the essence of feeling, why

could it not be that feelings, like playing-records and paintings, are there "all at once"?

ACHILLES: The difference I can immediately spot between a playing-record of a piece of music, and a mind, is that the former does not change by evolving "a bit at a time"; but a mind, in its interaction over a span of time with the exterior world, gets modified in a way that was not originally inherent in its physical structure.

TORTOISE: You have a good point. A mind, or brain, interacts with the world and thus is subject to change that one cannot predict by knowing the structure of the brain alone. But this does not in any way diminish the "aliveness" of said mind, when it introspectively ponders some thought, without any interference from without. During such a period of introspection, the changes it undergoes are inherent in it. Though it is evolving "a bit at a time," it is inherently there "all at once." I can clarify what I mean by drawing a parallel to a simpler system. The entire path of a thrown grapefruit is inherent once the grapefruit is released. Watching the fruit in flight is *one* way—the usual way—of experiencing its motion; it could be labeled the "bit-at-a-time" picture of its motion. But just knowing its *initial position* and *velocity* is another equally valid way of experiencing the motion; this picture of the motion could be labeled the "all-at-once" picture. Of course, in this picture we assume no interference by passing storks and so forth. A brain (or a brain catalogue) shares this dual nature; as long as it is not interacting with the exterior world and being modified in ways foreign to it, its time development can be viewed either in the "bit-at-a-time" picture or in the "all-at-once" picture. The latter picture is one that I advocate and that I thought you had come to agree with, when you described the record sailing out into space.

ACHILLES: I see things so much more easily in the "bit-at-a-time" picture.

TORTOISE: Of course you do. The human brain is set up to see things that way. Even in a simple case, like the motion of a flying grapefruit, the brain is more satisfied to *see* the actual motion "a bit at a time" than it is to visualize a parabola "all at once." But simply coming to recognize that there *is* an "all-at-once" picture was a great step by the human mind, because it amounted to the recognition that some regularities exist in nature, regularities that guide events in predictable channels.

ACHILLES: I recognize that *feeling* exists in the "bit-at-a-time" picture. I know this because that is how I feel my own feelings. But does it also exist in the "all-at-once" picture? Are there "feelings" in a motionless book?

TORTOISE: Is there music in a motionless playing-record?

ACHILLES: I am not sure any longer how to answer that question. But I still want to learn if "I" am in the Achilles book, or if the "real Einstein" is in the Einstein book.

TORTOISE: So you may; but for my part, *I* still want to learn if "you" are anywhere at all. So let us stick to the comfortable "bit-at-a-time" picture, and imagine the internal processes of your brain, Achilles. Imagine the "hot-spot," that infamous shower of electrochemical activity, as it zigzags its way along the "path of least resistance." You, Achilles, or what you refer to as "I," have no control over which path is the one of least resistance.

ACHILLES: I don't? Is it my subconscious, then? I know I sometimes feel my thoughts "spring up" to me as if motivated by subconscious tendencies.

TORTOISE: Perhaps "subconscious" is a good name for neural structure. It is, after all, your neural structure that, at any moment, determines which path is the one of least resistance. And it is because of that neural structure that the "hot-spot" follows that curlicue path and none other. This swirling electrochemical activity constitutes the mental and emotional life of Achilles.

ACHILLES: A weird and mechanistic song, Mr. T. I bet you could make it sound even stranger. Wax lyric if you can; let the verbs have their fling! Of Brain, Mind, and Man, let's hear the Tortoise sing!

TORTOISE: Your verse is surely inspired by the gods, my dear companion. The brain of Achilles is like a labyrinth of rooms; each room has many doors leading to other rooms—and many of the rooms are labeled. (Each "room" may be thought of as a complex of a few or a few dozen neurons—perhaps more; and "labeled" rooms are special complexes composed mostly of speech-neurons.) As the "hot spot" tears through this labyrinth, flinging open and slamming shut doors, from time to time it enters a "labeled" room. At that point your throat and mouth contract: you say a word. All the while the neural flash loops relentlessly along its Achillean path, in shapes stranger than the dash of a gnat-hungry swallow; every twist, every turn is foreordained by the neural structure present in your brain,

until sensory input messages interfere; then the flash veers away from the path it would have followed. And so it goes—room after room after labeled room is visited. You are speaking.

ACHILLES: I don't always speak. Sometimes I merely sit and think.

TORTOISE: Granted. The labeled rooms may have their lights turned low —a sign for non-utterance: you don't speak the words aloud. A "thought" occurs, silently. The hot spot continues—depositing, at door after door, either a drop of oil on the hinge to loosen it, or a drop of water to corrode it. Some doors have such rusty hinges they can't be opened. Others are so often oiled they nearly open by themselves. Thus traces of the present are deposited for the future: the "I" of now leaves messages and memories for the "I" of a time to come. This neural dance is the dance of the soul; and the sole choreographer of the soul is physical law.

ACHILLES: Normally, I think that *I'm* in control of what I think; but the way *you* put it turns it all around backward, so that it sounds like "I" am just what comes *out of* all this neural structure and natural law. It makes what I consider *myself* sound at best like a by-product of an organism governed by natural law and, at worst, like an artificial concept produced by my distorted perspective. In other words, you make me feel as if I don't know who—or what—I am, if anything.

TORTOISE: This is a very important matter to bring up. How can you "know" what you *are*? First of all, what does it mean to know something, anything, at all?

ACHILLES: Well, I presume that when I know something—or when, should I say, my *brain* knows something—there is a path that snakes through my brain, running through rooms, many of which are labeled. If I ever think a thought about the subject, my neural flash swishes along that path quite automatically, and if I am conversing, each time it passes through a *labeled* room, a sound of some type comes out. But of course I don't need to think about my neural flash for it to do this very competently. It seems as if *I* function quite well without *me!*

TORTOISE: Well, it's true that the "path of least resistance" does take care of itself quite well. But we can equate the result of all this functioning with *you,* Achilles. You needn't feel that your *self* is dispensed with in this analysis.

ACHILLES: But the trouble with this picture is that my "self" is not in control of myself.

TORTOISE: I suppose it depends upon what you mean by "control," Achilles. Clearly you cannot force your neural flash to deviate from the path of least resistance; but the Achilles of one moment is directly affecting what will become the path of least resistance in the *next* moment. That should give you some feeling that "you," whatever you are, have some control over what you will feel and think and do, in the future.

ACHILLES: Well, yes, that is an interesting way to look at it, but it still means that I can't just think whatever I *want* to think, but only what was *set up* for me to think, by an earlier version of me.

TORTOISE: But what is set up in your brain *is* what you want to think about, to a large degree. But sometimes, admittedly, you *can't* make your brain function as you will it to. You forget someone's name; you can't concentrate on something important; you become nervous despite your best attempts to control yourself; all of this reflects what you said: that in a sense *your "self" is not in control of yourself.* Now it is up to you whether or not you wish to identify the Achilles of now with the Achilles of bygone times. If you do choose to identify with your former selves, then you can say that "you"—meaning the you that used to exist—*are* in control of what you are today; but if you prefer to think of yourself as existing solely in the present, then indeed it is true that what "you" do is under control of natural law and not under control of an independent "soul."

ACHILLES: I am beginning to feel through this discussion that I "know" myself a little better. I wonder if it would be possible for me to learn *all about* my neural structure—so much so that I would be able to predict the path of my neural flash before it even covered its path! Surely, this would be *total,* exquisite self-knowledge.

TORTOISE: Oh, Achilles, you have innocently thrown yourself into the wildest of paradox, without the benefit of even the slightest coaching on my part! Maybe one day you will learn to do this regularly; then you will be able to dispense with me entirely!

ACHILLES: Enough of your mockery! Let's hear about this paradox I've inadvertently fallen into.

TORTOISE: How could you learn all about yourself? You might try reading the Achilles book.

ACHILLES: That would certainly be a phenomenal project. A hundred billion pages! I'm afraid I'd fall asleep listening to myself read. Or —horrors—I might even *die* before I had completed the task! But

suppose I were a very fast reader and managed to learn the contents of the *whole book* within the time allotted to me on the surface of our green sphere.

TORTOISE: So now you'd know all about Achilles—*before* he read the Achilles book! But you are quite *ignorant* about the Achilles who exists *now!*

ACHILLES: Oh, what a quandary! The fact that I *read* the book makes the book obsolete. The very attempt to learn about myself changes me from what I was. If only I could have a bigger brain, capable of digesting all of the complexity of myself. Yet I can see that even that would be of no avail, for possession of a bigger brain would make me all the more complex yet! My mind simply *can't* understand all of itself. All I can know is the outline, the basic idea. Beyond a certain point, I cannot go. Although my brain structure is right there in my head, exactly where "I" am, still its nature is not accessible to this "I." The very entity that constitutes "I"—and I am of necessity ignorant of it. My brain and "I" are not the same!

TORTOISE: A droll dilemma—the stuff of life's many hilarities. And now, perhaps, Achilles, we can pause to ponder one of the original questions that prompted this discussion: "Do thoughts occur in the *mind,* or in the *brain?*"

ACHILLES: By now, I hardly know what is meant by "mind"—except, of course, as a sort of poetic expression for the brain, or its activities. The term reminds me of "beauty." It is not something that one can locate in space—yet it is not hovering in an ethereal otherworld, either. It is more like a structural feature of a complex entity.

TORTOISE: Where lies the beauty, if I may rhetorically ask, of an étude by Scriàbin? In the sounds? Among the printed notes? In the ear, mind, or brain of the beholder?

ACHILLES: It seems to me that "beauty" is just a *sound* that we utter whenever our neural flash passes through a certain region of our brains—a certain "labeled room." It is tempting to think that to this sound there corresponds an "entity," some kind of "existing thing." In other words, because it is a noun, we think of beauty as a "Thing"; but maybe "beauty" denotes no Thing at all; the word is just a useful sound which certain events and perceptions make us want to pronounce.

TORTOISE: I would go further, Achilles: I would surmise that this is a property of *many* words—especially words like "beauty," "truth,"

"mind," and "self." Each word is but a *sound* which we are caused to utter, at various times, by our swooping, careening neural flash. And to each sound, we can hardly help but believe that there corresponds an Entity—a "Real Thing." Well, I *will* say that the benefit that one derives from using a sound imbues it with a proportionate amount of what we call "*meaning.*" But as to whether that sound denotes any Thing . . . how would we ever know *that?*

ACHILLES: How solipsistically you view the universe, Mr. T. I thought such views were highly unfashionable in this day and age! One is supposed to consider that Things have an Existence of their own.

TORTOISE: Ah, me, yes, perhaps they do—I never denied it. I suppose it's a pragmatic view of the meaning of "meaning," useful in the bustle of everyday life, to make the assumption that *some* sounds *do* stand for Existing Entities. And the pragmatic value of this assumption may be its best justification. But let's get back to the elusive site of the "real you," Achilles!

ACHILLES: Well, I'm at a loss to say if it's anywhere at all, even though another part of me is practically jumping to shout, "The 'real me' is here now." Maybe the whole point is that whatever mechanism makes me make everyday statements like "Spades are trump" is quite like the mechanism which makes me—or the Achilles book—say sentences such as "The 'real me' is here now." For certainly if *I*, Achilles, could say it, so could the book version of me—in fact, it would undoubtedly do so. Though my own first reflex is to affirm, "I know I exist; I *feel* it," maybe all these "feelings" are just an illusion; maybe the "real I" is all an illusion; maybe, just like "beauty," the sound "I" denotes no Thing at all, but is just a useful sound that we on occasion feel compelled to pronounce because our neural structures are set up that way. Probably that is what is happening when I say "I *know* I'm alive" or similar things. This would also explain why I got so puzzled when you brought up the version in which several copies of the Achilles book would be distributed to various people, and "I" would have conversations with all of them at once. I demanded to know where the "real I" was, and how "I" could take care of several conversations at once; I see now that each copy of the book has that structure built into it, that makes it automatically make pronouncements such as "I am the real me; *I* am feeling my *own* emotions and anybody else who claims to be Achilles is a fraud." But I can see that the mere fact that it utters such things doesn't mean that it has "real feelings"; and perhaps even more to the point, the mere fact that I, Achilles, utter such things, doesn't

really mean I am feeling anything (whatever that would mean!). In the light of all this, I am beginning to doubt if such phrases have any meaning at all.

TORTOISE: Well, of course, utterances about "feeling" one way or another are very useful, in practical terms.

ACHILLES: Oh, without doubt—I shan't shun them just because this conversation has taken place; nor shall I shun the term "I," as you can see for yourself. But I won't imbue it with such "soulful" meaning as I have heretofore tended to do, rather instinctively, and, I have to say, dogmatically.

TORTOISE: I am glad that for once we seem to be in agreement in our conclusions. I see that the hour is growing late; dusk is approaching —just the time when all my forces seem to gather, and I feel quite energetic. I know you must have been disappointed by the "no-show" of your friend; how's about a little footrace back to the fifth century B.C.?

ACHILLES: What a capital idea! But just to be *fair*, I'll give you a head start of, oh, three centuries, since I'm so fleet of foot.

TORTOISE: You're a mite cocky, Achilles. . . . You may not find it so easy to catch up with an Energetic Tortoise.

ACHILLES: Only a *fool* would bet on a slow-footed Tortoise, racing against *me*. Last one to Zeno's house is a monkey's uncle!

Reflections

"Well, all these fantasies have been fun, but they can't really tell us anything. They're just so much science fiction. If you want to learn the truth—the hard facts—about something, you have to turn to real science, which so far has had little to tell us about the ultimate nature of the mind." This response conjures up a familiar but impoverished vision of science as a collection of precise mathematical formulae, meticulous experiments, and vast catalogues of species and genera, ingredients and recipes. This is the picture of science as strictly a data-gathering enterprise in which imagination is tightly reined in by incessant demands for proof. Even some scientists have this vision of their profession, and are

deeply suspicious of their more playful colleagues, however eminent. Perhaps some symphony orchestra players view their business as nothing but precise noise-making produced under conditions of militaristic discipline. If so, think what they are missing.

In fact, of course, science is an unparalleled playground of the imagination, populated by unlikely characters with wonderful names (messenger RNA, black holes, quarks) and capable of performing the most amazing deeds: sub-atomic whirling dervishes that can be in several places—everywhere and nowhere—at the same time; molecular hoop-snakes biting their own tails; self-copying spiral staircases bearing coded instructions; miniature keys searching for the locks in which they fit, on floating odysseys in a trillion synaptic gulfs. So why not brain-book immortality, dream-writing machines, symbols that understand themselves, and fraternal homunculi without arms, legs, or heads, sometimes blindly following orders like the sorcerer's broom, sometimes feuding and conniving, sometimes cooperating? After all, some of the most fantastic ideas presented in this book—Wheeler's solitary electron weaving the universe, for example, or Everett's many-worlds interpretation of quantum mechanics, or Dawkins' suggestion that we are survival machines for our genes—have been proposed in complete seriousness by eminent scientists. Should we take such extravagant ideas seriously? We should certainly try, for how else will we ever learn whether these are the conceptual giant steps we need to escape from the most obscure riddles of the self and consciousness? Coming to understand the mind will probably require new ways of thinking that are at least as outrageous—at first—as Copernicus's shocking suggestion that the Earth goes around the Sun, or Einstein's bizarre claim that space itself could be curved. Science advances haltingly, bumping against the boundaries of the unthinkable: the things declared impossible because they are currently unimaginable. It is at the speculative frontier of thought experiment and fantasy that these boundaries get adjusted.

Thought experiments can be systematic, and often their implications can be rigorously deduced. Consider Galileo's crystal-clear *reductio ad absurdum* of the hypothesis that heavier objects fall faster than lighter objects. He asks us to imagine taking a heavy object, *A*, and a light object, *B*, and tying them together with a string or chain before dropping them off a tower. By hypothesis, *B* falls slower, and hence should act as a drag on *A;* thus *A* tied to *B* should fall slower than *A* by itself. But *A* tied to *B* is itself a new object, *C,* which is heavier than *A,* and hence, by hypothesis, *C* should fall faster than *A* by itself. *A* tied to *B* cannot at the same time fall faster *and* slower than *A* by itself (a contradiction or absurdity), so the hypothesis must be false.

On other occasions thought experiments, however systematically developed, are intended merely to illustrate and enliven difficult ideas. And sometimes the boundaries between proof, persuasion, and pedagogy cannot be drawn. In this book there are a variety of thought experiments designed to explore the implications of the hypothesis that materialism is true: the mind or self is not another (non-physical) *thing,* in miraculous interaction with the brain, but somehow a natural and explainable product of the brain's organization and operation. "The Story of a Brain" presents a thought experiment that is meant, like Galileo's, to be a *reductio ad absurdum* of its main premise—in this case, materialism in the guise of "the neural theory of experience." "Prelude, Ant Fugue," "Where Am I?" and "A Conversation with Einstein's Brain," on the other hand, are designed to support materialism by helping thinkers over obstacles that have traditionally stood in the way of comprehending it. In particular, these thought experiments are designed to provide a plausible substitute for the otherwise compelling idea of the self as a sort of mysterious, indivisible pearl of mind-stuff. "Minds, Brains, and Programs" is intended to refute one version of materialism (roughly, the version we defend), while leaving some underdescribed and unexplored materialistic alternatives untouched.

In each of these thought experiments there is a narrative problem of scale: how to get the reader's imagination to glide over a few billion details and see the woods and not just the trees. "The Story of a Brain" is silent about the staggering complexity of the devices to which the imagined brain parts would have to be attached. In "Where Am I?" the virtual impossibility of using radio links to preserve the connectivity in hundreds of thousands of nerves is conveniently ignored, and the even less likely feat of making a computer duplicate of a human brain that could operate synchronously is presented as nothing more than a fancy bit of technology. "Minds, Brains, and Programs" invites us to imagine a person hand simulating a language-processing program which, if it were realistic, would be so huge that no person could perform the steps for a single interchange in less than a lifetime, but we are cajoled into imagining the system engaging in Chinese conversations occurring in a normal time scale. The problem of scale is faced directly in "A Conversation with Einstein's Brain," where we are asked to tolerate a book with a hundred billion pages we can flip through fast enough to extract a few conversational gems from the posthumous Prof. Einstein.

Each setting of the dials on our intuition pump yields a slightly different narrative, with different problems receding into the background and different morals drawn. Which version or versions should be trusted is a matter to settle by examining them carefully, to see which features

of the narrative are doing the work. If the oversimplifications are the *source* of the intuitions, rather than just devices for suppressing irrelevant complications, we should mistrust the conclusions we are invited to draw. These are matters of delicate judgment, so it is no wonder that a generalized and quite justified suspicion surrounds such exercises of imagination and speculation.

In the end we must turn to the rigorous methods of hard science—the experiments, deductions, and mathematical analyses—to keep the speculations honest. These methods provide raw materials for suggesting and testing hypotheses, and even serve often as powerful engines of discovery in their own right. Still, the storytelling side of science is not just peripheral, and not just pedagogy, but the very point of it all. Science properly done is one of the humanities, as a fine physics teacher once said. The point of science is to help us understand what we are and how we got here, and for this we need the great stories: the tale of how, once upon a time, there was a Big Bang; the Darwinian epic of the evolution of life on Earth; and now the story we are just beginning to learn how to tell: the amazing adventure of the primate autobiographers who finally taught themselves how to tell the story of the amazing adventure of the primate autobiographers.

D.C.D.