From the Outside In

Also titled in other versions as…

"Cascades: The Secret to Automatic Language Growth"

With an Appendix

The Cosmic Shower

By J. Marvin Brown

Contents

Preface

I've been trying to learn languages and teach them all my life. I spent the war trying to learn Chinese, and I spent the next 50 years trying to learn 20 more languages and trying to teach two.

All this time I was aware, of course, that the only language I *really* learned was the one I didn't *try* to learn—the one that nobody *tried* to teach me. If I had only focussed on the word 'try', I might have guessed that the thing that was defeating real language learning might be 'trying'. After all, when a brain is 'trying', it's in a completely different mode than when it's 'experiencing'. But, like everyone else, I went along with the common assumption that children lose their magic at puberty. It took me 60 years to see that what really happens at puberty is not *losing the magic to learn with.* It's *gaining the ability to try with.* The culprit was indeed *'trying'.* And I finally figured out how and why.

In an educational system where *trying* is king, how could we ever hope to find out that *trying* was the villain? Especially when most of our tests are designed to measure the *trying* instead of the *results*. If it took *me* a lifetime to see this, maybe it could take *you* a lifetime too. But what if you could use *my* lifetime instead of your own? A few days instead of decades? That's the purpose of this book. To tell you about the lifetime that came to this conclusion.

Chapters 1 and 2 cover my formative years (age 3-20) and present the mindset with which I approached my professional life. The next two chapters show what went wrong as I acquired professional blinders (Chapter 3) and used them (Chapter 4). In Chapter 5 I start my escape from those blinders and in Chapter 6 I complete it. This sets the stage for the development of 'the secret to automatic language growth'. Chapter 7 covers the practice, and Chapter 8 covers the theory.

This lifetime of thinking had a single goal: a search for *reality*. And this search had the three stages underlined in the preceding paragraph: *mindset* (chapters 1 and 2), *blinders* (chapters 4 and 5), and *escape* (chapters 6-8). But throughout these eight chapters this all-important goal was never stated and may have gone unnoticed. The purpose of Chapter 9 is to *notice* this goal. It's an overview of the entire book from the point of view of *reality*. It could have been written as Chapter 1, and some readers may prefer to read it first.

Chapter 9 shows that this book, in spite of its title, is primarily about a unification of science in general, and that *language learning* is just one part. The science of language learning (*automatic language growth*), relies on the science of the brain (*the inner net*), and this relies on chemistry and finally on physics (*the cosmic shower*). Physics came to assume such a big part that it began to tilt the whole book, and I had to move most of it to the appendix.

—

This book is not a scholarly work. There are no footnotes or references. It's more like a story. But the development of my thinking is most certainly indebted to the scholarship of others. There are

three great scholars, especially, who contributed to my ideas. Their books will help to show where I'm coming from, and their bibliographies will serve to connect my thinking to the relevant literature.

William T. Powers. **Behavior: The Control of Perception** (1973), Aldine Publishing Company. **Living Control Systems** (1989) and **Living Control Systems II** (1992). The Control Systems Group, Inc., Gravel Switch, Kentucky.

Stephen D. Krashen. **The Input Hypothesis** (1985). Longman, New York.

Gary Cziko. **The Things We Do** (2000). The MIT Press, Cambridge, Mass.

I would like to thank the publishers for allowing me to use my own grammar. Since the whole book represents my fight for reality, artificial grammar would be out of place.

From Marv's Friends

The following book represents a compilation of some of the most original thinking of J. Marvin Brown. Marvin was an old and dear friend of ours. Adrian first met him in 1970 in Bangkok, Thailand, and stayed close to him until he died in XXXX. David first ADD

Marv wanted his book and the thinking it represents to be available to others interested in the topics he addresses. We all tried unsuccessfully to find a commercial publisher willing to take a gamble on such an unorthodox book. We (Adrian, David, and Marvin's wife, Kwansuwan Brown) agreed that publishing his book on the WWW would be the most efficient way of making his thinking accessible to others.

This work of Marv's deals with two main areas: second language teaching and learning and physics. His book takes the form of a story of the evolution of his thinking and addresses the thinking process as much as the product of his thought.

Marv was one of the most out-of-the-box thinkers we have ever known. He loved to ponder complex problems and figure things out. We hope you will enjoy following his thought processes and unique way of seeing the world.

If you would like to cite portions of his work, please be sure to attribute the material to Marv.

Introduction

In the beginning God created language. He then proceeded to create the universe in its image.

Most people wouldn't want to go so far as to actually *state* it like this, but don't we all sometimes *behave* as if it's true? Don't we sometimes think of language as basic? Isn't this what we're doing, for example, when we ask the question "What is consciousness?" Your reaction might be, "No, I'm not asking about the 'word', I'm asking about the 'meaning' behind it." To which I then ask, "Behind what?" Think about it.

Just how often do we appear to be looking backwards? As we look through the history of science, don't we usually start out getting everything exactly backwards. Look.

1. *The earth is flat.*
   No. It's round.

2. *The sun revolves around the earth.*
   No. The earth revolves around the sun.

3. *Fire consists of the release of phlogiston.*
   No. It's the taking in of oxygen.

4. *Animals change in order to better* fit their environment.
   No. They find environments to fit their accidental changes.

The following reversals are less widely accepted, but think about them.

5. *Gravity is a pull.*
   No. It's the blocking of a push.

6. *I think; therefore I am.*
   No. I am; therefore I think.

7. *Our perceptions control our actions.*
   No. Our actions control our perceptions.

8. *Learning is a gradual hooking up of neural connections.*
   No. It's the pruning down of excess connections.

9. *We learn to speak by speaking.*
   No. We learn to speak by listening.

10. *At puberty children lose the ability to pick up languages perfectly.*
No. They gain the ability to obstruct this.

11. *A sentence gets its meaning from the words.*
No. The words get their meaning from the sentence.

12. We learn languages from parts to whole: from words and rules to sentences.
No. We learn from whole to parts.

Why do suppose we're always getting everything *backwards*? We would expect, of course, to start out getting things *wrong*. But why exactly *backwards*?

The reality of our position in the universe is that we are objects getting battered by it. For us the driving force is from the outside in. But we *see* this from the inside out. *Backwards*. Our perceptions are backwards. Our language is backwards. And this is as it should be. For living life and for communicating and cooperating with other similarly battered objects, 'backwards' is exactly what we want. But if for some reason we want to understand *reality*, we've got to look *from the outside in.* Like everyone else, Copernicus looked from the earth outward and saw the sun revolving around the earth, and he used words like 'sunrise' and 'sunset'. But when he wondered about *reality*, he put himself outside the earth. I'll call it 'the Copernican principle': looking from the outside in.

The Copernican principle started with astronomy: "The earth is not the center of the universe". And within 200 years it had literally turned astronomy inside out. But then it ran into trouble. The next step should have been "The human mind is not the center of the universe." But Descartes blocked this with his "I think, therefore I am" logic. He 'proved' the existence of a ghost ('I') from which our vision of the universe could start. And there we remain today -- in philosophy, brain theory, even physics: starting from 'I' and looking out.

Yes, even physics. Notice Stephen Hawking: "It seems better to cut out all the features of the theory that cannot be observed." And John Wheeler: "All physical laws are dependent upon the presence of an observer to formulate them. A universe without an observer is not a universe at all."

But where's the Copernican principle when it comes to language learning? Do we see some people trying to learn from the inside out while others are learning from the outside in? That's exactly what we see. All language 'study' starts from 'I' and works out ('I' is the driving force: 'I' am studying the language). But while all 'students' of language are proceeding from the inside out (like swimming upstream), all toddlers are caught in a cascade of happenings that batter them from the outside. While the students are 'doing', the toddlers are 'being done'. And what about adults picking up a language in daily life? Aren't they caught in a cascade of daily happenings like the toddlers? No. They almost always start from 'I' to drive their actions. Instead of just getting hit by the happenings, they insist on starting from 'I' and asking questions like 'What

does that mean?', 'How do you say this?, and 'How do you spell it?' Can you imagine a toddler doing this? It will be useful to keep the image of 'being caught in a cascade' in mind throughout the whole book.

People everywhere have always noticed the vast difference in language learning between 'doing' and 'being done'. But since the 'doers' were almost always adults and those 'being done' were almost always children, they made the wrong connection. They focussed on *age*—not *direction*. "Children have a magic that gets lost at puberty," they said. But what would happen if an adult were put in the same situation as the toddlers? That is, unable to *do* anything; only able to *be done*. Actually, this isn't all that rare. The following story compares two adults taking up life in a new language. The first one tries to *do* things; the second one can only *be done*.

A Tale of Two Wives

Mary *meets and marries Chai while they're both studying at a university in the States. After a few years they go to live with Chai's family in Thailand. It's a typical extended Thai family: Chai's parents, brothers and sisters, and all their children. Maybe 20 people who can speak only Thai. Her husband is the only one who can speak English. After introductions, Chai's mother smiles at Mary, says something to her in Thai, and waits for an answer. Mary is embarrassed and asks Chai,"What'd she say? What'd she say?" Chai tells her,"She asked you what you think of Thailand." Mary then asks him "How do you say 'I like it very much'?" Chai tells her the Thai for this. Mary doesn't quite catch the words and asks, "How do you spell that?" She then proceeds to produce a fractured version of the sentence for her mother-in-law. This kind of struggling continues with slow progress for 2 years, but Mary still can't understand very much and it's very hard for others to understand her. She decides to take a course in Thai, but the course and the textbook also consist of telling her 'What that means', 'How you say this', and 'How you spell it'. It just does this a lot more professionally than Chai did. She never really learns to use Thai well.*

Zambi *came from the village of Makui in central Africa a hundred years ago and her parents arranged for her to marry a man in the village of Mujambi, which spoke a completely different language. She arrived there not knowing a word of Mujambi and nobody there knew any Makui—not even her husband. During the day, while her husband was hunting with the other men, the women took Zambi along with them as they did their basket weaving and gardening. At night everybody sat around the fire and listened to stories. Zambi's daily life could be described as 'silently tagging along'. After a year of this she understood almost everything that went on around her and could say a few words and phrases. After 2 years she was quite fluent, and after 3 or 4 years she was almost like a native Mujambi villager.*

- **Mary's way:** What does *that* mean? How do you say *this*? How do you spell it?'
- **Zambi's way:** 'Tagging along'—caught up in a cascade of everyday happenings without trying to say anything for nearly a year.

We don't have to go to the Africa of 100 years ago to find people using Zambi's way. We all used it ourselves. That's how we learned our native language: tagging along without trying to say

anything for the first year. It works for children. It worked for Zambi. Why doesn't it work for everyone? The common belief is that we lose the child's secret as we grow up. But what about Zambi? The answer seems to lie in the second part: *not trying to say anything for the first year.* You see, adults just can't resist Mary's way when it's available. But it isn't available to little children and it wasn't available to Zambi. *That's the secret!*

I can see the secret clearly now—and I can see how it happens and why. But even though I had heard about Zambi as a graduate student of linguistics 50 years ago, I didn't even come close to seeing it then. It took me a lifetime. I first thought I'd try to explain this secret, but then I realized that an explanation wouldn't have meant anything to me. I needed a lot more than an explanation. I needed a lifetime. So instead of telling you my *secret*, I'm going to tell you my *lifetime*.

As with most lifetimes, of course, mine wasn't all that interesting. But when I focused on my *mistakes* instead of my *accomplishments*, I found a drama of veils, shackles, ghosts, and follies—obstacles that were keeping me from the secret. I didn't recognize them as obstacles during the living, of course, but from hindsight I found the playback fascinating. A proper gentleman walking by doesn't catch our attention until he slips and falls flat on his face. The story of me falling flat on my face might turn out to be both amusing and instructive. So instead of telling you my *accomplishments*, I'm going to tell you my *follies*.

Chapter 1
Growing Up: Age 3-20

The Kid: Age 3-6

- "What do you want to be when you grow up?" I hated that question. How should I know? I didn't know the answer until after seven years of college. Parents are always embarrassing their kids with questions they can't answer. As I look back now I can see that the only thing I wanted to be was *loved*. And loved I was--unconditionally. But years later I found out that my mother had been telling people I wanted to be *a professor of foreign languages*. I don't know where she got that. As a child I had always said I wanted to be a forest ranger. But only because I had to say *something* and I was darned if I was going to be like everyone else and say I wanted to be a cowboy. So there were two points basic to my nature and my future. More than anything else I wanted to be *loved,* and second to this I wanted to be *different*. (And apparently my mother knew something I didn't.)

- I can't remember much before I was 3. This is unfortunate for my present purposes since most language learning takes place during this time. All I can do is to observe a 2-year-old and try to guess what's happening on the inside. Anyway, I'll start my story from the age of 3. At this age I spent hours sitting on the potty--'thinking'. My parents and sisters said I was 'thinking and stinking'. "What are you thinking about?" they kept asking. It's hard to put my 3-year-old answer into words, but I'm sure it felt something like this. "*Me*? *Thinking? I'*m not doing the thinking—the thinking is doing *me*." You see I wasn't to learn the passive voice until I was 5 or 6. It's one of the last things we learn in childhood English, but it's the first thing we learn in 'thought' and I knew it well. In fact the passive was the story of my little life. The thinking just *happened*—like the stinking. The winds strummed me like a harp. I was later to hear that 'life is a cabaret, old chum', but most of the things that *did* me were more like a *cascade* than a cabaret. Oh, sometimes they were only a *trickle* (sleeping), sometimes a *flow* (thinking and stinking), but most of the time they were a veritable *cascade.* Bathing me, rocking me, jostling me, buffeting me, pounding me. And what did I do? Passive little me? I didn't *do* —I *was done*. I just *bathed* in the cascades. I smiled, giggled, cried, flinched, shivered, purred. These cascades of happenings were often laced with speaking. And they kept coming. Into my eyes, my ears, my nose, my mouth, my throat. They came in here, they went round and round, and two years later they came out here: *speaking happened* (just like stinking and thinking had). I had all the answers then. I wasn't confused by those unknowns created by adults: "Where did I come from?" "What am I here for?" For me it was as simple as this: "I happened." 68 years later when I retired and returned to the States from abroad, I heard a new slang expression that gave me new hope for the adult mentality with its self-created confusion: 'Shit happens.'

- I wasn't a problem child. My mother told me I was a parent's dream. But that was on the outside. On the inside I sometimes felt great contempt for the adult mentality. "You'll understand when you grow up," they kept telling me. And of course they were usually right. But not always. Not with things like 'thinking happens' and 'speaking happens'. I *didn't* understand the adult versions of these things when I grew up—not yet, anyway. I encountered some pretty profound thinking in my 20 years of college, but I often thought that 'profound' was another word for 'nonsense'. 'I think, therefore I am,' for example. What *is* this thing called 'I', anyway? Some little neuron sitting at a control panel making all those decisions?

- But to be fair, I should tell you my clearest 3-year-old memory. We were at Lagoon, an amusement park north of Salt Lake. My mother was getting me ready to go swimming and was trying to get me into my little swimming suit. She stood me about 30 feet from the main walkway, turned me away from it, and pulled down my pants. I swung myself around to face the walkway and she swung me back. I was furious. I knew about the modesty of my peter and my behind. But I also had a keen sense of conceptual geometry. My behind was the size of a plate and my peter was more like a peanut. I visualized a plate full of peanuts to clearly illustrate the vast difference in size. I could also see that the clarity of vision of the people trying to sneak a peek was inversely proportional to the square of the distance. I couldn't express this in the confusing way adults do, of course, but I could clearly visualize cones of vision coming from my eyes, and I could see that a little distance out along these cones resulted in a big difference in area and thus reduced greatly the clarity of vision. From 30 feet they couldn't even see that I *had* a peter, but they could clearly see my behind. I couldn't tolerate such stupidity and I kept twisting myself around. I felt like Mom needed a course in conceptual geometry. The feeling of contempt that I felt toward my mother is the clearest part of the memory and to this day I feel it whenever I see a little kid reacting to adult stupidity. But when I grew up I had to admit that Mom was right. I learned a new principle: the degree of modesty is not necessarily proportional to the size. Sorry about that, Mom.

- I learned about language when I was 4. Before that I didn't even know it was there. Like air. But a Mexican playmate changed that (little Leo spoke both Spanish and English). One day cousin Zina was worrying about a test in college Spanish. It took us quite some time to figure out what her problem was, but we sure had a good laugh when we saw how much smarter little Leo was than 20 year-old Zina. Then a profound thought came to me (I'm translating my wide-eyed feeling with the adult word 'profound'). *I can speak English!*

- When I was 5 my father gave me my first lesson in science. He put a dot on an orange and held it in front of a lamp. The orange was the earth, the lamp was the sun, and the dot was me. I was on the dark side of the orange and couldn't see the lamp. Then he rotated the orange so that the lamp came into the view of the dot (sunrise), passed overhead (noon), and went out of view (sunset). The world I knew suddenly expanded to include wonders without end. "There are two versions of *everything*," I generalized. "There's what we *see* and there's what's *there*. And what's there can *explain* what we *see*. *Whew*!" The next time I felt a tingle like that was when I encountered Darwin's theory of evolution.

- I remember my shock when I found out there had never been a Mormon president of the United States. We all knew that America was the greatest country in the world, Utah was the best state in the country, Mormonism was the true religion, and so on. And yet not one of America's greatest men had managed to find the true religion? What did that make me? I was *born* with it! My mother explained this with one of her adult words: 'predestination' or something like that. I took it to mean 'just lucky I guess'. But then I started asking around. Little Ake said *Japan* was the greatest country; little Johnny said *California* was the best state; and little Leo said *Catholicism* was the true religion. Of course Ake was from Japan, Johnny was from California, and Leo was Catholic. "*Duh*!?" (The feeling was clear; the word for it came 50 years later.) I wasn't looking at *the* world. I was looking at *my* world. Ake was looking at *his,* and Leo at *his*. Everyone had their own world. Here a world, there a world … . I took it all in stride: the expanded world from my father's lesson and the many worlds of my playmates. But my future was clear. Just as I was darned if I was going to say I wanted to be a cowboy when I grew up, I was also darned if I was going to be taken in by my fortuitous upbringing. From then on, while everyone else was

smugly getting their kicks out of reveling in their upbringing, I would get my kicks out of *defying* mine. *Dammit*!

- Kindergarten was a wild time. It was my first social experience and I reacted not as a passive receiver but an active doer. I was the leader of all the boys and Beth Adel was the leader of all the girls. The two of us together ruled like king and queen. One day while we were together on our throne, I kissed her. Right in front of everybody. It's a good thing this was 1930. In 1997 I could have been arrested for sexual harassment.

At the age of 6, I had already picked up two major insights into the world and I had graduated from the school of childhood cascades with honors in six subjects.

1. Philosophy. Thinking happens.
2. Math. Conceptual geometry.
3. Language learning. Native mastery of spoken childhood English.
4. Science. The expanded world: 'Things are not what they seem.'
5. Objectivity. The many worlds: 'It ain't necessarily so.'
6. Social life. Ruling kindergarten with my queen.

And you know what? Without any study whatsoever I had reached a level in philosophy and science that the greatest philosophers and physicists haven't yet reached today (in my humble opinion).

The Misfit: Age 6-20

Hello study, goodbye cascades—at least during classtime activities. This was something completely new. *Study*. Normal kids didn't like it. Whenever possible they rushed from study to things like games, sports, activities, parties—even carousing and gangs. Anything to get away from that ridiculous thing called 'study' and get a cascade 'fix' (see 'Luann' cartoon). But study was the thing that got rewarded. 'Work hard and make good grades.' Maybe it was *rewards* that molded me. More than anything I wanted to be loved, and my good grades earned me so much motherly love I quivered.

Do you think it's possible that those study-hating, cascade-loving, normal kids in section 4 knew something the rest of us didn't? Could they have known instinctively that knowledge should be *grown*—not *stacked?* The teachers sure didn't know this. And our parents didn't. And I didn't. I had to wait 60 more years for *this* insight. In the meantime I kept *stacking* knowledge from classes and books while the normal kids were *growing* knowledge from life. 'King of kindergarten' may have been 'king' to my peers, but 'king of first grade' was called 'nerd'.

I went through 11 years of school and 4 years of college without ever speaking socially to a girl. Even though I didn't know the reason (which I now see as 'cascade deprivation'), I knew something was wrong. So did my friends—and they occasionally tried to help me. One day in junior high, for example, there was some kind of daytime party in the gym with dancing and snacks. One of my friends, trying to be helpful, said "Come with me, I want to show you something." He took me over to a line of wallflowers and introduced me to a shy little girl. I screamed and ran. I realize now I may have ruined that shy little girl's life. I only wish I could appear with her on a talk show today and apologize. "It was me. Not you." Years later, at the age of 20 while I was studying Chinese in the Navy, I decided that I could solve my problem by learning to dance. Twice a week for a whole year I went from Boulder into Denver to take dancing lessons at Arthur Murray's. I learned how to dance but it didn't solve my problem. You've got to be able to *talk* in order to get a date to go dancing.

My teen years may not have been the proverbial 'best years of your life', but they gave me something every bit as big as the two instant worldviews of my childhood. It just came as a slow crawl over a period of years. Let me tell you about it.

Can you remember opening your eyes one day and saying, "Hey look, I can see colors"? Not likely. We find out we have color vision only by meeting somebody who's colorblind. Well, I didn't know I was comparatively 'word free' until I met somebody who was comparatively 'word bound'. Here's an early example. It arose from this common 'puzzle'.

If a tree falls in the forest and nobody hears it, does it make a sound?

I was surprised that this had been posed as a puzzle. My first worldview gave the obvious answer. But then I was already beginning to realize that not everybody shared this view. They had all learned about night and day but they hadn't all made the generalization. I had to explain, "You see, there's the way we *hear* things and the way things *are,* and we can use the same word for both the perception and the reality. If 'sound' refers to the *perception* (vibrations in the ears), then with nobody listening there's no sound. If it refers to the *reality* (vibrations in the air), then there's a sound with or without listeners." I was prepared for the fact that some people wouldn't understand my difference between perceptions and reality, but I wasn't prepared for this next question. "Well then which is the *correct* meaning of the word 'sound'?" My jaw dropped. "Huh? *Correct* meaning?"

Stuart Chase called it 'The Tyranny of Words'. But with me, this idea soon grew far beyond what he had in mind. And it continued to grow throughout my life: a slow crawl out of word domination. And all this time it was the word-bound people all around me who kept me aware of what I was crawling *from*. "The *divinity* is *rightly* so called." Huh? "If something exists it must have a creator." Huh? "I think, therefore I am." Huh? "Is there *life* out there?" Huh? And so it went— all day, every day. Couldn't they see the difference between words and reality?

Notice how short this chapter is. And yet it covers all of my eleven pre-college years, my first three college years, and two of my years in the Navy. It looks like 'the best years of *my* life' were empty. I guess they were. But I made up for it.

Chapter 2
The Three Veils: Age 3-20

We've arrived at the 20-year mark of this story. A story of what and how I *thought--n*ot what I *did*. I had expected to find a few subtle clues here and there. After all, there's surely something to the concept of 'the formative years'. But instead of a few subtle clues, what I found was three bombs. 'Bombs' conveys the *impact*. The *form* is better shown by 'veils'. I found three veils between me and reality. More accurately, I found that I wasn't seeing reality at all. I was seeing veils. I peeked. And what I saw blew my mind. *Behind each veil was a whole new world.* Of course I assumed everybody did it. Peek, I mean. Don't we all feel the urge? But I now realize that some people just don't know that what they're looking at are veils. And I'm here to tell them. The veils are shown below by numbers enclosed in diagonals. To the left of each veil is the distortion we all see. To the right is the real thing.

Veil 1. Perception: Seeing is believing /1/ Reality
Veil 2. Faith: I believe! /2/ It ain't necessarily so!
Veil 3. Language: Words /3/ Experiences

Understanding how these veils were deceiving me was the thing that came to drive my life. Without this understanding, I was pretty much like everyone else. With it, I was me. *Perception, faith,* and *language:* those powerful forces that control human life. But it's the distortions to the left of each veil that's controlling human life. Not the reality to the right. Sometimes I would spot a distortion on the left, see the havoc it caused, and shudder. "All you've got to do is to look behind the veil, dammit!"

Veil 1: Perception

My first understanding of night and day gave me a warm glow. It was so clear how a lamp and an orange (which I could see) were able to reveal a reality (which I couldn't). From that moment, I became hooked on astronomy. The next such glow came from chemistry. Mendeleev's periodic table made me tingle, and I was sure I would be majoring in chemistry when I got to college. I learned about Darwin's theory of natural selection from many indirect references. Just as well. I'm not sure I could have survived getting it all at once. Even today it sends chills up and down my spine.

Astronomy, chemistry, and natural selection. Those were real tingles. I wanted to share them—like I shared other special things. Like when I say "How about them Yankees?" and my friend says "Yeah!" That's sharing. But it didn't seem to work here. "How about Mendeleev's periodic table?" "Huh?" You've got to feel the tingle in order to take part in the sharing, and I should have seen that other people weren't feeling it. But it took me years, even decades, to find out that these veils weren't widely realized and my tingles weren't widely felt. When I talked about my ideas I was usually assuming that other people saw and felt the same things I did and it wasn't until age 40 that I suspected this might not be the case. The following incident was the first to make me suspicious. But while it raised the question, it didn't give the answer.

Since I was a loner and rarely talked shop with colleagues, or *wrote* shop for journals, I wasn't really prepared for the extent of my isolation. Here's the first incident that made me take notice. I had been pretty much on my own in Thailand for ten years: thinking—not talking or writing. Then one day I got an invitation to contribute an article to America's leading linguistic journal in honor of one

of my old professors. I had never really thought of publishing but I was full of ideas. Surely I could dash off something from the top of my head. Something like my theory of phonemics. It only took me a few days. It was a good article. Short (just seven pages), simple (a child could understand it), but revolutionary. I was very proud. *It was rejected!*

"What? I didn't ask them to publish an article. They asked me to submit one. There must have been a mistake." I sent a copy to a friend of mine who had connections with the journal. "What's going on?" His response was something like this. "If I weren't your friend, as a card-carrying phonetician I would have taken offense." I still didn't know what was wrong, but as I look back now, I can see that the clue was to be found in the phrase 'card-carrying'. He had used the expression in fun of course, but it turned out to be metaphorically true. In moving from the perception side of the veil to the reality side, I had lost my card. I was in a completely new field. I had clearly announced my move in the title: 'Phonemics Without Sounds'. But card-carrying linguists were still carrying their cards as they read it. And as simple as that little article was, it just didn't fit into *their* world. Over the following years I showed the article to the occasional colleague who happened to be passing through. "Is this so hard to understand?" Most answers were something like this. "Just the opposite. It's too simple-minded. Not worthy of a scholarly journal. Anyway, what's it got to do with phonemics?" They were all card-carriers, of course. (The article was finally published 30 years later when I smuggled it into a reprinting of my doctoral dissertation.)

Notice that this whole section has to do with things we can't see. We can't see the earth turn and move around the sun. But we can see the orange and the lamp. That's how we get past the perception veil. I had this idea in my mind from age 5: using things we *can* see to model things we *can't*. So when I first came across the word 'science', I assumed that it meant just this: modeling a reality that we can't see. The clearest examples of my meaning of 'science' were astronomy, chemistry, molecular biology, and evolution. But notice that I never got a tingle from physics. And yet physics was supposed to be the mother of all sciences. It wasn't until I turned 50 that I realized this contradiction and I'll talk about it later.

Veil 2: Faith

I was darned if I was going to be taken in by my fortuitous upbringing. I don't mean customs. I didn't object to wearing clothes and speaking English. I mean ideas about reality. Compare Darwin, my mother, and my father. Darwin's theory of evolution was exciting. Mom's acceptance of the creation theory (I believe!) was sweet. But Dad's attempt to *prove* the creation theory was something else. Where Darwin had evidence looking for an answer (deductive reasoning), Dad had an answer looking for evidence (selective reasoning). Dad kept looking until he found a scientist that agreed with him and said, "See?" Darwin's way made me tingle. Dad's way made me mad. This was true when I was a little kid (I was darned if I was going to say I wanted to be a cowboy), and it's true today.

I had to get rid of the baggage. First, religion. As a kid I faithfully attended Sunday school, but I was always arguing with both the teacher and the other kids. By the age of 18, I had completely shed all religious beliefs. They didn't make me tingle.

Next came patriotism. The common saying, "America is the greatest country in the world", made me uncomfortable. Here are some anecdotes. 1) In high school there was constant talk about how terrible Hitler was. I argued that we were only hearing one side. Maybe Germans thought he was a good guy doing the right thing. I almost got kicked out of high school. 2) In the Navy we had to salute the flag when we passed it. I argued that it was only a piece of cloth. I almost got kicked out of officers

school. 3) In Midshipman School, a few weeks before we were to get our commissions, we were asked to write a short piece on 'Why I want to be an officer in the U.S. Navy'. We all joked with each other about which patriotic lie we were going to tell. I was the only one who said what we all thought. 'Being an officer would give us more pay and better uniforms—and thus attract more girls.' I almost didn't get my commission.

Don't get me wrong. I wasn't *disloyal*—I was *unpatriotic.* I have great loyalty to my groups: my family, my friends, my high school, all of my universities, my place of work, my country, and the Utah Jazz. But I don't necessarily think of them as being *right*.

After God and country, the next big thing to go was *species*. Notice that most physicists aren't interested in *reality*. They're interested only in observing, measuring, formulizing, and predicting what *we perceive*. Stephen Hawking came right out and said it: "It seems better to cut out all the features of the theory that cannot be observed." He wasn't interested in the universe as it is. He was only interested in how it strums *human sensors*. He may not be *egocentric* or *ethnocentric*. But he certainly is *anthropocentric*. Sure I feel there's something special about my species but I try not to let this affect my view of reality.

Veil 3: Language

The semanticists of the 1930's (like Stuart Chase, mentioned earlier) flourished precisely during the years my semantic awareness was developing. I cheered. But I was already beyond them. They talked mainly about words. I was concerned with language in general. Things like *loaded categories*, *abstractions*, *ghosts*, *voice* (active or passive), *causatives*, and so on. I don't mean I was *talking about* these things—or even that I was *conscious* of them. I was *feeling* them—and reacting. What I was feeling more and more through my teens was that language was getting in the way of thinking. Sometimes language seemed more like a mischievous devil than a veil. Of the many different parts of language that got in my way, I'll discuss three below: *words*, *loaded categories*, and *ghosts*.

1. Words

My first indication of trouble caused by words came through cases of 'I saw, he saw' (I was seeing things one way and someone else was seeing things another way). For example, he and I had both heard that the Mississippi-Missouri was America's longest river. He said this was cheating. The Mississippi-Missouri is obviously *two* rivers. I saw a stream of water running from Montana to the Gulf. He saw words. Instances increased and I began to wonder what was going on. What was it about words that was causing our differences? It looked to me like *my* words were more like tools--*pointing to* what was there, while *his* words were more like ready made pictures--*hiding* what was there. Reality painted my pictures; words painted his.

Years later I saw what Humpty Dumpty had to say about words. Alice had objected to his strange use of a word, and he said that he used words to mean exactly what he chose them to mean. Alice questioned his right to do this, and he replied, "The question is which is to be master (the word or the speaker)—that's all." I loved it. But there was much more to it than this, and the further I went beyond the semanticists, the harder it became for me to explain myself to others.

Veil 1 (perception) wasn't all that hard to talk about—even though others weren't aware of it. Most people can see the difference between the 'night and day' of the heavens and the 'night and day' of lamp and orange. They just don't generalize this to everything else—like I did. *Veil 2* (faith) was

even easier. Everyone knows that most people keep the religion they were raised in, and other such beliefs. They just don't fight it—like I did.

But veil 3 (language) was something else. It would appear that some people aren't even aware of the difference between the mental *flashing* of a memory and the verbal *telling* of it. They claim they *think in words.* I can only speak for myself. When I recall this morning's breakfast, for example, a moving picture pops up. I can watch it repeatedly from different angles—all without a word. It's very clear—even detailed. Then I start to tell you about it and it all goes downhill. "You had to have been there." The words don't sharpen the view—they muddy it. They leave out much of what I want to express (they were made for other happenings, not this one), and they insist on adding many things I don't want (things like connotations, emotions, emphases, and embellishments). For me, trying to paint a clear picture with awkward, ill-fitting words can be sheer agony. But even though clarity falls as we go from picture to words, it seems that respect rises. A whole case in court could judge a person guilty by word when he was clearly innocent by picture. Such is the nature of the language veil. Didn't everybody see this? Was I so different from everyone else? I was looking for some indication that there were other people like me. And if so, how many?

And then one possible measure appeared from a very unexpected source: the Clinton turbulence of 1998. It came to be called 'the great disconnect'. Every day, on almost every cable TV talk show, host would ask guest,"How do you explain the high approval ratings of the president?" You see they found it surprising. Most guests answered, 'the economy'. Others said, 'declining moral values' or 'the death of outrage'. One host even blamed it on 'the moron factor'. Just who were these people anyway? Mostly lawyers, politicians, moralists, and members of the media (affectionately called 'windbags' by one of their own members). In effect, windbags were asking each other how they could explain the 'perverse' thinking of 'the people' as shown by the polls. So there you have 'the great disconnect': the expectations of 'the windbags' and the polls of 'the people'. Just what were they doing differently?

Windbags specialize in words. That's their business. Real life is so cluttered. It needs to be tidied up with words. All you have to do is to reduce the endless clutter to a few clear categories and then speak simply with category names. Like 'truth' or 'perjury'. They can say 'perjury is perjury' without even blinking—or *thinking*. And once they've put those three words together, they treat our objections with contempt. "How can you argue against something as obvious as that? Listen again. Perjury is perjury, dammit!" It shows on their faces. *Smug*.

The People, on the other hand, are much more likely to be thinking with pictures from their experiences than with words. Let me speak for them since my views almost always agreed with the polls. When we look at the Clinton sexual episode, we don't think 'perjury'. We think of that Christmas party at the office when the sexy secretary came on to us and the two of us later agreed on the same lie to account for our brief disappearance from the party. Instead of 'perjury is perjury', we're thinking 'there's perjury and then there's perjury'.

Compare the faces of the windbags (as they confidently, even contemptuously, manipulate their words) with the faces of 'the people' (as we thoughtfully study our mental pictures). You can see us think. Our heads turn and tilt slightly and our eyes narrow. If the picture is about a man beating his wife, we add a grimace. If it's about a harmless sexual encounter, we add a sly smile. And "perjury (grimace) is not perjury (sly smile)". The windbags are infuriated. "Wipe that smile off your face. This has nothing to do with what happened. Look at the words, dammit." I often pushed the mute

button and watched only the faces. It was easy to see who was thinking with pictures and who was thinking with words.

So by watching the faces of the windbags as they wondered about the polls, I think I found my measurement of the third veil. I wasn't so different after all. Two-thirds of the people were supporting the president. I took that to mean that two-thirds of the people were thinking like me—with pictures. And when the windbags raged "Perjury is perjury"—*smugly*, we all smiled at them—*knowingly*.

2. Loaded Categories

When words get in the way of clear thinking, those of us who think with pictures can get around them. We can say the word either with a grimace or a sly smile. But when a *category* gets in the way, we're sometimes trapped. Let me try to clarify what I mean by 'category'. When we say that a 'word' has a 'meaning', the 'word' consists of a single unit that we can write down and point to. But the 'meaning' consists of an endless number of things, feelings, happenings, and so on, that can come under the umbrella of the same word. My use of 'category' here is like that umbrella.

Here's an example. Take the words 'homosexual' and 'heterosexual'. The words appear to be similar and the difference in meaning at first appears to be quite clear. But let's compare their umbrellas. The homosexual umbrella covers all kinds of interchanges and interactions between people. Every mannerism, facial expression, facial make-up, come-on, wolf whistle, wink, holding of hands, hug, kiss, living arrangement, and so on, will be put under the umbrella, and when a person desplays any of these things he might be accused of 'flaunting his sexuality'. But the heterosexual umbrella covers only what people do in bed. All those other things are part of *life*—not part of being *heterosexual*. When we see a husband kiss his wife at the airport, for example, we don't say he's flaunting his sexuality. Even people who are trying their best to be impartial are taken in by the umbrellas. The language won't let them be fair. If you think this doesn't apply to you, check your reaction to the following piece. It's from the Bangkok Post in a column called 'Nite Owl' by Bernard Trink.

Are you a heterosexual?

1. What do you think caused your heterosexuality?
2. When and how did you first decide that you were a heterosexual?
3. Is it possible that your heterosexuality is just a phase you may grow out of?
4. Is it possible that your heterosexuality stems from a neurotic fear of the same sex?
5. If you've never slept with a person of the same sex, is it possible that all you need is to try it?
6. To whom have you disclosed your heterosexual tendencies? How did they react?
7. Why do you heterosexuals feel compelled to seduce others into your life style?
8. Why do you insist on flaunting your heterosexuality? Can't you just be what you are and keep it quiet?
9. Would you want your children to be heterosexual knowing the problems they would face?
10. Since a disproportionate majority of child molesters are heterosexual, do you consider it safe to expose your children to heterosexual teachers?
11. With all the social support marriage receives, the divorce rate is spiraling. Why are there so few stable relationships among heterosexuals?
12. Why do heterosexuals place so much emphasis on sex?
13. Considering the menace of overpopulation, how could the human race survive if everyone were heterosexual like you?
14. How can you become a whole person if you limit yourself to exclusive heterosexuality?

15. There seem to be very few happy heterosexuals. Techniques have been developed that might enable you to change if you really want to. Have you considered trying aversion therapy or bible study?

Here's another example of loaded categories. Compare the names of different races. Most of my friends are American men with Thai wives, and their children are all half-and-half. I know some people who are half American Indian and some that are one-eighth or one-sixteenth. There are mixed races all around the world and the people are described as part this and part that. All except American Negroes. Why aren't there any part Blacks? Just look at the Afro-American umbrella. No matter what word you use to call it, the word doesn't refer to the Negro race. It means 'any detectable part Negro race.' And what kinds of things are defined by 'any part'—no matter how small the part? Contaminated things, for one. Royal blood, for another. The category just *has* to be loaded—the *category*, mind you, not the *word*. Here's a quote from an article I wrote in 1970.

It's impossible, now,
to describe without disparaging
with terms like 'Negro' and 'Black'.
Our language won't let us.

When 'black' can refer to a light tan skin,
it's surely not 'black', the color.
And a 'black' that can mean three-fourths European
is clearly not 'black', the race.
It's 'black', the *contaminant*.

For those of us who don't want to disparage,
it's embarrassing to use it.
And yet it's even worse when we try to avoid it,
since that might imply
we're ashamed for the race or the color,
instead of the implied contamination.
But the language gives us no alternative.

3. Ghosts

Compare what my father said about night and day with his ideas on creation. We couldn't see the movement of the earth any more than we could see the creation of the animals. How can we think about things we can't see—things like *the earth spinning* and *God creating animals?* We do it with models. For *the earth spinning*, the model for the earth was an orange, and a spinning orange is real. Even at age 5 I could see the orange spin right in front of my eyes. But G*od creating animals* is another matter. We can model 'God' as a person, but we can't see a person creating animals right in front of our eyes. We've used *words* for both models, but the words 'orange spinning' refer to substance while the words 'God creating' don't. Words with substanceless meaning are ghosts. And the jump from substance to ghosts is vast.

But science has got a long way to go. Here're a few of the thousands of ghosts that are blocking science. *Physics:* matter, energy, gravity, electricity, magnetism, the nuclear force. *Psychology:* mind, consciousness, thinking, memory, learning. *Linguistics:* phonemes, words, sentences, grammar. In daily life we can say 'seeing is believing'. But in science, it's precisely what we can see that's not real; (the colors, weights, and melting points of silver and gold, for example); and it's precisely

what's real that we can't see (the different numbers and arrangements of their protons, neutrons, and electrons).

This chapter has been about things that get in the way of clear thinking. I first called them 'bombs' to point up their impact. Then 'veils' to focus attention on the way they serve to hide or distort the true picture. Now I'll call them 'shackles' to emphasize the idea of constraint—even bondage. By the age of 20, I felt that I had rid myself of veils and shackles. But 40 years later I found out that while I had been seeing shackles on everyone else, I had been blind to my own. I had been so tightly shackled all this time I couldn't think straight—and I didn't know it. You see there was a fourth veil. And it led to my biggest folly. When I finally became aware of it, I felt like an evangelist caught with a prostitute.

But back to this point in my story. I'm 20 years old, self confident, and ready to take on the world. The mold has been cast and is waiting for the substance. The mold is the unshackling, and the substance will turn out to be *language*. It all started with the study of Chinese in the wartime Navy.

Chapter 3
The Professional Student: Age 20-37

University of Colorado: Dec 44 – Jun 46

After high school and one year of college, I joined the Navy. They called it the Navy V-12 program. In my case it consisted of 3 semesters of free-choice college followed by Midshipman School. The assignment I chose after getting my commission in the navy was to study Mandarin Chinese, and I mark this as the start of my 54 years in the field of language study.

The Navy had taken over the men's dormitory at the University of Colorado to house several hundred naval officers who were studying oriental languages— mostly Japanese and Chinese. We had been selected on the basis of our college grades so we had a dormitory full of straight-A naval officers. The purpose was to teach us all to read, write, speak, and understand the language we had been assigned. They didn't know how to do this then. In fact they still don't know how to do it today. But it seemed clear to them that for Chinese and Japanese it meant memorizing thousands of characters. The schedule was 4 hours of class a day and 9 hours of outside study. Chow lines consisted of long lines of flashers—flash cards, that is. Every month a few students were sent off to the Naval Mental Hospital in Bethesda, Maryland. I immediately became interested in language learning. I thought of 4-year-old Leo speaking Spanish while 20-year-old Zina was having difficulties, and I recalled my own realization at that time that I too had learned to speak a language. Then I thought of my 'memorize, memorize, memorize, test' days studying Latin in high school and German in college. But what about Chinese? This was for *real* (like my native English), not for *grades* (like my memorized Latin and German). I didn't flash cards with the rest of them, but I did memorize. I didn't know what else to do. Then one day, about four months into the Chinese course, something happened.

The teacher was late for class. It was a nice April day in that beautiful setting at the foot of the famous Flatirons and we all went outside to look for her. After a while she came wobbling up on a bicycle. She had never ridden a bicycle before and was very unsteady. When she got in front of us she didn't know how to stop and get off. She fell. Flat on her back with her legs up in the air and 10 U.S. Naval Ensigns smiling down at her. With an embarrassed giggle, a red face, and her hands extended to shield our smiling attention, she cried out in Chinese "Don't look at me!'

For four months I had been memorizing Chinese characters and sentences like 'This is a book', but this was my first bit of real Chinese. To this day, 54 years later, I can still see her lying on her back with her legs immodestly exposed, and I can still clearly hear the Chinese for 'Don't look at me!' echoing in my head. At the time it brought back the glow I had experienced with my father's orange and lamp. I'm looking at *the way things appear* ('This is a book', from class, and 'Don't look at me,' from life), and I'm wondering about *the way things are* (what's happening inside my head that could account for the 'plod' of the former and the 'flow' of the latter).

All day I kept thinking of this experience. In the period of a few seconds something had happened in front of me, sights and sounds had flooded into my eyes and ears, and something had clicked in my head that resulted in a new kind of 'knowing' or 'having' or 'being'. I want to avoid using the word 'learning'—it was nothing like things 'learned' in class. I didn't 'think' it—it 'flashed' and it 'echoed'. It was like a cascade of light and sound waves rushing in and washing over nerves in my eyes

and ears and then cascading on into my head to sculpture a device that could echo back similar waves on demand. A mechanism that could repluck the same nerves that had formed it.

That night I made some calculations. The bicycle episode had taken less than 30 seconds. At this rate we could experience 800 such cascades a day. That's 4,000 a week, 200,000 a year, and 300,000 for 18 months. Whatever it was that lay behind this magic, it was obviously a better way to acquire a language than writing 'this is a book' over and over. I really felt that this single *cascade* was worth as much as the previous 4-month period of *study*. If a 30-second cascade equals 4 months of study, just think of 300,000 *cascades!* Why do they force us to memorize things in order to pass a test? Why don't they just 'drench' us with happenings and let us absorb Chinese?

I thought of designing my own course. Let's see. Situation number 1: Teacher rides up on a bicycle, etc. Situation number 2. Hmm. This isn't going to be so easy. How am I going to pack each day full of dramatic happenings? And how can I arrange that the students will understand these happenings? After all, I *did catch* what she said. How did I do that? Maybe study *is* needed, after all. At least as a first step. I put the idea on hold. But this single glimpse had planted in my head the picture of cascades sculpturing language. And a sudden conversion was to come 39 years later. In the mean-time I had to wallow through a lifetime of a wrong-headed method called 'study',

I wallowed on for 15 more months. Did it work? Well, we did learn to read and write 3,000 Chinese characters. What about speaking and understanding? It would be a stretch to even use those two words. Let's call it 'struggling'. Was anybody disappointed? Not in the least. After all, we had all gotten passing grades, we knew all those characters, and we had never seen anyone do any better. *Isn't that what successful learning is all about?*

At the end of the course we were given a choice of where to go: China or Washington. It seems that the Navy way was to give you the one you didn't want, but we didn't know that then. I chose China and got Washington. Our job was to translate Chinese telegrams. Were we able to do this? Not even close. Can you imagine the problem of garbles when each character consists of a 5-digit code number that had to be looked up in a codebook? Think of it. We get a word that doesn't seem to make sense. Maybe the first digit was wrong. We have to look up and try out nine other words. Maybe it was the second digit. Ten more tries. And so on. Now add to this the fact that sometimes we couldn't make sense even when there weren't any garbles at all: 49 trips to the codebook for nothing—the first trip was right all the time.

One day we were assigned to take some visiting Chinese Generals out for a night on the town. I was elected to do the talking. After all, I had averaged 97% on 18 months of weekly tests. I got about 10% on this one. Was anybody disappointed? Not really. When they told us our goal was speaking and understanding, they were thinking of what happens in school language learning everywhere. That is, a kind of speaking that consists mostly of "uh…uh…" and a kind of understanding that consists mostly of "huh?…huh?". It's more like 'plodding' than 'speaking'. I'm not blaming *them.* I'm not blaming the ones responsible for the method. I was one of them for 40 years, and I never turned out any students who could do any more than plod.

University of Utah: 1946-48

After getting 4 years of free college in the Navy, I was rewarded with 5 years of free college on the GI Bill. Then I found that I could get half again as much by taking 24 class hours at a time instead of 16. What a way to make a living! I went back to the University of Utah and took whatever classes

interested me: mostly math, science, psychology, and languages (French, Spanish, and Italian). But this time, unlike my misfit days, I was using college for a lot more than study. I finally found an entrance to social cascades. I joined a fraternity. This is what I had needed all along—not Arthur Murray (though the dancing lessons did come in handy). I learned how to talk to girls and thus enter the other half of the world. I also met Paul Lee.

I had always assumed that everybody was affected by the language veil. Difficulty in communicating with others was just a fact of life. But Paul and I could communicate in half sentences! It was eerie. I can see now that Paul was well aware of the language veil, like me, and we were communicating our thoughts by throwing out free-size words to pluck similar thoughts in each other's head. But while I was *intrigued* by the language veil, Paul was *tortured* by it. The only way he could cope was to drink. He was a 19 year old alcoholic. I think the best way to show you what I mean when I say he was tortured is to show you a poem he wrote. I never wrote it down, but 50 years later I think I've been able to reconstruct it. Here's my recovered version of the poem.

WHY? By Paul Lee (1947)
When the unthinkable has been thought,
When the undoable has been done,
When the unbelievable is believed by all,
And sand is touched only by sun;
When the only right is wrong,
And the only wrong is right,
Someone, somewhere will still ask 'Why'
As I ask 'Why' tonight.
And that unknown created by man shall perish with him.

I hardly ever get anything out of poetry. I'm not even sure I know what poetry is. And this poem might not mean anything to anyone else. Maybe it's only for Paul and me. The last news I had of Paul was that he had disappeared among the winos of Los Angeles by 1950. I once tried to find him in the phone book. Next time you see a Los Angeles phone book, look up 'Lee'. ('Li' is one of the commonest Chinese surnames and half of them spell it 'Lee".)

University of California: 1948-51

After 2 postwar years at the University of Utah they told me I would have to take a degree (I had twice the number of required credit hours and easily qualified for a degree in math). But I didn't want a degree. I wanted to cash in my GI Bill on as many interesting courses as I could get. The only way I could see to keep doing this was to transfer to another university. I chose the University of California since it was the closest place that had these two things: Chinese, and a chapter of my fraternity.

As I browsed through the catalogue for Oriental Languages at Cal I found that they offered degrees in Chinese, Japanese, and Oriental Linguistics. I never knew there was such a field as 'linguistics', but I sensed immediately that this was what I had been looking for all along. Perhaps it could help me better understand how language can enslave most people, titillate me, and torture Paul Lee. So after 7 years of college, a major had finally found me. I spent the next 3 years studying linguistics as I plodded through 7 more languages. One of these languages was Thai.

The Army and Navy each had their own language program during the war, and neither one knew how to teach languages like Chinese and Thai. The Navy used makeshift; the Army turned to the linguists. With J. Milton Cowan in charge, the Army dealt out languages like cards to the available linguists. "Here's a language and a native speaker: analyze the language, write a textbook, and teach it. Charles Hockett, take Chinese; Bernard Bloch, take Japanese; Mary Haas, take Thai." And so on. It came to be called the 'Army Method', and each book was called 'Spoken Whatever'. After the war, Dr. Cowan and many of these linguists went to Cornell, which became the most enlightened center for language study in the U.S. But Mary Haas wanted to stay at Cal, where she had been teaching Thai in the Army, and that's where I discovered both linguistics and Thai.

By this time I had studied 8 languages using the same old 'grammar translation' method (memorize words and grammar rules, translate sentences back and forth, and pass tests). But Thai under Mary Haas was something else. It was mostly practice. Mary told me that all I had to do to master a language was to practice until I got near-perfect pronunciation and then immerse myself in the country for a year. This reminded me of the bicycle cascade 4 years earlier: study first, then bathe in cascades. I decided to become the unofficial guinea pig for the Army Method. I would study Thai with Mary until I 'mastered' the pronunciation and then spend a year of immersion in Thailand.

And so I practiced. I was living in a fraternity house that had a phonograph in the living room and I subjected everybody in the house to my practicing of Thai. With my hand on the needle arm I got to work on each word or sentence of a 12-inch record of 'Spoken Thai'. Listen, repeat, and back up the needle. Again and again for 10 to 20 repetitions of each word or sentence. Everyone lounging in the living room was exposed to this (there was no TV of course). Hongnaam yuu thii nay … screech. Hongnaam yuu thii nay … screech. Hongnaam yuu thii nay … screech. (This example means 'Where's the bathroom?') When I went back for a reunion nearly 40 years later, one of them called out to me "Hongnaam yuu thii nay".

I took a bachelors degree in Oriental Linguistics in one year and a masters in two more. That finished off my GI Bill. The GI Bill had been designed to help people whose education had been interrupted by the war. But look what happened in my case. After working my way through my first year of college, I got the next 9 years free: 4 years in the Navy and 5 years on the GI Bill. But what now? I easily got a scholarship to go on for a Ph.D. at Cal. But after just 2 days of this scholarship Mary Haas got a telegram that was to change my life.

Cornell University: 1951-53

The telegram was from J. Milton Cowan, head of the Division of Modern Languages at Cornell. He had been planning a course in Thai, and William Gedney was supposed to return from Thailand to teach it. (Gedney was the only American linguist other than Mary Haas who knew Thai, and Cornell was to become the only American university other than Cal to teach it.) But at the last minute Gedney was detained and Cornell was stuck. Cowan asked Mary, and Mary asked me. I left the next day for Cornell as the head of the Department of Thai, Burmese, and Vietnamese.

Actually, what this grand position boiled down to was teaching two students in Thai 101 and one in Thai 102, as I continued my work on a Ph.D. in linguistics. But never mind. Cornell had the best linguistics department in the United States and the only Center for Southeast Asian Studies. And there I was at their point of intersection. I had an office next to some of the biggest names in the field, and I had weekly staff luncheons with them. I had suddenly been transplanted into a linguist's paradise.

Bangkok: 1953-57

The Southeast Asia Program at Cornell was the main center in the country for sending out Ph.D. candidates to do doctoral research in the country of their specialty: Indonesia, Vietnam, Burma, or Thailand. To do this research, the candidates needed to learn the language of their country, and that's where I came in. I was teaching Thai to the future professors of Thai Anthropology, Thai History, Thai Economics, and the like. But after all, I was a Ph.D. candidate myself, and I had my own research to do in Thai Linguistics.

I easily got a one-year grant, which I managed to extend every year for a total of 4 years! Now what was my own language preparation? I had studied Thai for 2 years at Cal at 3 hours a week and 2 years at Cornell at 6 hours a week. (The Cornell method was to have an American linguist teamed up with a native speaker, so two years of my 'teaching' was also like two years of my studying.) So when I arrived in Thailand I had been through almost 500 hours of classroom study by the Army Method. I could make near-perfect sounds once I had assembled a sentence for delivery, but I couldn't even begin to 'carry on a conversation'.

I was still playing the role of guinea pig for the Army Method and was ready for my year of immersion. I dutifully moved in with a Thai family and didn't hear a word of English for my first year. Now was the time for the *cascade* I had been waiting for ever since the bicycle incident 8 years earlier. What I wanted was to have the experience of a child growing up. I would spend 2 months as a one year-old, 2 months as a 2 year-old, and so on up to 2 months as a 6 year-old. But I didn't have the slightest idea of how to arrange for this. In actual fact I spent the biggest part of my '24-hour-a-day immersion' as a 28 year-old alone in my room— sleeping, reading, and practicing with my tape recorder. I had meals with the family and occasional weekend trips with university students. This provided a few *cascades* every day, but nothing like the 800 I had conceived of 8 years earlier. My totality of *cascades* was more like a trickle. And, as I was to find out much later, even this trickle was going wrong.

So where had I gotten to at the end of my guinea-pig year? My pronunciation was excellent but my speaking was labored. I was *plodding*, but I was doing it *clearly*. I had expected to be *flowing* clearly—not *plodding* clearly. The Army method had provided the 'clear', but not the 'flow'. But do you think I reported back to Mary Haas and Milt Cowan that I had proved the Army method wrong? Quite the opposite. I thought I had proved it *right*. The process at work here is the thing that conceals the failure of language study everywhere. As long as we're getting temporary rewards (like my perfect pronunciation), goals automatically come down to meet actual progress. It's another one of Parkinson's laws: 'Goals shrink to fit performance'. The self-deception that serves to cover up failure sets in so gradually that it's never noticed. And this was only half of the explanation. Like everyone else in the language learning competition, I took 'failing less than others' to mean 'success', and I had clearly won the competition. It took me 25 more years to realize the truth. 'Learning' (as opposed to 'absorbing' or whatever it is that children do) puts us all on crutches, and the competition is to see who can use crutches best.

But let me tell you about those 4 years in Thailand. There aren't many foreigners left who knew the Bangkok of the 50's. It really *was* the proverbial 'Venice of the East'. Canals were laid out in concentric rings that ran from upstream to downstream across a bend in the river, and these 'rings' were connected by 'spokes'. The whole area was a delta, barely above sea level, and roads eventually de-

veloped along the raised earth formed when the canals were dug. This, of course, meant that every road had a canal at its side, and the commonest kind of automobile accident was running into a canal to avoid a collision. Everyone ended up in a canal sooner or later. Jinrikishas were now *pedaled* instead of *pulled*, and a few were even *motored*. 'Chinatown' proper was a long stretch of opium dens and gold shops, but all of Bangkok might have been described as 'Chinatown' since almost half the population and nearly all of the shops were Swatow Chinese.

The European community consisted of Embassy people, missionaries, a few businessmen (like the legendary Jim Thompson), regular visitors (like Somerset Maugham and Noel Coward), and me. This was the Bangkok that I went to in 1953. And since I was the only foreigner who could make correct Thai sounds, I was treated like a king.

Now linguistics was at an exciting stage and I was bursting with ideas for developing new theory. The purpose of my fellowship was simply to do 'linguistic research', and I lazed in this delightful setting studying myself picking up Thai and theorizing how it was all happening. It was the perfect foil to follow the two-year frenzy of linguistic ideas at the linguistic center of the world. I wasn't about to leave after my one-year's fellowship was up, and I extended for a second year. Then a third. And a fourth.

Anyway, I arrived in Bangkok in 1953 and within three days I was living with a Thai family. I had shared an apartment at Cornell with a Thai student of architecture who had been hired as my fellow teacher. He had returned to Thailand a few months ahead of me and was already a professor of architecture at Chula (Bangkok's leading university) when I arrived. One of his students offered to take me into his family.

There were nine Thais living there: five in the family and four servants. I had one of the rooms in the servant's quarters. It was something like the AFS (American Field Service) family situation that came later. But it turned out that my counterpart was rarely at home and my main language exposure was with the servants. I couldn't come close to filling my day with real life cascades so I spent most of my time reading (Thai novels and a daily Thai newspaper) and practicing with one of those giant tape recorders of that era.

After this year in family, I shared a house with my first student of Thai at Cornell. Bob was doing research for a Ph.D. in anthropology and had come to Thailand a year before me. His experience with Thai was 1 year study plus 2 years in Thailand, compared to my 4 years study plus 1 year in Thailand. A few months later we were joined by Don, a young American who had come to teach English at Chula. Don didn't know any Thai and he kept turning down my offers to teach him. I had a Thai girlfriend named Pu who came by every evening and we had a 40-year-old live-in servant named Som. Bob spent most of the day at his desk interviewing *samlor* drivers ('samlor' means 'three-wheeler'—the pedal rikishas described above). Like me and all of my students, his Thai was plodding. Luan (a Chula student) helped me as a linguistic informant whenever he was free from school. About 6 months later Don moved out and Peter took his place; but Don dropped in from time to time and I held open my offer to teach him Thai if he changed his mind. Peter had studied a bit of Thai at the London School of Oriental and African Studies and, like Don, had come to teach English at Chula.

It was a two-story house. There were 3 bedrooms upstairs with bare wood floors and unpainted wood walls. There was no furniture in these rooms and we slept on mattresses on the floor. The downstairs consisted of a big living room and a bathroom, both with tile floor and stucco walls. Fur-

niture consisted of a dining table and 3 desks. In back of the house there was a kitchen and servants quarters. The front 'yard' was a jungle the size of a football field with a long driveway along the side. We had to stomp heavily as we walked along the driveway at night to scare away the snakes. We built a *sala* (a roofed 'deck') on the edge of this jungle near the house.

A typical day saw Bob plodding at his desk with his *samlor* drivers, and me plodding at mine with Luan. Som was doing her housecleaning, laundry, and cooking. Things got more interesting when Peter got home from Chula. He, Pu, and I would be having beer and cockles in the *sala*. Peter was very playful and prone to tease, while Pu was very teaseable. Peter would spend a lot of time doing things like chasing Pu from *sala* to house, upstairs and down, trying to hit her backside with a ruler. Pu would be giggling and screaming playful oaths at Peter as she ran away from him. Bob would be going crazy at his desk. After a year of this, Bob had to ask Peter to move out. I decided to leave with Peter and we found a new house and lived together as a foursome (Peter having acquired a girlfriend). The playful situations continued for 2 more years.

Now all of this is merely the background setting for what I'm really getting at: the language learning that was taking place. I had taught Bob to plod at Cornell and he had been plodding in Thailand for over 2 years. I offered to teach Don to plod but he declined. I didn't consider for a minute teaching Peter to plod, but he picked Thai up fast. After a year Peter's Thai was more fluent than Bob's and after 3 years it was as good as mine. In other words, Peter had gotten a lot more than I had from the same 3 years of exposure. Why? It took me 12 more years to even make a guess and 30 years to find the answer.

Cornell: 1957-58

The book **Culture Shock** came out soon before I went to Thailand in 1953. It was about the shock a person might feel when going to a different culture for the first time. I had never been outside the United States but I was ready for anything. So as different as the Thailand of 1953 was, I was mentally prepared and didn't feel any big shock. But returning to the U.S. was another matter. Not only had I been in Thailand for 4 years but I had 'gone native', and I wasn't prepared for the return—I hadn't yet heard about **Return Culture Shock**.

When I arrived in San Francisco I went into a bar and asked for a beer. Now I don't remember how I said it nor how the bartender responded, but his attitude suggested 'What do you think I am? Your servant?' (Let me add that I'm extremely meek in such situations.) After that, things got worse—not better. When I got back to Cornell I had difficulty talking to my colleagues and students. And outside of my office and classes I didn't say a word to anyone for the full year except for exchanges necessary in shopping situations. The United States scared me, and I didn't know why. Twenty three years later when I returned again—this time with my wife—I think I figured out part of what was going on. Public interactions were much smoother if my wife did most of the talking. You see her non-native English suggested non-native culture and people made allowances. But my native English suggested native culture and I was more like Rip van Winkle.

Since I'd been gone from Cornell for 4 years, they had found someone else to take my place. But they could still use me since Thai classes had expanded and they had added Burmese. I taught Burmese (in effect, studied it) as well as Thai, and I was caught up again in the flurry of linguistic ideas—this time contributing my own new ideas that had come from my 4 years of thinking. But 11 months of cross-fertilization (not to mention my fear of the U.S.) was enough and I was ready for

more lone thinking in Thailand. By the end of the school year I had grabbed up a Fulbright fellowship and was on my way back to Bangkok.

Bangkok: 1958-1960

When I got back to Bangkok I found that Peter had moved to a house just across the street from our original house (the one with the jungle and snakes) and was living with a new girlfriend, Joke, who was soon to become his wife. I moved in with them for a month while I looked for a house of my own. I found a little house near my work for $35 a month, a live-in cook for $10, and a live-in housemaid for $5. A year later the big house next door became available and Peter and Joke grabbed it. I had been visiting them every week during this year, but now we were next door neighbors. We became the closest of friends and you will hear a lot more about them.

I was assigned to the College of Education in Bangkok as a consultant to the Thai head of the English Department. I taught a class in linguistics to the Thai teachers of English and a class in English as a demonstration for these teachers. I was also head of all Fulbright teachers of English throughout Thailand and made periodic trips to their various schools.

This was the first time I had been directly involved with English teaching in Thailand and it was quite an experience. I had expected out-of-date methods and non-native teachers. After all this wasn't Cornell, or even the University of Utah. But this was something else. Almost all students of English in Thailand study their English from Thai teachers who pronounce English words completely with Thai sounds. It was comparable to teaching Latin in the United States. No Latin teacher would make any claim to be using real Latin sounds and would be ridiculed if she tried (I'm referring to the full accent, not just to pronouncing 'Cicero' with *k*'s instead of *s*'s). There's no reason for an American to try to read Latin as it was pronounced 2,000 years ago (even if we could). Well, that's the way Thais looked at pronouncing English words.

Here's an example that happened to Joke 10 years later—after she and Peter had been living in England for several years and Joke had acquired near-perfect English pronunciation. They were visiting Thailand and Joke took an English class to learn how to read and write. The first day, her teacher, in an attempt at English conversation, held up a pencil and asked her, "Wat it dit?", to which she answered, "It's a pencil". The whole class hooted and jeered at this show-off who was 'putting on airs' by trying to sound like a foreigner. The teacher dutifully 'corrected' her pronunciation to the accepted Thai sounds, 'It it a pensin' (complete with Thai tones). She never dared to make that 'mistake' again.

Now when *I* taught English, the students were willing to accept my funny pronunciation; they expected a funny foreigner to make funny sounds. But they sure weren't willing to *imitate* my funny sounds and thereby invite social ostracization. They simply replaced the 'funny' (me) with the 'normal' (Thai).

But what about grammar? Surely I could make a real breakthrough there. I had come to the conclusion that the only reason Thais had difficulty using English tenses correctly was that we didn't have an accurate analysis of them. I was in a position to change this. I reduced the use of the perfect tense to an algorithm. Something like this: just ask yourself these four questions about the situation and if they are all answered 'yes', use the perfect tense (presumably thinking, 'Isn't that what I do when I'm looking for the right tense?') Then I gave them a test. They would surely all get 100%.

How could they possibly miss? It was foolproof. Not quite. In fact it was a disaster. After going through a feeling of "What am I supposed to do with stupid students who can't even use a foolproof algorithm?", I accepted the fact that something might possibly be wrong with my method of teaching. But I didn't know what. I was still 25 years away from finding the reason for the massive failure called 'study' that we were all participating in.

I extended my Fulbright fellowship for 6 months and spent another 6 months on my own doing research for my dissertation. I had originally planned to do my dissertation on Thai grammar, but that was taking too long. I only had six months left to complete my research. I changed to a historical study: reconstructing ancient Thai from modern dialects. I could spend a month on each of the four main areas (North, Northeastern, Central, and South) developing a questionnaire format and word lists for each area and then take sub-dialects at the rate of 4 a day. The College of Education offered a bachelor's degree to graduates from two-year colleges throughout Thailand and had students from all 72 provinces. I simply put up a notice asking for speakers of different dialects to enter their name and hometown into a daily schedule and show up at my office at the scheduled time. My preparation had been so good that this came off without a hitch. I got the pronunciation of over 1000 words in 70 different dialects in less than 2 hours per dialect, and I reconstructed the phonology of ancient Thai back at Cornell. By that time I was a little over the 10 year limit allowed for work on a Ph.D., but I got a one year's extension and finished my degree in January of 1962 (I had started in October of 1951). As with my earlier degrees I had savored it as long as possible. I was the complete professional student.

Cornell: September 1960 - January 1962

I returned to Cornell to teach Thai and Burmese and finish off my dissertation. I spent a lot of time in the Thai classes just talking to the students in Thai, and I felt I was at a whole new level of fluency. The difference between 4 and 6 years in the country (following 4 years of study) was very noticeable. I felt that after 10 years I had finally reached what the Army program had promised in 2 years. Either their estimate was way off or I was very slow. But I didn't worry about it. I was an expert at the self-deception that everybody uses to cover up the failure of language study.

Now I had reached the midpoint of my search for cascades. This search had started with a glimpse in 1945 (the bicycle incident) and would end with a conversion in 1983. In between these two dates came 38 years of language teaching and language learning experience. But now at the midpoint of this story we come to something that may have been more important in the finding of Cascades than anything else—even though this wasn't a language learning experience. This was my decision to spend my life in Thailand.

I had been hired for the 1960-61 school year as a 'teaching fellow'. Before the year was up I was close to finishing my Ph.D. at Cornell and they offered me the position of assistant professor (the first step on the tenure track to full professor). It was time for me to make the most important decision of my life. On the one hand, I could take the position at Cornell—a position at the very top of my field in both Linguistics and Southeast Asian Studies. On the other hand, I could try to support myself for 6 months while I finished off my dissertation, find $600 for a one-way ticket to Thailand, and arrive in Bangkok with no job or money.

As I was thinking of how I might support myself, the American Peace Corps made me an offer. They were planning to train the first contingent of the Peace Corps to Burma at Cornell. I would be hired for two months to prepare a course and two months to run it. The timing was perfect for my

purposes of finishing my degree and moving to Thailand. So what was it to be? A brilliant career at Cornell or broke and jobless in Bangkok? Now I've never in my life had to agonize over an important decision. I've never made a list of considerations and checked them off one by one. I always just followed my heart. Well this choice wasn't even close. My heart clearly chose Bangkok. I can still see the dropped jaw of J. Milton Cowan, head of the Division of Modern Languages and the wartime head of the Army Language Program, the man who had spent his life dealing out choice morsels to the chosen few: 'Hockett, take Chinese; Haas, take Thai; Brown, take the Department of Southeast Asian Languages at Cornell.' No thank you, Milt.

But things didn't go exactly as planned. After I had spent 2 months developing a Burmese course for the Peace Corps, the course didn't materialize. The Burmese government didn't want it from the start. They had been treating the whole thing as a joke. And people who really knew the Burma of 1961 guessed as much. My friend John Brohm, who was preparing the culture and area course while I was preparing the language course, had warned me that it would probably turn out like this. But the US government took it seriously and even sent us a complete list of names of volunteers that had already been selected. After a while the government had to report that there would be a delay. 'But please stay available'. Then another. 'But please stay available'. Well, the whole program fell through—including the government budget for it—and they couldn't pay us. I was broke and hungry. I crawled to the Southeast Asia Program, which had always taken care of hungry students. They hadn't taken my rejection of their offer kindly. "You dare ask for financial assistance after turning down a professorship?"

I've heard of students going through hardships to get their doctorate, but I ended up finishing mine hungrier than anyone I've known. Potatoes, onions, and cabbage were very cheap in the November of 1961. I bought a little margarine and ate on 10 cents a day. It's kind of nice to look back at, though. They tell me you're supposed to go through hardships to get a doctorate, and up to this point I had only gone through delights. Anyway, I finished the degree, sold my car for the price of a one-way ticket to Bangkok, and started out on a new life.

Chapter 4
The Linguist: Age 37-55

I arrived in Bangkok in March of 1962—broke, in debt, and without a job. I didn't need any money on arrival. I moved in with Peter and Joke (still living next door to my old house). For a job, I went to the Thai-American Binational Center, which was known locally as the AUA Language Center, or simply AUA. This was actually more like a Thai institution with partial U.S. sponsorship. The United States Information Agency (USIA) sent out two career specialists from Washington on 2-4 year hitches (the Director and the Director of Courses) and gave financial help for the library and cultural activities. But the Board of Directors was answerable to a Thai association (the American University Alumni Association, or AUAA). AUA was Thailand's biggest school for teaching English to Thais.

The American director at that time was an old friend of mine, Gordon Schmader. We had worked side by side at Cornell where he was doing 'Spoken English for Burmese' while I was doing 'Spoken English for Thais'. (This was the inverse of the Army Language Program: instead of Spoken Thai for American soldiers, I was doing Spoken English for Thais.) He hired me as 'Staff Linguist': a perfect title for a perfect job. As staff linguist, I was like an 'elder statesman' at the age of 37 (long on ideas and influence and short on responsibilities). Both Gordon and Dick Sitler (the Director of Courses) were linguists, but my knowledge of Thai put me way ahead of them. They knew this, they accepted this, and they respected this. I was not only free to do things my way, but I was free to choose what I did. And I was completely dedicated. I didn't know anyone else in the business that was as free and as dedicated. How did I manage this? I paid dearly for it. I could have been making three times as much money as a Cornell professor or six times as much working for the government (like Gordon). And if you're wondering why I didn't apply for a position with the government like that of Gordon's, it's because the government would have sent me to some place like Turkey, and they would have told me what to do. *Horrors!*

So in 1962 I finally started the job that was to be my life's work. This work was concerned with the teaching of both English to Thais and Thai to foreigners, and it took place at Thailand's biggest and most prestigious language school. But the job soon became much more than this. Since AUA was Thailand's best known language school, since it had a linguistic specialist as *staff linguist*, and since none of the other linguists in Thailand had such a function, my desk became the automatic center for many linguistic matters in Thailand through the 60's and 70's. *Within* AUA, I had complete freedom to pursue my job as I saw fit, and *outside of* AUA I was a perennial consultant and committee member for most important language teaching matters in Thailand. My academic preparation for this had been at the leading center in the United States for both linguistics and language teaching, and my mixture of study and field experience had been unique (one part at a university alternating with two parts in the field). I felt qualified and confident. It was the ideal position with the ideal preparation at the ideal place. And this was to be my position for the next 18 years.

My purpose here is to tell you about my ideas—not my job: where these ideas came from and where they led to. My starting point was the assumption of the Army Method that if you practice something long enough it will become automatic; that is, *correct without having to think*. After all, as official guinea pig I was the one who had 'proved' it. Now I was going to use it. In my mind I saw a whole new generation of Thais speaking English correctly and without effort. That was the picture that drove me. Compare this picture with that of my teaching at Cornell where the goal was for students to pass tests and get credit. So I'm going to tell you what I did with this idea of 'practice to perfection' over the period of 18 years. But let me first prepare you. Some aspects of my situation

were quite different from what you might be expecting. Especially these three things: the sheer *density of feedback* from my work, the nature of *my motivation*, and *my personal life.*

Here's what I mean by *density of feedback***.** I'm referring to the vast amount of information I got from trying out new methods and new materials at AUA. For example, when making up a new exercise or technique at a university, you might have 20 students to try it on. Then a semester or a year later you make changes and try the revision on 20 new students. For teaching English at AUA, by comparison, we tried new things on 500 students at a time, and 7 weeks later 500 more, and so on for 7 new restarts (and 7 new revisions!) a year. And in our *Thai* program, we had 40 new students every 5 weeks for 9 restarts a year. Over the 18 years, that's 162 restarts of Thai Book 1, with feedback from over 6,000 students. I got more feedback in 3 years than I could have gotten in a lifetime at a university—that's 6 lifetimes in my 18 years!

Now consider my *motivation*. From what I've seen, the motivation of most professors lies more in publishing than teaching. Motivation for teaching is limited to getting through a book, giving tests, and assigning grades. I never gave tests. My only purpose was to deliver *results*—not *grades*. (They *made* me give tests at Cornell and that may have been one of things that led to my leaving.) But all I was interested in at AUA was getting students to speak and understand the language better. I wrote drills and taught them; and when they didn't work as expected, I rewrote them and taught them again. And again. And again.

My personal life affected my work in many ways. I was a confirmed bachelor living in a bachelor's paradise. I loved getting up in the morning and going to work, and I loved going home in the evening and going out at night. And, above all, I loved Thailand. I had stumbled onto the culture that offered a perfect fit for my personality. Now creative thinking can't come from *trying*. It comes by accident while doing something else—with the mind prepared and relaxed. I was always relaxed—both at work and at play (remember, 'work' simply consisted of 'doing my own thing'). Work prepared my mind and the new ideas came during play—usually at bars. The perfect setting. It couldn't have happened at Cornell. But notice this. It turned out that *play* gave me much more than creative ideas. You see, *play* was where Cascades was hiding all the time. So I'm going to break down my story of these 18 years into *my work* and *my play*.

My Work

As I said earlier, I started from the Army method as practiced at Cornell. They called it 'mim-mem', for 'mimicry and memorization'. As I used the method myself in the study of Thai, I found that both the 'mim' and the 'mem' became simply 'practice'. I practiced words to the point of perfect *mim* and I practiced sentences and dialogs to the point of perfect *mem*. So when I started my work at AUA, 'mim-mem' had become 'practice to perfection'. Now given the fact that I believed in practice, what should I have done when it didn't work -- when it didn't get to perfection? The answer seemed clear. More practice. What if it still didn't work? Better practice. More and more. Better and better. But what if the idea of practice itself was wrong? What if a language gets into our head by a completely different means? How many failures would it take before I would abandon practice altogether and look for some other way?

Much has been said about sticking with something that doesn't work. Barbara Tuchman wrote a whole book about it: **The March of Folly.** She was concerned specifically with government policies that didn't work. And she further limited what she meant by 'folly' to policies that met these three criteria. 1) It was perceived as counter-productive in its own time. 2) A feasible course of action

was available. And 3) the policy was that of a group—not just an individual. Still, she managed to fill a whole book with unbelievable cases of follies that self-destructed.

Bernard Trink calls it 'riding a dead horse' in his column 'Nite Owl' in the Bangkok Post of 12 March 99.

> Lakota tribal wisdom says that when you discover you are riding a dead horse, the best strategy is to dismount. However, in business (and education and government) we often try other strategies with dead horses.
>
> Among them are buying a stronger whip; changing riders; saying things like "This is the way we always have ridden this horse", appointing a committee to study the horse; arranging to visit other sites to see how they ride dead horses.
>
> Increasing the standards to ride dead horses; appointing a team to revive the dead horse; creating a training session to increase our riding ability; comparing the state of dead horses in today's environment; change the requirements, declaring that "This horse is not dead".
>
> Hire contractors to ride the dead horse; harnessing several dead horses together for increased speed; declaring that "No horse is too dead to beat"; providing additional funding to increase the horse's performance; do a study to see if contractors can ride it cheaper.
>
> Buying a product to make dead horses run faster; declaring that the horse is "better, faster and cheaper" dead; forming a quality circle to find uses for dead horses; revisiting the performance requirements for horses; saying this horse was procured with cost as an independent variable; promoting the dead horse to a supervisory position.

As you read about my work over these 18 years, you'll see that I was riding a dead horse and you might find my folly amusing. Or, knowing that I didn't know it was folly, you might even admire my determination. But laugh, pity, or admire, I hope that my folly can help us toward our goal.

English Textbook Preparation

The English terms lasted 6 weeks each (30 hours of class). My basic method was to write a 30-hour book, teach two classes of it every day for a term, and then rewrite things that didn't work. Then on to the next book, and so on term after term. The trouble was that nothing ever really *worked*. I mean I couldn't give a drill practicing the r/l distinction and expect that the students could now consistently hear and produce the distinction without trying. I had to review it later. It still didn't work, and I had to keep reviewing it: twice, three times, ten times. You see I was trying to do something I'd never seen anybody try to do before. I was trying to get results in real language use. Most textbooks would just plan to *cover* the r/l distinction. Many textbooks practiced something until the students could *pass a test* on it. What was *my* goal? Not just *cover*. Not just *pass a test.* (I could easily have gotten success by testing.) *But get it right without thinking.* Isn't that what we do with our native language? *Right without thinking?* So what was I to do when something didn't work? What did Barbara Tuchman's clowns and jesters do in their **March of Folly**? They did more of the wrong thing. That's what I did. More. And more. And more. I could call this section 'Confessions of a Mad Structuralist'.

The first year at AUA I simply wrote material blind (using the methods I had used at Cornell while doing 'Spoken English for Thais). But during my second year I got a real education in the problems

of teaching English to Thais. One of AUA's functions was to teach English to students who were going on government grants to study for an MA in the States. The first step was to give them a 6-week term in English at 6 hours a day. Then we had to decide whether they were ready for a university in the States. (Notice that we had reduced the goal from 'work' to 'get by'.) Fellow staff linguist Ted Plaister was better at deciding this than anybody, and the two of us together formed a formidable team to interview these students and decide. We couldn't trust anyone else. The whole future life of these students was in our hands. If the two of us decided a student wasn't ready, he had to take another term and interview again. And if necessary, again. We interviewed hundreds of MA candidates. And here's what we found. Those who had studied at any of the elite schools that had native speaking English teachers from first grade almost always passed. All others almost always failed—no matter how many terms they took at AUA. In other words, our teaching was of little help. And my job became clear. I had to produce material that worked—or shut up.

I devised drills for language problems. They didn't work. I reviewed them. They still didn't work. I reviewed them again, and again. Then I started devising elaborate structurings of problem areas over a whole year. As an example, I would take a pronunciation difficulty through 5 steps starting with a contrast drill for *hearing* the distinction (something like rip/lip) and ending with a tongue twister for *producing* it (Malaria and Cholera are really rare in Little Rock). Then I would stagger 5 different series of drills in such a way that on a given day we would have, for example, step 1 of **r/l**, step 2 of **sh/ch**, step 3 of **v/w**, step 4 of **e/ey** (get/gate), and step 5 of **i/iy** (bin/bean). At the same time I would stagger several different series of grammar problems. Then I would start filling grammar drills with pronunciation problem words as a way of practicing correct pronunciation while conscious attention was on grammar. Neither students nor teachers were aware of the structuring, and they weren't supposed to be. It's just that the progression of difficulties was gradual and therefore supposedly easy. Every drill in a series of 3 books had to be right where it was in this intricate and elaborate structuring. If a reviser, without seeing the structuring, transposed any two drills or even changed words here and there, the whole structure would collapse. This actually happened later on and I felt like burning all the books (you may recognize the 'Fountainhead' syndrome here).

Nobody will ever know how far this elaborate structuring of gradual steps went. Even if they could get copies of those textbooks of the 60's, they could never uncover all of the structuring. What I'm trying to show here is how far a mad structuralist could go in a desperate attempt to prove that practice can work. And I do mean desperate. I had dedicated my life to 'practice' and I felt I had to make it work. Let me give a few examples of the hundreds of wild drills I made up.

a/an drill. To be sung rhythmically.
An A, a B, a C, a D, an E, an F, and a G.
An H, an I, a J, a K, an L, an M, and an N.
An O, a P, a Q, an R, an S, a T and a U.
A V, a W, an X, a Y, and a Z.

This same point was followed by substitution and response drills. For example, the teacher would say '*a C (N)'* and the student would substitute '*an N'.*

The single biggest problem for Thai students of English (for both pronunciation and grammar) is the **s/z** problem. Thai doesn't have the **s/z** distinction, and the closest sound it has in word *final* position is **t.** Students can't make either an **s** *or* a **z** at the end of a word—let alone distinguish one from the other. Now look how important the final **s/z** sounds are for English grammar: plurals (boy/boys), possessives (boy/boy's), third person singular verb endings (the boy plays/the boys play) contrac-

tions of *is* (the boy's going) and *has* (the boy's gone), weak forms of *as* and *his* (the boy's as tall as his father). Imagine the difficulty a Thai would have with a sentence like this. "Jones's is as useless as his sister's is." Thais get the idea that the only thing they have to do to sound English is to fill it up with hisses and buzzes (all in the wrong places, of course). Just like we have the idea that all we have to do to sound Chinese or Thai is to pronounce words with a singsong (all with the wrong tunes, of course). The mad structuralist had his work cut out for him. Here are some examples.

Substitution drill
Teacher: *The A Bz and the B Az.* (CZ). Student: *The C Zz and the Z Cz.* I was purposely stripping away meaning and drilling pure pronunciation and grammar. Meaning could be restored to this pattern with something like (rise, fall): *The rise falls and the fall rises.* You can imagine what this sort of thing could lead up to: *The H'es X the S, and the S X'es the H'es,* for example. (*The boys like the girl, and the girl likes the boys.)* Crazy?

But as crazy as this may seem, it looked for a while like we had made a real breakthrough. All classrooms had open doors and an observer could walk down a long hallway and hear what was going on at all different levels. A visiting fireman walking down a hallway once made this comment. "You really seem to be getting results. I passed a beginning class in room 111 and heard English spoken completely with Thai sounds, while a higher class in room 112 was using near-perfect English sounds." Actually, room 112 was the beginning level—the level that was using the crazy new drills. Room 111 was level 9—after 9 terms of the old system. My delight continued for a couple of years, but episodes like the following didn't go unnoticed. One day a student was doing the following substitution drill item.

Teacher: *It's in the bookcase.* (icebox). Student: It's in the icebox.

Now the sentence 'It's in the icebox' was purposely packed full of difficult sounds for a Thai—and the drill was more of a pronunciation drill than a grammar drill. You will rarely find a Thai who can pronounce this sentence perfectly. And yet the student's pronunciation was flawless. How satisfying. But then the student asked: "Teacher. Wat mean eye bock?" (Of course he was trying to say "What does 'icebox' mean?") Perfect pronunciation while *drilling* had had no effect on *speaking*. It reminded me of a Thai Elvis Presley impersonator I had heard sing. His pronunciation was perfect. I couldn't wait to hear him *speak* English, and I later said to him," Your impersonation was excellent." He smiled and asked, "Sow lye Enwit?" (Of course he meant "Do I sound like Elvis?")

The above example was from Book 1. The madness continued on book after book. Here're two examples of what I had gotten to by Book 6. They are grammar drills using poetic rhythm to accentuate the grammar patterns.

1. Stuff and Things
Above the column to the left is a picture of a splotch of glue and to the right is a pile of beans. To be sung rhythmically.

Stuff	**Things**
What is that stuff?	What are those things?
It looks like glue.	They look like beans.
Some of it's green	Some of them are blue
and the rest is blue.	and the rest are green.

There sure is a lot of it!
Tons of green and blue stuff.

Would you care for some?
Just a little, thank you.
How much would you like?
A spoonful should do.
That's not very much.
Just a spoonful of green and blue stuff.

Green stuff or blue?
A little of each.
Some of that over there?
Any you can reach.
It sure is sticky!
This spoonful of green and blue stuff.

How was the green stuff?
The green stuff was terrible.
And how was the blue stuff?
The blue stuff was worse.
You just don't appreciate
sticky, green and blue stuff!

There sure are a lot of them!
Thousands of blue and green things.

Would you care for some?
Just a few, thank you.
How many would you like?
4 or 5 should do.
That's not very many.
Just 4 or 5 blue and green things.

Blue ones or green ones?
A couple of each.
Some of those over there?
Any you can reach.
They sure are slippery!
These 4 or 5 blue and green things.

How were the blue ones?
The blue ones were terrible.
And how were the green ones?
The green ones were worse.
You just don't appreciate
slippery, blue and green things!

2. One, the other, neither, and both

To the left is a picture of a tall boy and a short one; to the right it a big pumpkin and a small one. To be sung rhythmically.

If the tall one takes the big one, then the short one gets the small one.
If the tall one takes both, then the short one gets neither.
If the short one takes the big one, then the tall one gets the small one.
If the short one takes neither, then the tall one gets both.

If the tall one takes one, then the short one gets the other.
If the short one takes one, then the tall one gets the other.
If both take the small one, then neither gets the big one.
And if one takes neither, then the other gets both.

If one takes the big one, then the other gets the small one.
If one takes the small one, then the other gets the big one.
If the short one takes the small one, then the tall one gets the big one.
If the tall one takes neither, then the short one gets both.

If both take one, then neither gets the other.
If one takes both, then the other gets neither.
If neither take the big one, then both get the small one.
And if neither take either, then the dustman gets both.

But if you think these drills are crazy, you should see the type of thing I was more likely to use before my days at AUA. In those early years I thought it was my job to *challenge* the students. Like this. (Not really. I wrote it, but I never used it.)

Non moth-eaten cloth eating moths
are moth-eaten cloth eating moth eaters,
while moth-eaten cloth eating moths
are cloth eating, moth eaten, cloth eaters.

Now a moth eating moth-eaten cloth
saw a moth eating moth-eaten cloth eaters,
and the cloth eating, moth eaten, moths
saw the cloth of the moth eaten cloth eater.

Did the cloth-eating, moth eaten, moths
eat the cloth of the moth-eaten cloth eater?
Or did the moth eating moth eaten cloth eaters
eat the moth with the moth-eaten cloth?

Soon after I had finished Book 6, I left the English department and put all of my time on teaching Thai. My reason for giving up on English wasn't that I had become convinced that practice was the wrong way to go. I was still 13 years away from believing this. I blamed my failure, rather, on the fact that peer pressure forced Thais to speak English with Thai sounds. You see, students who tried to sound like a foreigner were socially ostracized: "Just say the words; leave the funny accent to the funny foreigners." Furthermore, it was precisely these disallowed sounds that carried most of English grammar. I couldn't fight this. All I could do was to wait for these socio-linguistic forces to gradually change (as they largely did over the next 20 years).

Thai Textbook Preparation

When I took over the Thai department, the materials consisted of a set of dialogs prepared under the direction of Gordon Schmader. I started immediately to modify, add, and mimeograph; then modify, add, and mimeograph again. And again. With a new term starting every 5 weeks, I had 9 chances every year to modify, add, and mimeograph. After 4 years of this, I had lessons ready to print and a method ready to write up. I called the method 'Focus-Practice', and I de-scribed it in the introduction to Book 1 of the course. This was published in 1967 and the outside world had a chance to see my extremes. But the following examples should be enough for anyone just wanting to follow my story.

I was firmly convinced that the secret of success for applying my method to Thai was *tones*. My four years of teaching Thai at Cornell had clearly shown that students who got the tones right did much much better than those who didn't. Every lesson of my first 3 books had a section on *hearing* tones (tone identification), one on *making* tones (tone production), and one on *using* tones (tone manipulation). Manipulation was the real trick. Most students, with proper teaching, could learn to hear and make the tones. But *keeping* them as you speak was another matter—the slightest distraction could wipe them out. My plan was to trick the students with distractions, but to do this ever so gradually as we proceeded through the 60 lessons and 225 hours of Books 1-3. The tone manipulation sections of Lessons 11 and 52 are shown below as examples.

Lesson 11 consisted of a substitution drill made up of 5 verbs (one of each tone) and 5 nouns (one of each tone) in the verb-object construction. There were thus 25 different two-syllable tunes. Now the distraction was that English has the same intonation for all 25 and is constantly trying to exert itself. Here's the English for the 25 tunes. In order to see that these represent 25 two-syllable tunes, you'll have to consider translations like this. Have fish. Add fish. Like fish. See fish. Have chicken. Add chicken. Etc.

Have	Fish
Add	Chicken
Like	Shrimp
Buy	Beef
See	Pork

I have fish. (chicken).	I have chicken.
I have chicken. (add).	Add chicken.
Add chicken. (shrimp)	Add shrimp.
Add shrimp. (I like)	I like shrimp.

The students go through this drill again and again with increasing speed. Then on to lesson 12. And lesson 13. Look where they had arrived by lesson 52.

The Thai words for 'dog' and 'horse' differ only in tone: maa (rising tone), and maa (high tone). And the words for 'near' and 'far' differ only in tone: klai (falling tone) and klai (mid tone). Now try to imagine how devilishly perverse the Thai for the following English interchanges could be for the student.

The dog is here and the horse is over there.
Which is further?
  The horse. The horse is further than the dog.
Isn't the dog further than the horse?
  No. The dog is <u>nearer</u> than the horse. The <u>horse</u> is further than the dog.

And so on. With all possible combinations. Increasing the speed as you go. On and on. Faster and faster. And notice the English intonation imposed by the underlined words. Talk about distractions. I'm sure you can't imagine the devilish perversity. You have to experience it. I think there's a saying in English about building character through adversity. Well I was teaching Thai tones through *perversity*. It didn't work.

My Play

So I bungled it. 1962 to 1980 was probably the most exciting period in the history of language teaching. And there I was at the right place in the right position at the right time to make the breakthrough. My background was first class. I wasn't as smart as some but I had more opportunities. A perfect laboratory, perfect surroundings, complete freedom, and a dedication that was second to none. But I bungled it. Barbara Tuchman calls it 'wooden-headedness': "It consists in assessing a situation in terms of preconceived fixed notions while ignoring or rejecting any contrary

signs. It is acting according to wish while not allowing oneself to be deflected by the facts." That was me at my work all right. All day, five days a week, for 18 years. Wooden-headed. But what was I doing all this time *outside* of work? As it turned out that's where the breakthrough was hiding.

For eight years I led two completely different lives. The professional language teacher by day and the professional bachelor by night. I loved both lives and pursued them with complete freedom and dedication. In my daytime work there was no control from either institution or boss—only from me. In my nighttime play there was no control from family, society, religion, or God—only from me. As always, I just followed my heart. As with my work, I'll discuss my play only as it has to do with language learning. This will serve to bring into focus the comparisons that I missed completely at the time. The units of language learning in my work were teachers, books, classes and courses. The comparable units in my play were *cascades*.

Peter's Cascade

I've already told you about Peter's learning of Thai in 1955. There was Bob, plod-ding—just like I taught him to. And there was Peter, passing Bob up in a year. Then, with these two examples staring me in the face, I repeat my offer to teach Don Thai. Notice how the ghost 'teach' had me trapped. What would have happened if I had used the expression 'provide for' instead of 'teach'? I had provided for Bob to get Thai at Cornell. I had provided for Peter to get Thai at our house. And now I offer to provide for Don to get Thai from me. I couldn't have duplicated the Peter cascade for Don, of course, but I could at least have taken note. "Hey, Peter learned much faster and better than Bob did. There must be a message there somewhere." Remember my glimpse after the bicycle incident in 1945? Two steps were needed: I had to *see* it and I had to *act* on it. In 1945, I saw but wasn't able to act. This time I didn't even see. And this time *it was my business*. Shame on me! I encountered many more cascades over the next 25 years—some of them much clearer than Peter's. But, like the whole world, I kept missing the secret. *Zambi's second rule.*

The Typical Adult Cascade

Some time after I arrived in Bangkok in 1953 I ran into a few old Bangkok hands who had been there forever. None of them had ever studied Thai—it wasn't available then. They had picked it up by cascades. It was terrible. I knew of only three foreigners who spoke clear Thai in those days: Mary Haas, Bill Gedney and me. And we had all gotten there through study. As the years went by I saw more and more people like Mary, Bill, and me, and more and more people like those old Bangkok hands. The message seemed clear. Study works better than picking up.

But as I look back now, I see something completely different. For a whole decade I had experienced both study and picking up every day. My work was concerned with study and my play was concerned with cascades. Which worked better? Some cascades were far better than study, and some were far worse. Let me tell you about those different cascades.

Joke's Cascade

Peter and Joke are the two main characters of my story. I had been part of the team (with Pu) that provided for Peter's 3-year cascade, and now I was to become part of the team (with Peter) that would provide for Joke's 3-year cascade. Joke's cascade was much slower but eventually much better. It started in 1958 when I was in Thailand on my Fulbright Fellowship. Peter and Joke had just set up housekeeping and I lived with them for a month while I looked for a house close to the College of Education, where I worked. I found a tiny house within walking distance of the College. Then, after my first year in this house, the big house next door became available and Peter and Joke grabbed

it. So we were next-door neighbors during my second year. I spent every evening with them for drinks and dinner. When I returned to Thailand in 1962 they were still in this house and I moved in with them. Two years later they moved to England. So Joke's cascade covered a period of 3 years altogether.

The house was pretty much like the house where Peter, Bob, and I lived 5 years earlier: 3 bedrooms upstairs (but with beds this time), a big living room and bathroom downstairs, kitchen and servants quarters in back, and a nice lawn and pond in front (unlike the jungle of the previous house). In addition to Peter, Joke, and me, there were 5 other Thais: the gardener with his wife (our housekeeper) and baby girl, the cook, and a baby sitter (one of Joke's nieces). Peter and Joke's little girl was born a month after my return in 1962.

Peter, Joke, her niece, and I usually played croquet on the front lawn in the evenings. Then Peter and I would have an hour of drinks before dinner. None of the Thais knew any English, so you can pretty well guess the mixture of Thai and English that took place during croquet, drinks, and dinner. Joke was exposed to this mixture every day for 3 years, but she never tried to speak English (Zambi's second rule). Peter and I would usually speak to her in Thai, but whenever we did say something to her in English (which we did with increasing frequency over the years) she would always respond in Thai. They moved to England in 1964. When they returned on a visit in 1967, Joke's English had passed up both Peter's Thai and mine. Anyone could tell that *our* Thai wasn't native, but it wasn't so easy to tell that Joke wasn't born and raised in England. And now, 30 years later, there's only a rare indication that she's not a native Brit.

Let's look at some of the differences in these three cascades: my year with family (1953-54), Peter with Pu and me (55-57), and Joke with Peter and me (60-64). At the time I didn't think of cascades as a way of learning languages. They were just parts of my life. But let me point out some differences that will turn out to be important. My cascade was preceded by 500 hours of study and I spoke Thai from the beginning. Peter had studied 100 hours and spoke a little Thai while chasing Pu with a ruler. Joke had never studied English and she didn't say a word in English during her 3-year cascade. I was still a long way away from an explanation for all of this.

My Nighttime Cascade

The famous Thai smile is readily available in many Thai bars and restaurants. In some restaurants you can hire a Thai smile to feed you. For example the smile will peel you a grape, remove the seeds, and pop it into your mouth. Or remove fish bones, crack crabs, and prepare bite-size mouthfuls as you lie back and open your mouth (you're resting on pillows around a low table). A one-on-one situation doesn't provide much of a cascade, but think of a group of four men, each with a smile on his lap. The four smiles will produce a cascade with each other as they pop the grapes.

Much more common are the Thai smiles in bars. For the price of a drink you can get one to sit with you, and if you're part of a group a cascade will emerge. Now I couldn't do this. I was always alone and I couldn't afford to buy drinks for the smiles every night of my life. I did even better. I simply sat with those who didn't have customers: 8 to 20 Thai smiles bubbling away in their waiting area. First at the Roma, then on to the Rose, and then the 99.

Two hours a night every night for 8 years—mostly just listening. I learned a lot of Thai. Now those who might say that 8 years is a long time to *spend* on language learning are missing the point. I didn't *spend* any time at all—any more than a baby *spends* 6 years in order to learn his native language, or a

young man marrying into a Mujambi village *spends* 2 years tagging along on elephant hunts in order to learn Mujambi. And surely Peter didn't *spend* 3 years chasing Pu with a ruler in order to learn Thai, nor did Joke *spend* 3 years playing croquet in order to learn English. All of these people would have been doing all of these things *anyway*. And that's the key. The cascade is *unsolicited, undriven,* and the words are *unnoticed*.

Now my purpose in telling this part of my story isn't to show how lucky I was or how wicked. And I'm surely not suggesting that *you* should try this—unless, of course, it's your style. You could just as well find your cascades in church. I just want to compare *my* nighttime success at learning Thai with *my* daytime failure at teaching it and thereby derive a lesson about language learning.

Kwan's Cascade

With my marriage in 1970, my nighttime cascades stopped and Kwan's cascade started. Contrary to popular opinion, the cascade between husband and wife is minuscule. I heard of a survey of the amount of talk between husbands and wives which reported a daily average of between 3 and 4 minutes (and most of this consisted of things like 'Where's the newspaper?' and "The coffee's cold."). Now almost all of the social contacts over our 30 years of marriage have consisted of Thai wives with British or American husbands, and the only cases of any of them learning their mate's language well were Peter, Joke, Kwan, and me. The Thai wives we know in America have lived here for 5 to 30 years, and they speak typical Thai-English. The American and British husbands we knew in Thailand had lived there for 10 to 20 years, and the little Thai they spoke was typical English-Thai. You've already heard about 3 of the successful cascades (Peter, Joke, and me). Now let me tell you now about Kwan.

When I first met Kwan, she had never studied English and had never been exposed to it (a rarity in Bangkok). After about a year of speaking only Thai to her, I started inserting an occasional English word in Thai sentences (very common things like 'news-paper', 'coffee', and 'take a bath'). Imperceptibly I increased the number of words over the years, but she never tried to say anything in English (Zambi's second rule).

Six years later I took her to the States on a visit. After a week at my sister's place in Salt Lake I went to the Summer Linguistic Institute in Hawaii for 6 weeks and left her alone with my sister and her two sons. The sons were both a bit older than Kwan but were both living with their mother at the time. Now an occasional English word in Thai sentences from a husband who spoke to her only 4 minutes a day for 6 years isn't a lot. She could understand a little of what they said to her, but she had never tried to speak English at all before this and I'm sure communication wasn't easy. *But they got along famously.*

A few months after we returned to Thailand we moved into a compound where an Anglo-Burmese family was living. Anglo-Burmese English was their native language. Their Burmese was non-native and their Thai was minimal. Kwan became close friends with the old Auntie and they talked a lot. Two years later I left my job at AUA and we went to live in the States with my sister. Kwan's English had improved quite a bit during her 2 years with Auntie, but talking with my sister and nephews was still a struggle.

Soon after we got to the States Kwan started studying hairstyling at a beauty college in Salt Lake. She spent 2 hours a day listening to the teacher and 5 hours doing hair (mostly for talkative old women). In the meantime I had gone from speaking to her in Thai with the easy words in English to

speaking in English with the hard words in Thai. She still spoke only Thai to me. We lived there for four years and I would estimate that her ratio of hearing English to speaking it during this time was about 10 to 1. We then moved back to Thailand for 10 years during which time we were mostly 'cross talking' with each other (I was speaking to her mostly in English and she was speaking to me mostly in Thai).

Now here's the moral to Kwan's story. Unlike almost all the Thai people I know, her English doesn't sound Thai. It sounds American. Her two closest Thai friends have lived here in the States for over 25 years and their English is nothing like hers. Joke's English sounds British, Kwan's English sounds American, and the English of all the rest sounds Thai.

Servants and Bargirls

Most Thais learn their English by studying it in school. Joke and Kwan learned theirs from cascades of a rather rare kind. Let's look now at the commonest kind of cascade: people in jobs that interact with foreigners. I'll compare servants in an English-speaking household with bar girls in a bar for foreigners. Notice this. The main job of servants is to *listen*. The main job of bargirls is to *talk*. And even though I hadn't yet found Zambi's secret, I did expect the servants to end up with much better pronunciation than the bargirls. Long before I had ever thought about teaching by cascades I had come up with this formula in my classes: 'pronunciation index' = 'percentage of language heard' divided by 'percentage of language spoken'. Servants might say one word for every 100 they hear, for a pronunciation index of 100. Bargirls might say 100 words for every 100 they hear, for an index of 1. And sure enough, it's quite obvious that servants have far better pronunciation than bar girls.

AFS Students and Mormon Missionaries

AFS originally stood for American Field Service, but it later went international and dropped the translation. Students spend their last year of high school living in a foreign country with a foreign family and attending a foreign high school. Ideally they have a 'brother' or 'sister' in the same family who is attending the same grade in school. They study the language for their first few weeks. Mormon missionaries study the language for a little bit longer and then go to the foreign country to teach and preach for about 18 months.

In the late 60's both groups came to AUA for language study. We gave both groups our first intensive term of 5 weeks, and after that their learning proceeded by cascades—12 months for AFS, 18 months for missionaries. Which group did better?

Like servants, the job of AFS was to listen. Like bargirls, the job of missionaries was to speak. I predicted that the AFS students would do better. They didn't! Was there something wrong with my ideas? With my formula for index of pronunciation? I later found the answer. The missionaries did all of their preaching in pairs. For their first 6 months they were juniors, and the seniors did all the talking. The juniors just listened. They listened to both their senior and to the people they were preaching to. They didn't speak until they became seniors. The AFS students, on the other hand, were constantly encouraged to speak outside of class. You might even say they were *hounded*—by both classmates and family. The fluency of the two groups, on the average, was similar. The pronunciation of the missionaries, on the average, was better.

Peace Corps Volunteers

Peace Corps Volunteers had about the same amount of language training and time in country as AFS students and Mormon missionaries. But their duties varied so much that no generalizations could be made. A few Peace Corps Volunteers ended up better than anybody in the other groups, but most of them ended up worse. If I were to make a survey to find the answers, I would ask only one question: "How many hours of Thai did you hear a day and how many hours did you speak?"

Miscellaneous Cascades

I've spoken above mostly about *types* of cascades. Examples of fairly successful *individuals* consisted only of Peter, Joke, Kwan, and myself. These were the only successful individuals that I knew enough about. There are, of course, a great number that I didn't know enough about. There was the American lawyer who immigrated to Thailand the same year I came. As a way of learning Thai he lived in a Buddhist temple out in the country for a year. His Thai ended up far better than mine. I asked him how much Thai he tried to speak during this time. Practically none. Then there was the young Swedish boxer who came to Thailand to study Thai boxing. He lived with a boxing school at Pataya (a beach resort) for a year and eventually learned fluent Thai. I asked him how much Thai he tried to speak during that year. Practically none. It's people like this who emulate Zambi and make fools of the rest of us. I hope somebody will research them and write a book. Just ask around for foreigners who speak perfect Thai and interview them. But you've got to know the right questions. How much study? How much living in real life? How much listening? How much speaking?

I observed all of these cascades without understanding the forces involved. I didn't know why Joke did better than Kwan, who did better than Peter, who did better than me, who did better than the old Bangkok hands I had known. I didn't know why servants did better than bar girls or why Mormon missionaries did as well as AFS students. And I didn't understand why it took me over 5 years of near immersion to get as far as AFS students got in one (see below).

I understand these forces now. The preface says it all in a single phrase: *tagging along in a cascade of everyday happenings without trying to say anything for nearly a year*. This phrase contains Zambi's two rules. The first rule is 'tagging along'. The second rule is 'without talking'. As you and I look back now at my work and my play, we see these forces constantly staring us in the face. But at the time I didn't see them. I feel sheepish—and you must be smiling at me. But it's even worse. Not seeing these forces is one thing. But sometimes I *did* see them—and *guffawed!* Here are two cases that I noticed but immediately dismissed.

- The AFS students, after finishing their year in Thailand, used to put on a show in AUA's auditorium. From the stage they would talk to hundreds of our Thai students of English and answer their questions. All in Thai. I had given them the introductory lecture one year earlier when they didn't know a word of Thai, and now I was hearing them chatter away in front of an audience. My first year in Thailand had been similar to theirs: living in a Thai family with a Thai 'brother' and attending university classes. How did I compare with them after my first year? I not only took note; I even put it in the form of equations.

  Me: 500 hours of study + 1 year in family = 50% (the grade I gave myself)
  Them: 100 hours of study + 1 year in family = 70% (the grade I gave them)

I then solved the equations: 400 hours of study = -20%.

I laughed. "Very interesting. But I don't believe it for a minute." And when their representative asked me to reduce their study time the following year from 5 weeks to 2, I kicked them out in a huff. "AFS around the world has shown that this is best," she said. "As the world's leading authority on the teaching of Thai to foreigners, I disagree," I thought. Even though I had an *equation* that supported their view and destroyed mine. I think that's what Barbara Tuchman meant by 'wooden-headed'.

- I once met a man from a small village in the Assam hills of India who had migrated over the mountains into a Burmese village as a child and then over the mountains into a northern Thai village as a teen-ager. As a young man he had come to Bangkok where he picked up central Thai, got an education, and eventually worked in a bank. Like my students, he was an adult when he learned Thai. Unlike my students, his Thai was near-perfect. My students never came close. Nor did I—even after 30 years. I laughed. "Sure! But that's cheating." I swear. That's what I thought. It's cheating to live in a village. To get a language by immersion in real life. (Wooden-headed in my work, blind in my play, and embarrassed in both.)

Look again at the section above called "The Typical Adult Cascade.' Why was I so wrong? Why is the whole world so wrong when they say that the adult has lost what it takes? We're all looking at typical adult cascades—which don't follow Zambi's second rule. And we all manage to find a way to dismiss the untypical cascades--which do. All we have to do is take note of these cascades and sort them by the degree to which they follow Zambi's second rule. The closer they come, the better the results. Here's my ordering by results. Joke, Kwan, Peter, me, and the old Bangkok hands. And here's the ordering by amount of language spoken (from least to most). Joke, Kwan, Peter, me, and the old Bangkok hands.

Summary of the 18 Years

The 60's

The decade of bliss. New ideas came faster than I could write them up. My doctoral dissertation was published in 1965 and the Division of Asian and Pacific Languages at the University of Hawaii made me a better offer than Cornell had. I could have my own department of Southeast Asian Languages to develop in any way I wanted. We didn't get to money. We didn't have to. As always I just followed my heart. "No thank you." But afterwards, since Hawaii didn't have a salary cap like many universities, I playfully asked *myself* about money. Would I have taken it for $50,000 (this was 1966, you know, and I could have expected something more like $12,000)? No. $100,000? No. Even with a million dollars a year and a private jet I couldn't get to my Thai bars every night and Honolulu sure couldn't offer the equivalent. Anyway, I would've had to give tests at the university. I tell you this to show you how satisfied I was during the 60's. And it was much more than my nightlife. 'Head of the Depart-ment of Southeast Asian Languages at the University of Hawaii' couldn't come close to matching 'Staff Linguist at AUA'. *I didn't have a price.*

The 70's

The decade of apathy. In the first month of the 70's I found out what the professor's sabbatical was all about. After 8 years of fervent activity I ran dry. My job had always been 50% new ideas and 50% administration. But now the new ideas had stopped. I sat at my desk and nothing came. I

couldn't accept money for just sitting at my desk so I went on half time status for 3 years. And whereas $4,200 a year was enough to live on, half of that wasn't. After 3 years I managed to get back to writing some materials, but I never recovered the excitement. And I later realized why. It wasn't just the 'sabbatical rundown'. Though I didn't realize it at the time, I had got myself bogged down in a no-win business. It was Barbara Tuchman's 'March of Folly'. I was riding a dead horse. I was trapped in a massive failure. I was trying to teach languages by a method that didn't work. And I didn't know it.

My Thai

As I come to the end of my days at AUA, let me bring you up to date on my ability to speak Thai. Where was the guinea pig after 32 years? I told you that by 1960 I thought I had arrived. Well I kept getting better and better through the 60's (due, no doubt, to my 'nighttime cascade'). People described my Thai as 'legendary' and I tended to believe them. When I gave lectures to Thai schools, the teachers would later tell me that my Thai was better than theirs. Now I knew full well how damning this comment can be, but I still lapped it up. More convincing were things like this. I phoned to speak to an American friend, and the servant who answered the phone later told him that a Thai man had called—and swore by it. "Are you sure it wasn't a foreigner with perfect Thai?" (he had been expecting me to call). "No. It was a Thai. I'm 100% certain." I could see through this too, but I was succumbing to something I said earlier: 'Short term satisfaction tends to blind us to long term goals.'

But what were the long-term goals of the guinea pig? I had set out to prove that the Army method could produce perfect speakers. *Then*, I thought I had proved the method right. *Now*, I can see that I had proved it wrong. The difference is hiding in the word 'speak'. *Then,* I was thinking of 'delivery' (how the speaking comes out). Since my delivery was near perfect, I had proved it right. *Now*, I'm thinking of 'production' (how I get from thought to sentence). Since my production of Thai is very different from my production of English, I must have proved it wrong. Let me put it this way. When I speak Thai, I think in Thai. When I speak English, I think only in thought—I pay no attention to English. Remember my 3-year-old 'answer' to my sisters' question, "What are you thinking about?" It was this. "I'm not doing the thinking—the thinking's doing me." Well, when I speak Thai I'm doing the thinking. When I speak English the thinking is doing me.

So here's the official report from the official guinea pig. When they said 'perfect speaking', they meant 'perfect delivery'; and sure enough that's what I had been able to do. But the neural machinery used for perfect delivery was built at the expense of that used for perfect production. The need for monitoring my delivery had prevented the machinery for perfect production from building. Judged from the inside, my speaking of Thai hadn't even been going along the same track as my speaking of English. I was doing something completely different: I was speaking partly through my monitor. Sometimes I felt like I had two different Thai languages in me: the conscious monitor (built by study and kept alive by my daily editing of Thai textbooks) and the subconscious language (built from cascades in real life). And the conscious part could never get completely out of the way. In fact, when they finally fought it out in 1980, the conscious won.

Here's what happened in 1980 as the time of my leaving Thailand approached. Leav-ing AUA was traumatic. While my main reason for leaving was to study physics in the States, the thing that set it off was some ill will at AUA. I hardly slept for months and my hair started to turn gray. Over my last 6 months before leaving, my subconscious Thai gradually disappeared, and on the last day (which was clearly marked by moving out of our house and into a hotel) all I had left was my moni-

tor. I had to consciously construct every sentence. This sort of thing is not unheard of. Some people have lost whole languages due to traumatic experiences. This has nothing to do with the purpose of this book (I'm not claiming that studied language will push out naturally learned language), but I have to mention it in order to make sense of later reports from the guinea pig. You see I never fully recovered. Here's the final report. I peaked in the 60's without ever having entered the native track, I went slightly downhill during the 70's, I crashed in 1980, and I've been unsteady ever since.

What I Learned about Teaching Languages

At the end of those 18 years it seems that I hadn't learned anything. I was still convinced that the answer was practice, practice, and more practice. My experience with what works and what doesn't was richer and denser than that of anybody I knew. Everything in my work kept screaming out "*Teaching and study can't produce real language learning!*" And everything in my play kept screaming out *"You don't do it. It does you!"* The experience was there—but the screams went unnoticed. I was still unaware of the fourth veil.

It took many more years and a jolt at rock bottom. But it happened. In the meantime I looked in other directions. And I got back the tingles.

Chapter 5
The Second Wind: Age 45-70

Ghosts and Blinders

I haven't lost sight of the purpose of this book. It's to reveal the secret of automatic language growth. But instead of trying to state this idea, I chose to trace its development—to try to lead you along the path I took in finding it. That path started with an enlightenment at the age of 5, wended through three veils and countless ghosts by the age of 20, and came to a magnificent valley at the age of 23. That valley was the science of language.

It's not that I was looking for this valley. I just stumbled into it. I clearly remember the definitive moment in the summer of 1951 when this valley first came into view. It was the first day of a class taught by Bernard Bloch at the annual Linguistic Institute, which was being held at my own University of California that year. Bloch had just finished with the usual introductory question, "What is language?" He then followed this up with "*Where* is language?" Now 'what' can be used to ask about ghosts, but 'where' is another matter. It points straight to *reality*. I turned and looked out the classroom window to the Golden Gate Bridge across the bay as I felt goose bumps. "Hey! Language is *real*!" The whole field of linguistics is built on ghosts, but when Bernard Bloch asked "Where is language?", I looked for it. And I was looking for some *thing*—not some *ghost*.

My choice of linguistics was confirmed. Notice how I stumbled into it. I didn't *go* to the Linguistic Institute of 1951. It came to me. With Bernard Bloch. I didn't *apply* to go to Cornell three months later. Cornell came for me. With Charles Hockett. And even though linguistics was built on ghosts, Bloch and Hockett came closer than any other linguists to seeing beyond the ghosts.

So the path that started with my enlightenment and passed through veils and ghosts brought me to this valley—and I settled down there for over 30 years. I was a linguist. But I wasn't like other linguists. I was aware of the veils and ghosts. Recall my article 'Phonemics Without Sounds' that was turned down by the main journal of linguistics. I felt that I was a notch above other linguists because I didn't believe in ghosts.

But now I'm looking at this valley from hindsight and I see something else. There was a fourth veil. It had taken me 20 years to see through the first three, but number four took me 40 more. I'll call it the *professional* shackle. Sometimes the word 'blinders' will fit better. Every profession has its blinders. Can you imagine giving a Ph.D. in physics to a candidate who refused to accept relativity and quantum mechanics? I don't have the physics blinders and can sometimes see things in physics that physicists could never see. Likewise, physicists can sometimes see things in linguistics that I could never see. In fact that's precisely what happened. A physicist (among other things) named William Powers was able to see what was needed to make language real.

So here's where I am as my path approaches its second wind. A linguist who is free from ghosts but not from blinders.

The 5 Ideas of the 70's

The decade of the 70's started with three major reversals. 1) I ran out of steam; 2) a new boss arrived from Washington; and 3) I got married.

Look at the size of these reversals. *Running out of steam:* an eight-year explosion of ideas in my work suddenly dropped to zero. *The arrival of a new boss:* all those years as respected elder statesman suddenly flipped to the opposite extreme. "We'll pay you for six more months if you'll resign now." *Getting married:* a playboy nightlife that buzzed with throngs of vivacious Thai smiles every night of my life was suddenly replaced by one: my soul mate.

These are the three upheavals that came in the February of 1970. What did I do? I ignored the 6-month nonsense, quit the half of my job that had run dry, and spent this newfound time on my own thinking. In his weekly television program on 'The Joy of Painting', Bob Ross often said this as he painted. "We don't make mistakes—we only have happy accidents." My reversals were happy accidents. They changed my life for the better. Of course going on half time cut my meager salary in two but I soon found that 2 can live cheaper than 142.

The 70's, in some respects, reminds me of my misfit period (age 6-20). In both periods my daily activities (schoolwork in one and office work in the other) were non-fulfilling—even empty. But in both periods my *thinking* was booming. Could it have been the *emptiness* of the activities that provided the space for the *thinking*? And could it have been this thinking that pointed me to *the language veil* in the first period and the reality of *brain* and *universe* in the second? As I look back now I see the 70's as the important turning point in the history of my thinking: the tapering down of my first wind overlapping with the tapering up of my second. Here's a rough timetable of the new things I found and did with my second wind. They're all in the area outside of my professional blinders, but they all serve to build up the pressure that would later blow these blinders away.

1970: I wrote an article on America's race problem.
1971: I found the reality behind *perception* from David Hubel.
1972: I was inspired by the DNA story.
1974: I found the reality behind *behavior* from William Powers.
1976: I learned about natural learning from Timothy Gallwey.
1979: I found the old 'wind theory of *gravity'* in a note by Richard Feynman.

The first of these may have served as an escape route from my years of folly: a means of giving my linguistic blinders a rest. But it was the next five points that would provide evidence for my second wind. These five ideas together with the three veils (repeated below) should show the true nature of my thinking.

Veil 1. Perception: Seeing is believing /1/ Reality
Veil 2. Faith: I believe! /2/ It ain't necessarily so!
Veil 3. Language: Words /3/ Experiences

But if my childhood (my first wind: the 3 veils) and the 70's (my second wind: the 5 ideas) represent the true nature of my thinking, what in the world was I doing all that time in between? I loved those 25 years. They were carefree, fun, rewarding, and even creative (to the extent that blinders would allow, that is). Maybe the word I need for the enjoyment of that period is 'bliss', as in 'thinking with blinders is bliss'. And the word for the other kind of enjoyment is 'tingle'. You see, during those 25 years I didn't get a single tingle.

But then the tingles started again. I combined the ideas of Hubel, Powers, and Gallwey and saw how people learned to do things. Like tennis—which lay outside my blinders. But not language. You see I already had the answer for learning languages. Practice. Hubel, Powers, and Gallwey gave me a brilliant spotlight that lit up everything around me—except language.

When the confrontation of tingles and bliss finally came, it was big. But that's for a later chapter. What's needed now is to present the ideas of the 70's. As with everything else in the book, this presentation is given from hindsight. In the live version, the ideas just happened—with no conscious planning. From hindsight, I'll try to impose a plot.

Race

Here's how the race problem fits into my plot. For 25 years I had been coasting from the impetus of my linguistic training with all of its blinders. Before I could apply this new thinking to language teaching, I needed an escape. I needed full concentration on something completely different for a year.

I had never really been exposed to America's racial problem. There was only one Negro in my high school of 2,000 students, and the only contact I can remember in the Navy and all of my universities was a cook and houseboy in my fraternity at Cornell. And during all my years in Thailand my only knowledge of what has going on in the States was one newspaper and one newsmagazine. But by the late 60's the proportion of news devoted to America's race problem had increased to the point where even someone like myself had to wonder just what was going on over there. For me, this point came on March 9 of 1969 with the appearance of a Time cover story and a Max Lerner column in the newspaper—both on the same day. Time called it "… the toughest moral and political dilemma of the postwar era: how to ensure justice for its blacks and tranquility among its races." And I thought, "Blacks? Races?" Max Lerner said, "Let's not kid ourselves. This isn't a political or economic or even moral crisis we are in. It is an intellectual crisis." And I thought, "Perhaps the problem is all in our language."

I thought I had the answer and I felt obliged to write it up. I hadn't done very much writing in my life and I soon saw that this wasn't going to be easy. It was at this point that I went on half time at my job, and I ended up taking half of every day for a whole year writing this article. Here's how it started.

Race, Complexion, and Ancestry

I found this entry in a Chinese dictionary.
Chu: 'A horse with a white left hind leg.'
What a strange category to have its own word!
There must be a reason!
Some special implication? Some special need?

Here's another one, closer to home.
American Negro: 'An American with
any detectable amount of black ancestry.'
What a strange category to have its own name.
There must be a reason.

I never did find the reason for 'Chu'.
I'll have to ask some Chinese historian.
But I can guess the reason for 'American Negro':
A cruel, ugly category (not a word) is filling a need!

Whatever we call that strange category,
(be it 'Nigger', 'Colored', 'Negro', or 'Black')
it fabricates a prejudice.
(''Nigger' reveals the prejudice, 'Black' hides it;
and more harm is done by the hiding.)
The prejudice, in turn, fills a widespread need.

The point developed in the article was that 'any' (any part black) implies contami-nation (or royalty!). No other racial mixtures are defined like this. They all speak of *parts*. There must be a reason you can't be part black. But 'any' is only half the problem. The other half is the 'anyway' implied by the remedy. "Even though you're contaminated (by 'any'), you're entitled to your rights ('anyway')." In effect, that's what the 1954 Supreme Court Decision implied. How noble! Notice that the problem in this example lies in *categories*—not *words*. This is much more difficult to fight. In fact, even though I see the problem clearly, I still can't find a way to keep from implying that certain people are contaminated. Our language gives me no way.

I sent the article in to a couple of journals but there were no takers. Twenty-five years later, after I moved back to the States and found that it still applied, I touched it up and sent copies to selected people, but there was no interest. I still think it points up the problem and shows the solution.

Perception

Now I needed something to remind me what real creative thinking was. For 25 years I had been deceiving myself with lazy man's creativity. I had been trying to make new arrangements in old space. I had completely forgotten about the tingles that come from clearing new space. I needed a jolt.

As I looked over old issues of Scientific American I came across a 1963 article on "The Visual Cortex of the Brain" by David Hubel. It grabbed me. For the first time I saw a mental unit that had substance. A specific perception (like me looking at a kitten in front of me right now) consisted of a specific structure of converging neurons that I likened to a neural tree. This structure existed in space and in time. It had size; it had shape; it had location. In my imagination I could see it take shape, and I could see it work. Compare this with the usual ghosts of the 'mind': 'thoughts', 'memories', 'consciousness', and the like. How big is a thought? What's its shape? What's it made of? See what I mean? A thought has no substance. And what are things that have no substance? Ghosts.

Here's how the idea developed. I had read numerous explanations about how brain cells work and wasn't expecting anything special as I started to read the article. Like the rest, Hubel was looking at neurons—not perceptions. He never said anything like "Here's the neural structure that corresponds to the kitten you're looking at." But as I read on, that's precisely the picture I started to get. He provided the pieces and showed how they worked. That was the hard part. The amount of painstaking work that went into this was enormous. I just put the pieces together to form a perception. That was the easy part. Why hadn't Hubel done that? Blinders, I guess.

Hubel's first view was *inside* the neuron. Different kinds of neurons are turned on by different things. If a neuron's *thing* is vertical lines, for example, it will buzz like crazy when it sees one. Call it buzz strength 10. If it sees a line slightly off vertical it will buzz 9, and so on down to 0 for a horizontal line—which does absolutely nothing for it. Hubel's second view was *between* neurons. Each neuron has many lines of input (from different areas in the eye or from other neurons) and each

input can be different (one line might carry buzz 5, another buzz 2, and another buzz 1). It adds these inputs together (or combines them in some other way) and sends buzz 8 (or whatever) down to hundreds of different output lines leading to hundreds of different neurons on the next level. (My imagination went wild on the two parenthesized parts of the previous sentence; that is, 'combines them in some other way', and 'whatever this combination may be'.) Hubel's third view was between levels and between areas. There are several levels of neurons with a maze of crisscrossing connections from level to level.

But wait. Where's the kitten? On the outside I was looking at a kitten. On the in-side I saw only a maze of connections. Where in that maze was my kitten? I went back to the eye and followed Hubel as he worked his way in. The basic structuring was a convergence of many neurons onto one, and this time I highlighted the path as I went. I'll refer to levels of neurons as A, B, C, and so on. Many A's (nerve cells in the eye) converged onto a B. Many of these B's converged onto a C. And so on until the whole kitten came together. Clearly highlighted in that maze of connections that crossed several different levels was a neural tree. From leaves to branches to trunk. And that neural tree was my kitten. All its characteristics were there. The tilts of its lines were in the leaves of the neural tree. *Tilts* had converged into *shapes* (as the leaves converged onto a twig). *Shapes* had converged with *colors* (as twigs converged onto a branch). And so on until we finally reached the trunk. That trunk was a neuron that connected the whole kitten together. It was the thing that made it possible for the whole tree to light up as a unit. And the totality of what's connected to what, in any given flash, is precisely what a perception is made of. Because of that final neuron, the neural tree that was my kitten was able to flash as a unit.

Notice where Hubel and I had parted. Hubel went from neurons to connections, to <u>levels and areas</u>. I went from neurons to connections to <u>trees</u>. He saw a massive maze of crisscrossing connections; I saw a massive forest of trees. Before that day I couldn't see the trees for the forest. But once I saw the trees, look what followed. Each neural tree, once formed (built or grown), stayed right there. Right where it had formed. While I was looking at the kitten, the flashing neural tree was my *perception* of it. When I stopped looking, the same neural tree stopped flashing but it didn't go away. It was a dark *memory* of the kitten. When I thought of it later, it flashed again—as a *thought*. "*But it's the same tree,* Dummy!*"* (I said to myself). "The *perception*, the *memory*, and the *thought*. *They're all the same damn tree!"* And this tree was no ghost. It was real. How big was it? At least several inches (from eyes to the back of the head). What was its shape? It resembled a tree. What was it made of? Nerve cells. I had made an *intangible* perception, an *intangible* memory, and an *intangible* thought all *tangible*. It felt great. I looked at the house across the street. *Sproing!* Another tree popped up. I looked above at the clouds and the birds. *Sproing!* Neural trees were popping up all over—all day long. Then I started flashing old memories. 'Breakfast this morning.' *Click!* The tree lights up and I examine it in detail. 'Dinner with friends at a restaurant three months ago.' *Click!* I can see where the entrance is, who's sitting where, the waiter bringing the duck—everything. It wasn't a ghostly memory; it was a physical tree. *The same damn tree* that had been built three months earlier.

The crucial point of my idea needs repeating. A live perception and all later replays have the same physical reality—the same flashing neural tree. As we look at the kitten *out there,* our sensors scan it and build the tree *in here*. The kitten out there is real. The tree in here is real. We *look at* the kitten (with our 'sensors' scanning the kitten); we *see* the neural tree (with a 'cursor' scanning neurons). Compare 'look at' with 'see' in the preceding sentence. I'm using old words in new ways with the hope of getting you to look at old ideas in new ways. Like the reality of night and day, this new reality gave me goose bumps.

See the source of my tingle? I had found the *substance* behind the *ghost*. The ghost was the words: 'seeing a kitten' or 'thinking about seeing the kitten'. The substance behind 'seeing it' and 'thinking about it' was a neutral tree—the same neural tree for both the seeing and the thinking. And that, to me, is what science is all about: *finding the substance behind the ghosts.* This was the source of my tingles: replacing ghosts with something real. There had been Copernicus (night and day), Mendeleev (atomic structure), and Darwin (natural selection). And now there was Hubel (perceptions). For the first time my search for reality had entered the brain. On that memorable day I made intangible perceptions tangible.

As I look back now I wonder why I didn't pursue it. "If it made you feel so good why didn't you run with it? Why didn't you use it to change your way of teaching and analyzing languages?" And now I know. Blinders. It's one thing to see something new, but it's something else to focus it on yourself. "Those damned blinders!" Anyway, there were too many things left unexplained. This had only been step 1. It just floated around in my head making me feel good for 20 more years. Then it happened. In quick succession came step 2, step 3, step 4, and step 5. *"Eureka! The Inner Net."* (See chapter 8.)

The DNA Story

Now that I had rediscovered the tingle, I needed help. My original model for my tingles had been 'night and day'. But I had become so lazy for so long that I needed something a lot stronger than that. I had heard of the DNA molecule in the 50's and the genetic code in the 60's, but I was far too busy with my own pathetic bliss to take much notice. Now I had the time to take a look, and what I found was just what I needed.

It wasn't just what the DNA story had to tell me; it was how it started me thinking. Remember when I was reading about the neural basis for perception, I focussed not just on the neurons and their interconnections but on a larger meaningful unit: a *neural tree.* Similarly, as I now looked at the molecular basis for genetics I focussed not just on *present* molecules but on the whole history of where those molecules came from. Notice this progression of excitement. 1) Knowing what a DNA molecule is and how it reproduces itself. 2) Knowing how this molecule directs the production of all other molecules needed to produce a particular plant or animal. 3) Knowing how this whole process came about in the first place; that is, the evolution of these molecules. Three steps: what it is, how it works, and where it comes from. It was steps 1 and 2 that I read about, but it was step 3 that I looked to for the real excitement. Like the trunk of that neural tree that brought the whole kitten together, it was the *development* of that giant molecule that brought the whole DNA story together.

This was to become the bigger and better model for clearing new space in my second wind. The night and day model of my first wind was powerful but simple. I needed something more elaborate. You may know a lot more about molecular biology than I do but I want you to look at it from my simple-minded perspective. Just as sun and earth was simplified to lamp and orange, I want to simplify actual molecular structures to 'balls', 'sockets', and 'hooks'.

Let me set the stage. All you have to do to make something like *me* is to put a *seed* in a *soup* and *stir.* The seed is my DNA molecule, which is the complete 'how to' manual for assembling me. The soup contains the necessary raw materials. And the stirring consists of electrical forces jostling shapes around until they fall together. Then, with nothing more than a 'ball' finding and filling the 'socket' that fits, *I* appear. And it's all *automatic.* The molecules just 'fall together'. *I* just fell together. With words like 'automatic' and 'fall', I can dispense with words like 'intention', 'intelli-

gence', and 'miracles'. In the soup, I see this 'how to' manual *reproduce* itself. Automatically. I see this DNA molecule *build proteins.* Automatically. I see proteins *build* all of the other molecules needed to build *me.* Automatically. And when I wonder where this plan came from in the first place, I see it *come about* automatically. (If you're starting to wonder what all of this has to do with the purpose of this book, look again at the subtitle.)

It's the excitement of the overall picture that I'm trying to show. Not the technical details. In order to get the big picture I have to simplify and generalize to a point where details might get distorted or lost—but never *countered.* I once saw a university class on TV dealing with the genetic code. Presumably they had chosen an expert teacher for television, and I must admit he was good. The trouble was he was *teaching* the lesson. The subject matter was as gripping as a good murder mystery—and he was *teaching* it. Can you imagine *teaching* a murder mystery instead of *telling* it? "Now remember what the butler told the policeman because I'll be testing you on it next Friday." I'm not kidding. This good teacher was saying things like that. Well I want to *tell* the DNA story—not teach it. I want to focus on 'who done it' instead of the details of the clues.

I mentioned three stages of the story. How the DNA molecule reproduces itself, how it builds other molecules as needed, and how it came about in the first place. I'll use simplified explanations for the first two stages but I'm going to use a fairy tale for the third. The important thing in stage 3 is not to show what actually *did* happen, but to show how such things *could have* happened. That is, how unexpected accidents can *cause* such things to happen—*automatically*.

Stage 1 shows how the manual makes copies of itself. Nearly all textbooks on genetics show a section of a DNA molecule—often on the cover: two intertwined helixes. Let's separate the two, straighten them out, and inspect them. Each one is a chain with four kinds of links: A, B, X, and Y (this will be easier to follow than the customary A, T, G. and C). All four links have similar ends: a 'ball' at one end and a 'socket' at the other. Any ball can lock into any socket, so you could snap any number of links together in any order to form endless different chains.

Now in addition to a ball at one end and a socket at the other, all links also have a 'hook' on the side. And unlike the balls and sockets, the hooks aren't free size. An A can hook sideways only with a B and a B with an A; an X can hook only with a Y, and a Y with an X. So any link has three points for connections. An A, for example, can attach to any link at one end, and any link at the other, but only to a B at the side. Now picture two chains lying side by side with every link of chain 1 hooked onto a link of chain 2. For any chain 1, no matter how long it is, there is one and only one chain 2 that can be so hooked. Chain BBYA, for example, can hook up only with AAXB. That's just the way they fit. But the angle of hooking is such that the two chains don't lie straight beside each other. They coil together and resemble a spiral staircase. They form a double helix.

Now as we watch in our imagination, we see the helixes unzip (to some signal)— leaving the two halves, BBYA and AAXB, floating in a soup full of free A's and B's and X's and Y's. And these two halves each have four different *mouths* along their sides, one on each link, snapping up free links floating around them. Watch BBYA. The B's each snap up an A, the Y snaps up an X, and the A snaps up a B. Then as soon as the snapped up A and A and X and B come into position, balls fall into sockets and the chain AAXB is formed as it coils up with BBYA. The other unzipped half does the same thing and our original double helix has become two identical double helixes. It has multiplied. To get a feeling for the joining up of balls in sockets and hooks in hooks, picture tumbleweeds blowing over the land. As long as there's a wind they will keep tumbling until they get caught in a niche that fits. *Caught in a niche that fits.* This can explain how the entire universe works.

Once you get an explanation of all the shapes, everything else is nothing more than *wind* and *niche*. It's as simple as lamp and orange.

Stage 2 shows how each copy of my DNA manual goes about turning everything I eat into me. It's still a matter of *wind* and *niche*, but there's a complication that can easily distract us. I'm going to put off this complication by first assuming a simplified evolutionary level of protein construction that might have come eons before the famous genetic code. The complication will then be taken care of in stage 3, which deals with the evolution of it all. This imagined level of a billion years ago used the same three steps used today—the same three steps my DNA uses to make me. Here they are. 1) A short *section* of the enormous DNA molecule unzips (to some signal) and, in the same way that the whole DNA molecule reproduces itself, this short section builds a copy of a slightly different type. They call this molecule RNA instead of DNA. 2) This RNA molecule floats off and proceeds to assemble the particular protein that fits into its hooks. 3) This protein molecule is then used either to weave some required tissue or as a tool (an enzyme) to construct other molecules needed to make me. The three steps are thus DNA to RNA, RNA to proteins, and proteins to everything else.

Let's look at protein molecules and see how RNA molecules go about building them. Like RNA, the protein molecule is a chain, but instead of 4 kinds of links (A, B, X, and Y) it has 20 (a_1, a_2, … a_{20},). These 20 kinds of links are called amino acids, and they all have the same balls and sockets at their ends and can thus join up in any order. Just imagine how many different hundred-link long proteins you could make out of twenty amino acids! (Figure it.) Now it turns out that a given RNA molecule can build one and only one protein. That is, if you put one of these molecules in a soup of amino acids with the right conditions, one and only one protein will 'fall together' ('grow', 'be assembled').

The RNA molecule does this with a complicated molecule called a ribosome. I'm going to simplify the ribosome in both time and space. In time, I imagine a much simpler version of a billion years ago. And in space, I reduce the whole molecule to the hooks on its two ends: an RNA hook on one end and an amino acid hook on the other. A-a_1, for example, shows a ribosome molecule that can hook onto an A at its RNA end and an a_1 at its amino acid end. At this remote period of time there were only four different ribosome molecules: A-a_1, B-a_2, X-a_3, and Y-a_4.

Now suppose an RNA molecule, like ABXY, enters a soup of these molecules—each with its amino acid in tow but with empty RNA ends. We soon hear four clicks: A clicks onto a molecule towing an a_1, B clicks onto one towing an a_2, X clicks onto one towing an a_3, and Y clicks onto one towing an a_4. This lines up the four molecules a_1, a_2, a_3, a_4, and we hear three more clicks as they join hands to form protein a_1-a_2-a_3-a_4. Of course all proteins would be made up from only four different amino acids instead of twenty. But this was a billion years ago when life was simple. Stage 3 will show how these simple proteins eventually evolved into those of today.

But so far we've only shown how RNA can build proteins. What about all the other molecules needed to build me? A protein molecule is more likely to be made up of a hundred links than just four as in the above example. When this long protein chain floats off the RNA assembly line, the shapes and electric forces of one part of the chain are attracted by those of another part, and the chain automatically coils, crinkles, and clicks together in a precise way as it tumbles into itself. Weird shapes with precisely shaped pockets are formed. This is an enzyme. Its distinctive pockets can trap foreign molecules that happen to fall into them and get stuck. Two pockets that happen to face each other along this crinkled string can hold their trapped molecules in such an attitude that they click together. These two molecules could never have gotten together in any other way. Or, in another instance, a pocket might trap a big molecule and hold it in a position such that an arm of the enzyme, like a tool with precisely the right position and shape, can neatly unclick it in two.

See how I was made? By electric forces clicking shapes together in a soup following the instruction manual that was uniquely me. Nothing supernatural. But then the question arises. "How did this fantastic structure of molecules come about in the first place? Surely there had to be a creator." And the answer out-tingles even the tingle of how it works. It's *Darwin's theory of natural selection,* which shows what happy accidents can do.

Stage 3 is shown by the fairy tale I promised you. It will give you an idea of how I view the evolution of the DNA story. My 'Molecule Fairy' has been observing molecules from the beginning but I'll take up her story at the point that molecules started to get very large. Here is my translation of this part of her story.

"Right from the start, molecule building was simply a result of 'wind and niche' and the odds of a hundred atoms falling together to form a really big molecule were remote. Simple molecules like water (H_2O), methane (CH_4), and ammonia (NH_3) were falling together all the time, but I sometimes had to wait millions of years to see a molecule as big as twenty atoms. Even when one did appear it usually didn't last very long. There were just too many accidents that could befall big molecules. This twenty-atom molecule may have been able to do wonders, but once it fell apart those wonders came to an end. It would take millions of years for a new one to come together.

"But then one eon an interesting molecule appeared that changed this: a big mole-cule that could make copies of itself. What a treat for a molecule watcher. Molecule J would make millions of other J's and they would all proceed to do their wonders. Of course accidents happen and when an inferior *j* resulted, it couldn't compete with the J's and it soon died out. But after seeing millions of inferior copies come and go, one eon I saw an accident produce a magnificent *J* that could actually outwonder the J's. This time it was the J's that lost out. Competition had actually introduced a *direction* to accidental change. Bad mistakes couldn't compete with the old, and they died out. Good mistakes out-performed the old, and it was the old that died out. The direction that had been introduced was 'up'— better and better ('better' being defined by the wonder it was performing). This was one of the two most exciting things I saw in my experience as a molecule watcher. The other one had to do with the evolution of the so-called genetic code.

"Throughout the period of single-celled organisms the RNA construction of proteins was limited to four different amino acids in the same protein: one for each of the four RNA links. If the four amino acids were 1, 2, 3, and 4, you could get proteins like 313224112433, but never one like 31522. All that was needed to build all these 1234 proteins was four molecules of the type A-a_1. Within a fairly short period of time (like a hundred million years) most of the different combinations of four had arisen by accidents, they had competed as they did their wonders, and the better one had won. But whatever the best combination was, it was still limited to just four: perhaps a_6, a_9, a_{14}, and a_{15} instead of a_1, a_2, a_3, and a_4.

Then one eon a breakthrough accident took place: a molecule of the type AB-a_1. You see it was easy for A-a_1 to change to A-a_{20} by accident, but for A-a_1 to change to AB-a_1 by accident was something else—the odds were staggering. I had to wait many eons but it finally happened and it soon became possible to make proteins of 16 different amino acids in the same protein instead of 4. That is, instead of 4 units making selections of amino acids (A, B, X, and Y), there were 16 (AA, AB, AX, AY, BA. BB, and so on). This may have been what was needed to make organisms of more than one cell. Of course they still couldn't put all 20 amino acids in the same protein, but many eons later this too came to pass. Something like ABX-a_1 happened, and before 'long' the whole genetic code emerged. It made me tingle."

If the combination of Darwin's theory of natural selection and the genetic code could make the Molecule Fairy tingle, think of what it did to me. Anyway, I'm passing out tingles. And I'm not going to test you on Friday.

Behavior

One of the first things we learn about the brain is the difference between *perceiving* (receptor nerves) and *doing* (motor nerves). Professionals prefer terms like *sensory discrimination* versus *motor control*, or they show the relationship between the two with the term *sensorimotor coordination*. But whatever terms we use, everybody agrees that there are two different functions involved. Or do they? Think about what we mean by 'playing the piano by ear'.

I was looking in the 'Letters' section of **Science** in 1974 and I saw a reference to the book, **Behavior: The Control of Perception** by William Powers. It used the expression 'a hierarchy of control systems': three of my favorite words and all in the same expression. It reminded me of my 1965 article, 'Phonemics Without Sounds', which no one had understood. I sent a copy to Powers. He understood, he was impressed, and a correspondence began. He knew the importance of language to his theory and he had been looking for a linguist who could understand him. We clicked. I got a copy of his book and studied it for two years. Then in 1977 I went halfway around the world (Bangkok to Chicago) to talk with him. Just what is the breakthrough behind that backward sounding title? What is controlling what?

I had seen the reality of *perception* after reading Hubel, and I was looking for the reality of *behavior*. And then on to the big one: *connecting them up*. Isn't that what language learning is all about? You've got to start with 'hearing,' and you end up with 'speaking'. But how do you get to 'speaking' from 'hearing'? My answer had always been 'practice'. But what was the reality behind 'practice'? After all it was only a ghost. Well Powers was saying that the brain's role in behavior was like that of a thermostat. The engineers call it a closed feedback loop. You look at what you've got (the thermometer), subtract what you want (the thermostat), and the difference activates whatever it takes (furnace or air conditioner) to bring this difference to zero. In other words, it's the difference between *what you want* and *what you've got* that determines *what you do*. And you know what's controlling what? Do you think it's the *thermostat* that's controlling the *furnace*? No. It's the *furnace* (behavior) that's controlling the *thermometer* (the perception).

When we *think about* what we do (like a golf instructor has to do) we proceed as if we're controlling our muscles. "Keep your head down!" "Follow through!" But when we *don't* think about it ("Catch!", as I suddenly throw a bottle at you), we pay no attention to our muscles whatsoever. Powers is fond of making up examples of not noticing our muscles as we do things. Here's one of them. I loop together a string of elastic bands and put a marker in the middle. I then hand one end of the joined bands to you, and tell you to try to keep the marker over a coin on the table as I manipulate the other end. As I stretch my end, raise and lower it, and move it from side to side, I watch your movements. At one point I suddenly ask, "Where's your hand now?" You're surprised as you look around and find your hand near the floor in back of you. You weren't paying any attention to your hand. You were watching only marker over coin. Your behavior was controlling your perceptions.

Here's another one. You've heard a catchy tune and you're trying to pick it out on the piano. Are you controlling your index finger? Or are you controlling what you're hearing from the piano to

make it sound like a tune in your head? I think it's quite clear that your behavior is controlling your perception.

The crucial unit is the mental picture of the desired result: marker over coin, tune in your head, thermostat setting. Powers calls it the *reference signal.* For most of your *natural* behavior (unlike your golf swing), a mental image is in charge (as a *reference* signal—not as a unit of *control*). But it's so automatic that you don't notice it. Notice it now.

- Pick up something on the table in front of you. Notice the mental image of hand on object that must precede this action. Pick up something a little farther away on the table. Notice the mental image of you bending and stretching your arm. Now something still farther. You flash the image of you bending as far as you can, and when the image shows your hand falling a few inches short you change the image to you standing and bending. It's all done with mental images of your goal. You never for an instant consider the muscles involved.

- Here's an interesting action that I experienced. We were playing Frisbee on a large motor boat going quite fast down a river in Thailand. The Frisbee went over the side. Within half a second it would have been gone. I could have jumped in and got it but I would have been gone too. Fast thinking was needed. It was easy. I simply flashed a picture of me in the air with one arm reaching for the side of the boat and the other reaching for the Frisbee.

- Imitate John Wayne saying 'A man's gotta do what a man's gotta do'. It's surely not a matter of what you do with your mouth. It's just a matter of a mental image of picture and sound.

- Sing 'Mary had a Little Lamb'. Notice the mental image of words and tune that must appear before you can do this. You can't say or sing anything without first flashing it.

So all you need in order to do something is a mental image of the result of the action. And what is a mental image? A neural tree just sitting there waiting to be flashed. Examples like those above seemed obvious. But could they be generalized to all actions? I could easily see mental images at work in the teaching of dancing, golf, and tennis (especially after seeing Timothy Gallwey's book, **The Inner Game of Tennis**, a couple of years later)—they were outside my blinders. But I didn't think for an instant that mental pictures could replace practice in learning a foreign language. This would mean that we learn to speak by *listening*, not by *speaking*. And I don't think I would have gone along with this even without blinders. You see I had always compared language learning with learning to play the piano, and I couldn't imagine learning to play the piano without practice. So what are the differences in the use of mental images in picking up an object, singing a song, learning to dance, learning to play the piano, and learning a foreign language? I didn't know then. I didn't even think of it then. Here's what I think now.

Sensorimotor coordination is indeed needed in order to do anything. Coordination between eye and hand is needed every time we pick something up. And coordination between ear and mouth is needed every time we say something. But for all common human behavior these coordinations are formed during infancy: the former, in the infant's groping stage and the latter, in its babbling stage. The child acquires a repertoire of all common human actions and is later able to use mental images to play anything in this repertoire. Picking something up and learning a foreign language are in this repertoire; playing the piano is not. But notice that just as all normal babies get eye-hand coordination from groping objects, some people get ear-hand coordination from groping piano keys. And our name for the latter says it all: learning to play by ear. Some people would argue that a child's bab-

bling is limited to the sounds of the surrounding language. I would say that the child couldn't even start on surrounding sounds until it had largely finished the coordination from its own random sounds.

All of this didn't occur to me *then*. Not even ten years later. And all the time that I was failing to get results with 'speaking through practice', there were Hubel, Powers, and Gallwey looking over my shoulder with condescending smiles. The harm caused by professional blinders will be one of the major points in this book, and it's convenient having myself to whip. I certainly don't want to be so rough on other professionals. I'll even try to be kind to myself and just smile.

Physics

For me, physics was always an enigma. I considered myself the complete scientist and physics was supposedly the most scientific of all sciences. And yet physics never made me tingle. Then in 1977 something happened. I was writing an article trying to get linguists to be more scientific. "Like physicists," I said. I thought I'd better see what I meant by that so I started looking around. I was looking for instances of the scientific power of physics so it wasn't an impartial search. I could easily skip over nine negatives and still be impressed with one positive. So I wasn't prepared at all for what was to happen.

It was sudden. Not little by little as I read more and more. It was a sudden jolt that almost knocked me off my chair. "*My God! Physics has abandoned the method of science!* " I looked behind its veils and there was nothing there. Just words with no substance. Matter, energy, light, gravity, the electric field, the magnetic field, the nuclear force. They were all *ghosts.* Physicists were building their models out of *words,* not *things*. How can the universe be made out of words? Surely it was operating perfectly well before we came along with our puny *words*. Hadn't they learned what I'd learned by the age of five? For me, science had always been *guessing what's there* (like 'earth around sun')—not *observing what's there* ('like sun around earth'). Real things—not words.

Here's what had happened. My feeling for physics had been based on little more than the solar system and the atom. These were both clear cases of *guessing what's there*. I had generalized these examples to all of science, and I assumed that all physicists had done the same thing. Now I suddenly find out that for almost everything besides solar system and atom, they were all *observing what's there.* Stephen Hawking later came right out and said it: "It seems better to cut out all the features of the theory that cannot be observed." He was actually *bragging* about it. I couldn't stand it! From 1977, I turned my main attention to physics and in 1980 I quit my lifetime job in Thailand and returned to the States to study physics and try to do something about this catastrophe. Imagine it. Physics abandoning the method of science. *My God!*

That's how I felt then. Now I can be more broadminded. Instead of saying who's *right* and who's *wrong*, I can say we're *different*. We're just doing different things with different goals. They're after equations and I'm after tingles. More realistically I think the difference has to do with the use of *models* (guesses at reality) and *math* (measurements and equations). I model before I measure; they measure before they model (and they frequently don't model at all). But enough of this broadmindedness. Let me tell you how they screwed things up—how they came to invert the use of models and math. Here's how I would explain their departure from Copernicus, Galileo, and me. On a scale of 10 for reality, let me give Copernicus and Galileo a grade of 9. Now observe *the fall of physics.*

1, Newton said, concerning the nature of light, 'I make no hypotheses'. And he wasn't apologizing. He was bragging. He was belittling the role of guessing. The reality score dropped to 7.

2. Maxwell used Faraday's models of reality to work out his famous equations about electricity and magnetism. But once he got the equations, he bragged that he no longer needed the models. After going from *guess* to *measure*, he wanted to cover up the guessing. Reality dropped to 5.

3. Einstein appreciated models of reality (note his famous *thought experiments).* But his fame, ironically, came from giving up. When *he* couldn't make sense of the perception of light, he blamed the limitations of the *human brain.* "Let's face it: there are some things it just can't do." Where Newton had *belittled* models and Maxwell had *denied* them, Einstein *eliminated* them. This was a terrible blow to the goal of guessing reality. Score it 3.

4. Feynman used his famous two-slit experiment to show that electrons can't be explained as either particles or waves. I would have expected him to apologize for the limitations of physicists. Instead, he flaunted them. He said that it's impossible, "*absolutely* impossible, to explain in any classical way." And you could tell that he was bragging about how abstruse his field was and how brilliant the physicists were. Where Einstein had *regretted* the impossibility of making sense, Feynman *reveled* in it. Reality had dropped to 1.

As much as I enjoyed scoring the 'fall of physics', let me retreat to *different*, not *wrong*. We're doing different things and I'm going to talk about *my* thing. Just at the time that my enthusiasm for my work was at an all time low, I became all fired up with *my* kind of physics. The first two years got me nowhere. I spent hundreds of hours staring at a picture of the so-called magnetic field, for example, trying to guess the reality behind it. Notice how I was falling into their trap. I was trying to explain their ghosts. What if there *was* no such thing in reality as a magnetic field? I was trying to guess <u>what</u> it was when I wasn't even sure <u>that</u> it was—and, in fact, it <u>wasn't</u>. This kind of misguided thinking continued for two years. Then came the breakthrough.

It was in Richard Feynman's **Lectures on Physics** (1963). He tells of an interesting theory of gravity that many people had thought up independently since 1750. It goes like this. Space consists of particles (I'm going to call them 'trinos') moving in all directions at the speed of light. We get hit equally from all sides and thus feel no pressure. Most of these trinos pass right through the earth and right through us—but not all. A few trinos are strained out by the earth and we thus get hit by a few more from above than from below. The excess number of trinos hitting us from above exerts a pressure on us towards the earth. This pressure is gravity.

I had been trying all my life to figure out what gravity was. Whenever I was in a waiting situation, I would ponder things like gravity, light, and time. Here's an ex-ample. I mentioned earlier that at the age of twenty I took a bus from Boulder to Denver twice a week to study dancing. An hour going and an hour coming, twice a week. And what did I do during those four hours a week for a year? I pondered things like gravity. And so it was with idle situations for the next 34 years. *But I never found any real answers.*

Now he tells me! Lots of people had thought of it, he says. But nobody told *me*. It seems to have been one of the best kept secrets of physics. Feynman explains why nobody pursued it. "If this theory were true," he says, "the orbiting earth would get hit more from in front than from behind and this would long since have stopped it in its orbit." He admits that it's an exciting theory, *but t can't be true.* "Surely you're joking, Mr. Feynman." You don't judge a new theory with the terms of the old one. You ask the *new* theory why the earth isn't slowed down.

Once I got this picture of space consisting of trinos moving in all directions the idea spread far beyond gravity. Just look what it implies. I'm constantly receiving trinos from every part of the universe, and every part of the universe is receiving trinos from me. It's a veritable *cosmic shower*. It will be able to explain the problem of force from a distance for *everything*—not just gravity. My excitement quickened.

In quick succession I pictured trinos moving in every imaginable way. Here are some of the pictures that flashed in my mind.

1) What would happen if I hit a trino from the side? It would edge sideways as it continued on its way. This would push into the space of neighboring trinos that were going in the same direction and were thus stationary relative to it. After all, these neighboring trinos would be the only ones it knew. All the rest would be in another world. Think of this trino and its neighbors as a spaceship. The trino would just be getting knocked back and forth by its fellow passengers—and it would bounce on forever as it went its way. The trino's inherent forward motion would have added the transverse motion that it got when I pushed it from the side. It would be moving in the path of a sine wave. Something like a *photon of light?*

2) What if I gave the trino a spin? The spin could be clockwise or counterclockwise. Two opposite directions of the same thing. The *electric force?*

3) And what if I hit a *spinning* trino from the side? That wouldn't be the same as hitting a neutral trino. Spinning trinos have direction of spin (an axis) as well as direction of motion. Maybe the hit would serve to *turn* the axis of the spin instead of *push* it to the side. I compared *turning* with *pushing* in my imagination, and what I saw was a trino going into orbit. It kept its original speed but it wasn't getting anywhere. It was going around in circles. Of course it would have to keep getting hit in order to stay in orbit (like the earth does), but isn't that what you would expect? I mean once it got outside its spaceship it would constantly be in the way of other trinos—like a car turning out of its lane. And getting hit equally from all sides would not only hold the trino in orbit; it would also hold the whole orbit in place. You see for every push it got from this side of its orbit it would soon get an equal push from the other side and it would just wiggle around in a fixed space. But isn't this the meaning of *mass?* How tightly something is held in place. This looked to me like a *proton* (clockwise spin in orbit) and an *electron* (counter-clockwise).

4) Then, as I was looking at that shower of trinos holding that errant trino in orbit and holding that orbit in place, I saw some *spinning* trinos join in the battering. Look! Lefts were hitting orbiting lefts, lefts were hitting orbiting rights, rights were hitting orbiting lefts, and rights were hitting orbiting rights. I had a quick flash of polarized light where one of two angles gets through while the other rebounds. The jump from 'angles fitting angles' to 'spins fitting spins' was instant. I was looking at electric *attraction* and *repulsion.*

This exciting rush took place with mental pictures, of course, not words. And it flashed in much less time than it takes me to tell about it. I was on fire. This *cosmic shower* would explain everything. I had to pursue it. You can see why I quit my lifetime job and went back to school.

Since that original blinding flash I've been through four years of physics at the University of Utah and twenty years of thinking. I've made a lot of guesses that can explain a lot of mysteries. Things like "Why isn't the earth slowed in its orbit?" and "Why do electrons behave like waves?" In fact I've found something like a unified theory of the universe. But remember that my purpose is to tell you about how I think. Not how the universe works. I want to catch the attention of those of you

who might think like me. That rules out most physicists, linguists, and language teachers. But I suspect that more people think like me than like them. You see *they're* all wearing blinders. *We're* free to see new things. The point is that if I can attract you with things like gravity, maybe I can prepare you for new ideas about language learning.

For those who want to look deeper into what my kind of thinking did with physics, I'm putting my physics ideas in an appendix. But now I want to finish off the purpose of this chapter.

This 'second wind' started in 1970 when I blinked and looked around me. It was concerned mainly with race, perception, DNA, behavior, and physics. For 25 years my focus had been on linguistics and language teaching, and my purpose had been to find the final answers to both. But after I blinked and smelled the roses, *focus* changed back to *wonder*. The same kind of wonder I had felt at the age of 5 when I learned about night and day. "*The world I knew suddenly expanded to include wonders without end. There're two versions of everything. There's what we see and there's what's there. And what's there can explain what we see."* At the age of 5 and again at 45 I had felt the freshness of *wonder* as opposed to the stagnation of *focus*. But it wasn't until the age of 60 that I saw the real power of this distinction. I found that the distinction between focus and wonder was basic to how languages are learned, to learning in general, and to the actual structure of the human brain.

Chapter 6
The Conversion: Age 55-60

While my own outside thinking was booming, my work was collapsing. Results from our teaching methods were still far from what I had hoped for and I had run out of new ideas. On top of this I had suffered eight straight years of uncooperative bosses from Washington. The collapse of my work was telling me to get out of there. And the boom of my thinking was telling me to go study physics. The two different feelings converged onto the same plan. In the past I had always followed my heart in a beat. Being without money and job had never stopped me before. But now I was married.

I worked it out. I had a loving sister who lived alone one block away from the University of Utah. We could sell everything we owned and go live with her for a year as I studied at the U and my wife studied at a local beauty college. After a year we could both get jobs. But what kind of work could I do? The teaching of Thai in the States had dropped from thirteen universities during the Vietnam War down to four—leaving lots of Thai experts out of work. The waiting line was two or three deep at each place that taught it. They were all using my textbooks but that turned out to be a disadvantage. Over-qualified! A department head in his thirties wouldn't want the old man working under him—and he would hardly want to step down.

What about Chinese? That was being taught almost everywhere. Could I teach Chinese? Well I had a degree in linguistics, I had thirty years of experience teaching a tonal language, and I once knew Chinese. Of course I hadn't spoken a word of Chinese in 35 years, but maybe I could get it back. Anyway, that was the plan. I would study physics (for me) and Chinese (for a job). Of course for physics I needed math. I already had a degree in math (which I hadn't bothered to finalize) but, like Chinese, that was nearly 35 years ago. So it would be physics, math, and Chinese. I gave AUA 6 months notice while I finished writing my last Thai text-book and found a replacement. Then I headed straight for spring quarter at the University of Utah.

I loved it. After all, I had been a professional student for as long as I had been a professional linguist. It was my favorite occupation. I soon finished off math. I took algebra, trig, and calculus 1 in the spring, calculus 2 and 3 in the summer, and differential equations in the fall. I was obviously going to be there a lot longer than a year, and it looked like I would level off at two classes of physics and one of Chinese every quarter. But that wasn't enough to keep me happy. I needed more.

The extreme structural methods of the linguists had already come under attack by 1964. Wilga Rivers (**The Psychologist and the Language Teacher**) had said that while the linguists' methods might work for linguists, they didn't work for the other 99% of language students. Maybe so. But I couldn't see that she offered anything better. I felt sure that as a linguist I could still get a lot from practicing drills even if most people couldn't. Why couldn't I teach the other 99% how to do it my way? Even if this took a special preparatory class in linguistics, it still might be the fastest way to learn a language. But I wasn't even sure that it worked for me. In my 18 languages (up to that point) I had never really practiced any language long enough to prove that practice worked. It was about time that I took care of that. Two or three years of Japanese should do it. The course at the University of Utah was of the practice variety and I could use tapes to practice as much as I wanted.

I'd show them. And that gave me enough classes to keep me happy: two of physics and one each of Chinese and Japanese.

So my return to college life now had three purposes. 1) To feed my appetite for physics. 2) To prepare for a job. And 3) to prove that practice works. This was to take four years instead of one. Here's what happened.

Studying Physics

There were four streams.

1. Conceptual physics. Only one class. No math required.
2. Physics for non-scientists. No calculus required.
3. Physics for scientists. Calculus required.
4. Physics for physicists.

I tried all four, starting in the summer quarter with the single class of conceptual physics. I was in luck. They had persuaded the legendary Dr. Parmley to come back at the age of 81 and teach this class. He was an entertainer as well as a great physicist and the class numbered in the hundreds. There were newspaper reporters and even some TV coverage. It was the best possible example of what I wanted: the kind of thing I had gotten from my father at age five.

I then followed this up with the other extreme: beginning physics for physicists. The professor was a cocky young physicist with an agenda. His first words were these. "This is going to be the hardest class you've ever had in your life." It was the cocky version of Richard Feynman's declaration: "This is absolutely impossible to explain." Physics is hard. Physics is impossible. Aren't physicists great? And here I was thinking that everything in the universe consisted of an infinitesimal particle just doing its thing. The conceptual physics class was sometimes referred to as 'dumbbell physics'. Perfect. And my own physics was even dumber.

What I wanted was four years of dumbbell physics. What I got was a single quarter of it. Everything else consisted of hard, harder, and hardest. I wanted explanations. They offered equations. I soon dropped 'the hardest class you've ever had' and spent nearly four years on 'hard' and 'harder'. Of course I didn't expect them to change their way of teaching physics just to suit me, but I was willing to put up with this in order to get the chance to ask questions. But this didn't happen. It wasn't easy for me to ask. And when I did ask I rarely got answers.

Here's why it wasn't easy to ask. Most professionals soon build up a defense against cranks—but I suspect that physicists are touchier than most. Just seeing this old guy in their class made some of them suspect a crank. When I walked into their office they stiffened. And when I introduced myself as a linguist, they were sure. "How can I politely get rid of this old crank?" I couldn't bring myself to put them through this.

And here's why I rarely got answers. I wanted explanations; they gave equations. I had often wondered about the reflection of light, for example. I looked through dozens of books to no avail. They always just pictured a wave or a photon hitting a straight line and rebounding. "The angle of

incidence is equal to the angle of reflection." That's all I could find in books; and that's the answer I got when I asked. But the photon isn't hitting anything like a straight line or plane. It's running into an electron here and there in mostly empty space. They would get mad, and I would get embarrassed. After all, dumbbell physics wasn't their field and I had no right to expect it. (As it turned out, the answer to the reflection of light was known and I came across it later. But is wasn't needed in the physics of equations and went largely unnoticed and untaught.)

Even though I had trouble asking questions and getting satisfactory answers, I still thought that they knew something I didn't. And this continued for four years of classes. Then it happened.

It was in my twelfth quarter—a cold day in the April of 1983. I had found a textbook that tried to explain the reality of magnetism in addition to the math. The realities of relativity are not easy for an old brain to picture and it was taking me time. I spent two days wrestling with one page of this book—trying to get their picture. I finally got it. And they were wrong. "Hey!" It hit like a bolt of lightning. A sudden realization that was both clear and irrevocable. It was like the bolt that started it all in 1979: "Quit your job and go study physics!" Clear and irrevocable. This one was "Quit your studies and strike out on your own!"

Preparing For a Job

My wife finished her course in cosmetology at Hollywood Beauty College after a year and took the State Board exam, which was needed to practice hair styling in Utah. She was good at hair styling and had won a competition at the end of the course. She sailed through the practice part of the exam, but her English wasn't good enough to pass the written part. In desperation she got a sewing job at a clothing factory and was supporting us as my savings ran out. But what was I going to do?

As planned, I had gotten back quite a lot of my forgotten Chinese and was ready to start looking for a job. But by this time I had also learned a lot of Japanese and I was considering the possibility of teaching Japanese as well. I got a list of job offerings and applied for about ten of each. I was over-qualified for teaching Thai and underqualified for teaching Chinese and Japanese. I couldn't get a job.

As I continued to get rejections for my Chinese and Japanese applications, I got an indirect feeler from AUA in Bangkok. The American lady who had replaced me when I left had taken another job in Bangkok and AUA was looking for someone to take her place. But I had left in a huff. Even though my main reason for leaving was to study physics, I had also been insulted when I found out that for my entire 18 years at AUA I hsad been at the very bottom of the pay scale for the American staff. It was awkward for them to ask, and it was awkward for me to accept. Hence the indirect feeler. But I was interested. I couldn't get a job in the States and I had finished my physics fling. If they would put me at the top instead of the bottom, why not?

I most certainly wasn't bubbling with enthusiasm about going back to a job where my ideas had run dry. In fact it was the first time since I was 25 that I was considering doing something more for money than enjoyment. But this period of 'why not' didn't last long. Before the feeler got any further, my life changed.

Proving Practice

I was excited as I walked into the Japanese class that fall quarter of 1980. I had never been less than number one in a language class—and that was without trying. This time I was going to knock myself out. Getting an "A" wouldn't be enough. Being the best in the class wouldn't be enough. I was going to be the best the world had ever seen. You wouldn't believe the extremes I went to. I was more like a threatened animal fighting for its life than a student trying to learn a language. Forget about the drills. Let me tell you about the speech contests.

Japanese classes always had speech contests. The winners from each class would come together at the end of the term for the finals. I was a natural. Every term I would compose a speech and have the teacher correct it and record it. Then I got to work. I practiced until I could deliver it with perfect pronunciation and without a single hesitation. Then I practiced up to double speed without a hesitation. The next step was to make sure I wasn't just performing practiced sentences. I had to wire it up so that a flash of thought would elicit the practiced sentence. Then on to hierarchies of thought so that a wider thought would lead to subthoughts and thus build up a whole paragraph of the speech. Did it work? To observers, it looked unbelievable. I always won in my class but lost out to higher classes in the finals. But whatever it looked like on the outside, from the inside it didn't feel like language at all. I remember one term something tripped up my performance in the finals. I had to start over from the beginning! It reminded me of doing the same thing in a piano performance as a kid. With this kind of practice, every act is triggered by the preceding act (even after all that time I spent wiring the performance up to meaning). After an interruption, where's the trigger?

As I look back now, I can see the folly. Perfect performance isn't the goal of language learning. It isn't the means of learning languages. And it isn't the proof of language learned. But if that's true, just what is this 'perfect performance' I had been aiming for all my life? Could it be nothing more than doing the wrong thing better than anybody else?

I did this sort of thing with daily drills and quarterly speeches for three years. It didn't work. And I could see that it never would. Not a single sentence was ever triggered by a thought. And this had been one of my requirements for success. I had set out to prove the success of practice. I proved, instead, its failure.

It's surprising how good we get at changing goals to meet results. I had to admit that I couldn't speak Japanese, so I changed my goal from speaking Japanese to practicing it. I could practice Japanese better than anyone else in the world! (It reminds me of a 'Duffy' cartoon. Duffy said, "I always followed the old adage, 'practice makes perfect.' And look at me today. Perfect at practicing." (Copy of cartoon to be attached.) What could I do with this skill? Teach students to practice Japanese, of course. And why should I do this? Well they weren't learning to speak Japanese anyway. With my help at least they would be able to deliver practiced sentences and get praise and grades—like I had done all my life. I teamed up with the head of the Japanese department to teach beginning Japanese the following quarter. I would orchestrate the practice. She would provide the talk.

I was delighted with the results. I thought the students loved me and had learned more than anyone ever had before them. How quickly I had forgotten that I had proved the failure of practice. I couldn't wait for the students' appraisals to come in. I got them on December 14, 1983, and with my heart beating wildly I read them. They all hated me and my practice—even those who had done

it perfectly. And they all loved the delightful Japanese teacher with her charm and her natural talk. I cried myself to sleep that night. I had hit rock bottom.

Let me introduce my colleague Adrian Palmer (Buzz). He had come to Thailand after finishing his doctorate in linguistics to get a few years of experience in the field before starting a career at a university. During his four years in Thailand we became close friends. We even wrote two AUA Thai textbooks together. He eventually ended up at the University of Utah so we saw a lot of each other during my four years of study at the U.

The day after that awful night when I cried myself to sleep, I went to see Buzz in his office. "What went wrong?" He handed me a copy of **The Natural Approach** by Krashen and Terrell that he had received that very day. I knew all about Stephen Krashen's ideas on language acquisition. Buzz had been a close friend of Krashen for many years and had kept me informed. I was interested in Krashen's ideas all this time, but I had those damned blinders. What does it take to get past lifelong blinders? Rock bottom, that's what. I had read Krashen's previous book looking down from above. I now read this one looking up from rock bottom. It was a sudden conversion.

Near the end of that fall quarter of team teaching (before I had seen the student appraisals), I had been so pleased with myself that I had listed a similar evening class for the winter quarter and I lined up a young Japanese man to assist me. The class was to start on January 6 and I had hit rock bottom on December 14. What could I do? Knowing what students thought about me, I certainly couldn't repeat the debacle of the previous term. And I couldn't cancel the class. I had two weeks to design a course in Natural Approach Japanese and train my assistant. Now while I was convinced of the basic principle of the Natural Approach, I certainly wasn't convinced of Tracy Terrell's way of teaching it. In those two weeks I had to take my version of the Natural Approach and create a class. Whew!

It was 1984 and the room number was 101 (a student explained the meaning of this to me). We took it one day at a time. I would stay up all night planning for the next day and then meet with the assistant for an hour before every class. It was terribly awkward. I couldn't speak Japanese; I only had two weeks to invent a teaching method; neither my assistant nor I had ever done anything like this before; and he only had an hour before class every day to find out what he was supposed to do. Terribly awkward. At the end of the quarter I braced myself for the student appraisals. They loved it!

During that fateful quarter I was also sitting in on Buzz's class on language teaching theory. When he got to the Natural Approach, I agreed to give his students a demonstration. I taught them an hour of natural approach Thai. They wanted more. We arranged to give a class in NA Thai the following quarter. All fourteen signed up, along with a few others. It was still awkward. But unlike Japanese, I could speak Thai. And I was now experienced (one whole term!).

Experienced? Only a few of the activities I had used in the Japanese class were worth trying again and after a few days I had run dry. I often stayed up all night looking for a couple of possible activities to use the next day. I had completely rejected Tracy Terrell's method, which consisted mostly of asking the students questions about themselves. The only other ready-made sources I knew of were doing things with colored blocks and James Asher's Total Physical Response. Asher's method was to have students do what you told them (instead of answer what you asked them).

From things like “Stand up!” to “If the student on your right is a man, shake his hand; if it’s a woman, stand up and bow to her.” I did things like this when I couldn’t find anything else. Less than half of the things I tried worked, so I learned a lot. That is, I learned what not to do.

After a few days it occurred to me that the students might think they weren’t getting real Thai and I brought Kwan in to join me. My only motivation was to show off. “See? My Thai sounds just like hers.” But it turned out to be the biggest single step in the whole development of my kind of natural approach. I had done team teaching at Cornell 30 years before, but that was only a way to bring together a person who knew how to teach with a person who knew how to speak. The same thing was true of the two terms I teamed up to teach Japanese. But since I could speak Thai fluently it never occurred to me to have two teachers. Not until the day I decided to show off.

There were two big differences between my way and that of Krashen and Terrell. Krashen had said that the students shouldn’t try to say anything during the first ten hours. He called it the ‘silent period’. Buzz and I both agreed that the silent period should be lengthened considerably—perhaps by many times. If indeed ‘you learn to speak by listening’, why should they speak at all? Any time spent with the students speaking would be wasted. Terrell’s method consisted of constant interchanges between teacher and students, so half of the time was wasted. But two-way talking is what language is all about. How are the students going to hear questions and answers? Of course! Two teachers talking to each other. So there were the two basic differences. Two or more teachers and nonspeaking students. I can’t even imagine a successful program that didn’t have both.

I stumbled through that spring quarter, learning mostly what not to do. The one big breakthrough came on the last day. From time to time I had spent a few minutes on daily routines: getting up in the morning, walking to school, making a sandwich, and the like. Nothing more than five minutes at a time. But on the last day, as a review, I brought them all together. I went through a whole day of routines—from getting up in the morning to going to bed at night. It took most of the hour. Student attention was riveted on my every move and they understood everything. It was a big success. When I later went back to AUA to develop the natural approach, I designed the classrooms to have sinks, stoves, and other fixtures so we could go through routines a big part of every hour.

Buzz often attended the classes and we talked almost every day. Some of the students kept diaries of the learning experience, and we planned a book to tell the whole story. By the time the book finally came out, I had taught Natural Approach Thai at AUA for two more years, and we had become so different from Krashen and Terrell that we needed a new name. We called it ‘The Listening Approach’, and the book by this name came out in 1988.

Even though only half of the activities during that first term actually worked, it was enough to sell the method to those future teachers of languages and I myself was completely convinced. My future was fixed. I couldn’t accept a job that didn’t give me complete freedom to teach languages my way. I knew of only one place in the world that could give me this freedom. AUA. They wanted me to come back and run the Thai department in the old way as I rewrote my old Thai textbooks. I said this was impossible. It had to be NA or nothing. They said I could come give a demonstration class in NA for one term and then decide.

We moved back to Thailand in October of 1984 and my new life began.

Chapter 7
Putting Cascades in the Classroom

Two very different beginnings: 1962 and 1984.

March, 1962: Brown starts to work at the AUA Language Center.
October 1984: Brown starts to work at the AUA Language Center.

These two beginnings look alike, but they were vastly different. The first should have read 'Brown-1' and the second 'Brown-2'. Brown-1 was probably the world's most extreme linguist in the direction of structure and practice. And Brown-2 was the most extreme in the opposite direction. What I want to show now is how these two different Browns felt as they went about their work, and how they were received.

I've already told you about the Brown that started at AUA in 1962, but let me now add this example to show how perfect the fit was. It has to do with "The General Form". The linguists who had developed the Army books during the war (Spoken Thai, Spoken Burmese, etc.) set out to reverse the project at Cornell during the 50's with books like 'Spoken English for Thais' and 'Spoken English for Burmese' (you see speakers of different languages have different problems learning the same language). This team of linguists wrote a general form as a guide (the 'Spoken English' part of the title) and then appointed specialists to adapt this to each of the targets (the 'for Thais' or 'for Burmese' part of the title). I was the one assigned to do 'Spoken English for Thais' and Gordon Schmader was the one assigned to do 'Spoken English for Burmese'. Schmader and I had adjoining desks at Cornell as we worked on the project in 1952-53. And, of course, we were both working from "The General Form', which had been printed up as a book and was available to certain outsiders as well as us specialists.

When I got a grant to do research in Thailand for the year of 1953-54, we agreed that I would continue working on 'Spoken English for Thais' in Thailand at the same time. But when I didn't return after that year, they turned the project over to a whole team in Washington. I heard that the team had finished the project but I never saw any printed results. And I never saw or heard of the results of Schmader's 'Spoken English for Burmese'. In the meantime, 'The General Form' was quite well known and some people with ties to the Linguistic Society of America were able to get the General Form and teach English directly from it. When I first arrived in Bangkok in 1953, for example, I found that the newly opened AUA was using the same book I was. While I was using it to write from, they were using it to teach from.

When I went job hunting at AUA in March of 1962, it was immediately obvious that we were made for each other. AUA had used the General Form throughout its ten years of existence—they were receptive to it and they were experienced with it. Furthermore, at that time the director was none other than Gordon Schmader, who had taken up a government career which moved him from country to country in four-year hitches. When he arrived at AUA, he proceeded to adapt the General Form to speakers of Thai, Then when I arrived, he had actually finished the job I had started in 1952, he had published it, and they were using it for the first three terms of the AUA English course. That's where AUA stood when I arrived.

Now where did I stand? I not only had the same training and experience with the General Form as Schmader, but for the Thai version of it I was the clear leader. On top of this, there was no

professional jealously or rivalry between Schmader and me—only mutual respect. As I said, it was obvious that AUA and I were made for each other.

So how did Brown-1 feel as he went to work in 1962? Confident. And how was he received? As an expert. And what did he do? Whatever he wanted. And what did he want to do? Set the languge-teaching world on fire.

Now compare this with 1984. Whereas my job as staff linguist in 1962 had been concerned mainly with the teaching of English, in 1984 it was concerned only with the teaching of Thai. My reputation for English in 1962 was 'the chosen leader for applying the method of the General Form to Thais'. That was what everybody wanted and that was what I had a burning desire to do. My reputation for Thai in 1984, on the other hand, was 'author of Thai textbooks used around the world'. That was what everybody wanted and that was what I had a burning desire to change (Brown-2 was ashamed of Brown-1's books). They wanted Brown-1 back, and they were just waiting for Brown-2 to fall on his face.

So how did Brown-2 feel as he went to work in 1984? Eager but unsure. And how was he received? With mixed feelings. And what did he do? Fight. The single word 'fight' might best present the atmosphere permeating my attempt to put cascades in the classroom—the subject of this chapter. In 1962 I was leading the world. In 1984 I was bucking it.

Getting Started

Every time I think about that 5-week demonstration term in November of 1984, I almost die of embarrassment. The director had advertised it as a whole new way to learn a language, and he had invited professors and language teachers from all over Bangkok to come and observe it in action. The class consisted of my wife and me and 15 students in front of nearly 100 observers (mostly linguists and language teachers from the universities). It was like giving a piano concert in your first week of piano lessons. Not only was our teaching little more than fumbling in the dark, but I was doing the fumbling in my non-native Thai. I cringe as I recall the experience. The class met 2 hours a day and I spent most of the other 22 hours groping for ideas. It wasn't a satisfying experience.

That term had been financed by a grant from USIA in Washington. I had been given a round trip ticket from the States and was paid per diem for the 5 weeks. But the reaction from the 15 students was positive, and AUA decided to hire me starting January 1985 to give natural approach classes (NA) along with their regular course of structural approach classes (SA). When students applied to study Thai they could choose "NA or SA". The director compared it with "Coffee, tea, or milk?" In the first term, the choice came out as 20% NA and 80% SA.

(The director had advertised our method as 'Natural Approach', and we were stuck with the name. In Thailand, 'NA' had come to mean 'AUA's variety of the Natural Approach'. For the world market, we used the name 'The Listening Approach' or sometimes 'the Natural Approach as practiced at AUA'. We now call it 'Automatic Language Growth' or 'ALG'. This chapter tells the history of the development of our method, and I'll call it what it was known as throughout this period: NA. The reader can take 'NA' and 'ALG' to be interrchangeable.)

The Methods

By the time we started the first term of 1985, I had stumbled through three ex-perimental terms: Japanese at Utah, Thai at Utah, and that demonstration term at AUA. But this one was no experiment. It was the first term of an ongoing course. And I wasn't leading the world like before. I was bucking it. Most people thought I had lost something in my old age. You see after 32 years of one extreme, I had suddenly switched to the exact opposite. From 'practice speaking till it hurts' to 'no speaking at all.' Crazy! That's what it looked like to others. But it wasn't a sudden switch. The one extreme had been set during the first 4 of these 32 years, but the switch took place over the next 28. Here's how it went.

The first 4 years were spent teaching at a university, where my job was to lead the students in practice, give tests, assign grades, and move on to the next term. The next 28 years were spent in a completely different setting. Real language learning experiences: in my work, in my play, and in my outside thinking. In my work I led the students through even more practice than before, but I didn't give tests, assign grades, and move on, as before. Instead, I looked for positive results, found few, and moved back. Years of this kept suggesting that 'practice doesn't work'—and this accumulated. In my play I experienced language cascades; and years of this kept suggesting that 'exposure without speaking does work'—and this accumulated. And in my outside thinking, especially following Hubel, Powers, and Gallwey, I started to get explanations—and these accumulated.

As I look back, I see all these experiences come in, get processed, and get filed away. Then I look again and see something going wrong. They're getting misfiled. The cascades were going under 'life' and 'play'—not languge learning. And the ideas from Hubel, Powers, and Gallwey were going under 'perception' and 'behavior'—not language learning. But my field was language learning; and these ideas were concerned with language learning. You would expect that language learning would be the first place they would go. No. It was the last. This is the usual way with professionals. As they gain their professional knowledge, they gain blinders to protect it. I've already talked about 'professional blinders', but now I'm going to switch metaphors. My addiction to practice was like a dam. And after 28 years the accumulated reservoir of 'practice doesn't work', 'exposure without speaking does work', and 'behavior controls perception' had built up an enormous pressure behind this dam.

It had to break. The dam was built over a period of 4 years; the reservoir accumu-lated over a period of 28 years; the burst came overnight. From the inside, I felt the 28 year build-up. From the outside others saw only the break. And it wasn't a dam they saw break. It was more like my sanity. And who were those 'others'? Students, teachers, my superiors, outsiders, and all the people around the world who were using my books. So even though I had a pretty good idea of the course I was setting out to build, I didn't know how to handle those 'others'.

Here's the most obvious example. I felt sure that we had to keep the students from trying to speak. But the students wanted to speak. The teachers wanted them to speak. My superiors wanted them to speak. The whole world wanted them to speak. And they were all ganging up on me! You get the picture of my early years of this new course.

'No speaking' was just an example of the course I had in mind. Here's a more complete list. (Keep the toddler in mind as you read these points.)

1. The minimal unit of natural learning is an interesting experience (a happening).
2. The non-speaking part of this happening should carry most of the meaning.
3. There should be two or more teachers talking through the happening,
4. The students should be involved in the happening without speaking.
5. The students' attention should be on the happening—not the teacher talk.

This section on 'methods' deals mostly with point 4 (don't speak the language) and point 5 (don't think about the language). These two points follow.

Don't Speak

William Powers had given me the general answer years earlier with his 'behavior is the control of perception'—which becomes 'speaking is the control of listening' when applied to language learning. But even then there are a couple of steps remaining to complete Powers' loop and give the answer 'you learn to speak by listening'. It took me 10 years to complete this loop. So when the damn broke, I wasn't able to get any help from Powers. It was Stephen Krashen that came to my rescue.

As I lay there at rock bottom looking up at Krashen's message, that dam broke. It was a clear case of "Why didn't I think of that?" I knew about Zambi. I knew about the toddlers of the world. I knew about all those cascades that had produced successes in exact proportion to the absence of speaking. I knew about Powers' reference signals and his feedback loops. So why in the name of Copernicus, Galileo, and Darwin didn't I think of that?

Krashen's method, in my view, can be reduced to these two sentences. "Humans acquire language in only one way—by understanding messages," and "Speaking is the result of this acquisition—not its cause. "I especially liked the two word version of the second sentence: "Speech emerges." Brilliant! He made the breakthrough; I just restated it my way. Like this. "Speaking plays no part in weaving the web that is language. Happenings weave the warp and resonance weaves the weft. And once this web is woven, it can speak."

"Understanding messages" and "speech emerges." When you apply this to toddlers and Zambi, it's obvious. But can we put it in the classroom? The classroom answer to the first part would appear to be "provide lots of understandable messages". But what do we do with the second part? The answer really should be "nothing"—it's the automatic result of the first part. But when you're bucking the world of 'you learn to speak by speaking', all hell breaks loose. You've got to have a better answer than 'nothing'. Here are three levels to buck with. 1) Don't force speaking. (Obviously.) 2) Don't encourage speaking. (Any time spent speaking wastes valuable that could be spent on understanding.) 3) Don't even allow speaking. (Speaking during the first 500-1000 hours causes permanent damage.) Here's the progression again. Speaking isn't necessary, it wastes time, and it causes damage. So what do we do about it?

I remember that day back at the University of Utah when Buzz Palmer and I put our basic guideline into three words: Involvement without speaking. Students and teachers were to be involved in a happening laced with talk—but all of that talk was to come from the teachers. The teachers would talk to the students and even ask them questions, but the students would have to answer with facial expressiong and actions (picture parent and one-year-old) or an occasional word in English. But never any words in the target languge. Not for the duration of the course. The course was for learning—not using; and 'you learn to speak by listening—not speaking'.

Outlawing student talk may be a bit drastic, but surely it was easy enough to im-plement. Simply make an announcement in the introductory lecture and proceed with the happenings and teacher talk. "There is to be no speaking of Thai by the students in class." That's what I told them. But guess what. They tried to speak!

I told the teachers not to let students speak Thai in class. Still they tried to speak!

So the teachers were weak. And they themselves weren't completely convinced. After all, they had been encouraging students to speak all of their lives. Both teachers and students needed a constant reminder of my introductory announcement. I put up signs in all classrooms, "Don't speak Thai in class." Still they tried to speak!

Well, I could understand that some of them might not have noticed that little sign on the board. I papered doors and walls with signs—big ones, "Don't speak Thai in class." Surely they can't miss all of those signs. Still they tried to speak!

I know what the trouble was. Nobody believes signs. There were lots of signs in our parking lot that said "No Double Parking" (compare, "No Speaking"), and yet the guards never stopped people from double parking (compare, 'teachers didn't stop students from speaking'), and even helped push the cars out of the way when blocked cars were ready to leave (compare, 'encouraged speaking'). I gave up on signs and went from class to class telling the students "Don't speak Thai in class." They still tried to speak!

I thought of traffic regulations. If you really want to enforce speed limits you don['t just put up signs—you impose fines. I told the teachers to fine students 10 baht (about 50 cents) for every word of Thai the spoke in class. But they still tried to speak! And when the teachers chose to enforce the fine, they paid. The teachers used the money for a party every Friday.

When drivers defy traffic fines, the police can take their drivers license away. I told the teachers to report offenders to me for possible expulsion. The students still tried to speak, but the teachers didn't report them to me. It was a collusion.

This has gone on for 15 years now, and many of the students still try to speak. See what I mean by 'bucking the world'?

Did speaking really cause damage, or was I being unrealistic? Hard evidence had to wait three years. In July of 1987 we started the first year-long class of more than a thousand hours, and there were four students eager enough to go the distance: Paul, David. Peter, and Charly. Paul and David never spoke; but, in spite of all our warnings, Peter and Charly did—right from day one. They finished the course, they all settled down in Thailand, and they all dropped in to see us over the years. After a few years, Peter and Charly were struggling with broken Thai like all long-time foreigners. But Paul and David had passed me up. Me! The original guinea pig of practice and 40 year resident of Thailand!

[I will continue to use my own language competence as the crucial dividing point on the overall scale. My point marks the maximum that the Army method (practice followed by immersion) can produce—simply because I practiced best and immersed longest. Many foreigners have passed me up, to be sure, but never any that started with hundreds of hours of practice. My numbers were 500+40 (500 hours of practice followed by 40 years immersion). I've seen cases of 50+10, for

example, that passed my mark; and 20+6. But now we had Paul and David with 0+4—and counting.]

Now, 15 years and thousands of students later, we've had hundreds of students who went more than a thousand hours *with* speaking and dozens who went the same distance *without*. None of the 'speakers' ever got close to my mark while some 'non-speakers' *eventually* passed it. *But not all*. That is, some 'non-speakers passed me and some didn't. It looked like there was something besides speaking that was causing damage.

Recall Zambi and Mary. Two things led to Zambi's success: 1) tagging along for a year, and 2) without saying anything. Three things led to Mary's failure: 1) "What does that mean?", 2) "How do you say this?", and 3) "How do you spell it?" It was easy to spot the 'Marys' in our classes. Not only were they trying to speak, but they were also asking questions, flipping through their pocket dictionaries, and taking notes. When we said 'Don't speak', some of these Marys obeyed, but we still saw them flipping through dictionaries and taking notes. And, like the 'speakers', none of the 'dictionary flippers' or 'note takers' ever made it. We had been saying "Don't speak! Don't speak! Don't speak!" We now changed this to "Don't speak! Don't look up words! Don't take notes!" But over the years we found an occasional 'non-speaker', 'non-dictionary-flipper', and 'non-note-taker' who still didn't make it. What else could be causing the damage?

Don't Think

One of the reasons I studied so many languages during my structural period was to keep in touch with students' problems. Over the years I had forgotten what it felt like to be a beginner at Thai, for example, so I studied Vietnamese with my practice approach to get that feeling back. But when I started *natural* teaching, I was blind. Imagine how I felt telling students how to do it when I had never done it myself! I desperately needed to experience NA. To do this I needed to find an NA course in a virgin language (one in which I hadn't already been damaged). Maybe some day there would be NA classes in Korean, for example. But I wanted the experience now!

Then one day it hit me. Two of our teachers had been raised in Swatow Chinese families. They were trained NA teachers and they were native speakers of Swatow. That's all that was needed for 'instant NA Swatow'. It used to take me months of writing lessons before I could even *start* teaching a new languge, but I started Swatow the next day. And I continued for 8 years at 1 to 2 hours a day.

We started out with a class of eight: seven of our teachers and me. But after a year all but me had dropped out, and I was alone with two teachers from then on. In order to make sure I was getting full Swatow instead of just the childhood variety, one of the teachers brought in a friend who was born and raised in Swatow, China. And a couple of years later, after this old lady had gotten the hang of it, she brought in another friend who was also born in Swatow. I listend to these two old ladies complain about their husbands and children for the next three years.

What an experience! I had hoped not only to find out what it felt like but also to learn fluent Swatow. I got neither. But I got something even more valuable—something I couldn't have gotten in any other way. I found out what else could have been causing damage—what else besides the terrible four: *speaking, questions, dictionaries,* and *notes.* I avoided the terrible four faithfully, but I still failed. I had discovered the terrible *fifth.*

You see I'm a lifetime linguist. I can't listen to anyone speak in any language without noticing all kinds of things. After two days I had noticed that Swatow had five tones: rising, falling, high, low, and mid; and syllables ending in a sudden stop (like p, t, k, or a glottal stop) could carry only two: high and low. Then after two weeks I had noticed that all these tones turned upside down in weak position: rising changed to falling and falling to rising, high changed to low and low to high. And, of course, mid stayed mid. That was wild. How could a *linguist* not notice something as wild as that? And not only was I a linguist; I was the best. It would have taken other linguists months to work this out, and I got it in two weeks— without even wanting it. In fact, I was trying *not* to notice things like this—*but I couldn't help myself.*

Sometimes, to be sure, a happening was so overpowering that it drowned out the language, and whenever this happened, I learned right. But more often I had time to notice and think, and I learned wrong. So I soon had a headful both of things that worked (overpowering happenings that drowned out the language) and things that didn't (anything I was free to notice and think about). As an example of each, I'll tell you how I learned the word for 'white' and the word for 'hundred'.

First, 'white'. Like Thais, the Chinese place importance on light complexion— especially for beautiful women. The Swatow word for 'white' is 'pae', and whenever the teachers were emphasizing the beauty of this girl or that, this phrase would come ringing out: "paepae" (*really* light skinned)—sung to the tune from *do* to *sol*. Whenever one of those stories about beautiful women popped into my head, "paepae" popped with it. I didn't *think* it; it *popped*. I had done it right (that is, *right* had done me). That was NA learning as it should be—echoes attached to happenings. It felt so natural. So good. Just like "Don't look at me!" in Mandarin 40 years earlier— a flash with a soundtrack.

Next, 'hundred'. One day I was trying to check out my Thai friend who had just said 'one hundred baht' in Swatow. (Thais like to make fun of the Chinese by imitating their speech; like Californians sometimes make fun of Mexicans.) I wasn't trying to speak, now, I just wanted to catch my friend in a mistake. The Swatow for a hundred baht' is 'pae phuak'. I had *noticed* this and *learned* it as words. The expresion wasn't tied to any special experience, so it couldn't *pop* up—I had to *think* it up.

Here's how I went about thinking it up. I knew that the *Mandarin* word for 'hundred' was 'pai' (with a dip) and the word for 'white' was 'pai' (with a rise). (Mandarin is about as far from Swatow as Spanish is from English.) But, in Swatow, these two words ended in a glottal stop and could carry only high tone or low. If one was high, the other had to be low. I popped up 'the beautiful girl' and started the following mental gymnastics. 'Paepae (do-sol)'. The first syllable was weak, so its tone was inverted (do) and the basic tone for 'white' had to be the high second syllable (sol). (Notice that I was finding the tone from an echo—not a memory.) Hah! The word for 'hundred' had to be *low*. But 'hundred baht' had 'hundred' in a weak position so its tone had to invert. Now I was quite sure that the word for 'baht' was 'phuak' with a low tone, so 'a hundred baht' was 'pae phuak' (sol, do). It took a long time to *tell* you all of the thinking involved, but it only took me two seconds to *think* it. I triumphant-ly told my friend, "Aha! You're wrong, it's 'sol-do'—not 'do-do'. You forgot to invert the weak tone. So there!"

Now compare the right way (white) with the wrong (hundred). The right way (beautiful light-skinned girl) was instantaneous—a flash and a pop. I didn't even know that 'white' *had* a tone until I popped it up and looked. The wrong way (a hundred baht) took all of the following thinking: *five tones / two tones in stopped syllables / all tones inverted when weak / comparisons with Mandarin.*

Now look again at the terrible four. *"Don't speak. Don't ask. Don't look up words. Don't take notes."* I wasn't doing any of those things. A new prohibition was needed. What? It seemed obvious. *Don't think!*

But wait. 'Don't think' covers them all—not just the linguist's meddling. Obviously you've got to think about the language for these three: asking questions, looking up words, and taking notes. But what about speaking? After the language has been built, you don't have to think it up—it pops. But *before* the language has been built, it can't pop—if you want it, you have to think it. "Don't think about the language" covers all of the terrible four.

The terrible fifth then becomes "don't analyze", and the terrible five become one: "Don't think about the language." But there's still something different about the fifth. While we could easily see and hear the students speak, ask questions, look up words, and take notes, we couldn't see them *analyze*. I had to experience the terrible fifth myself in order to discover it. And not being able to detect it from the outside makes it all the more insidious. It explains why the occasional student who was avoiding speaking, questions, dictionaries, and notes could fail. We now have the answer to the question posed at the end of the preceding section: "What else could be causing the damage?" It's "Don't analyze!"

We've finally reached the elusive magic to natural learning. *Never think about the language!* Toddlers score 100% on this, of course, while most adults, like Mary, score close to 0%. The difference is so great that it gave rise to the myth that chil-dren lose it at puberty. But what about Zambi? What about Joke? What about the American lawyer at a Buddhist temple? What about the Swedish boxer at Pataya? Adults can do it right in the right situation, so it's clearly not the physiology of the brain. And what is that right situation? The one that Zambi, Joke, Lawyer, and Boxer all had in common? They weren't *studying* the language. They weren't in a classroom. So the overriding question becomes this. "Can the secret to automatic language growth be *put into a classroom?"* And this is what I was wrestling with as I bucked the world in Bangkok in the late 1980's.

The Teachers

Developing NA Teachers

After the demonstration term in late 1984, one of our teachers showed an especially strong interest in NA and became my assistant as we stumbled through the first two terms of 1985. She then stumbled through the third term with another interested teacher as her assistant. But in the fourth term it happened. In just a matter of days she went from fumbler to expert. I was stunned by the sudden transformation.

But that was nothing compared to the young man who had been her first assistant. He had graduated to lead teacher in his third term and, like the rest of us, was very uncertain. He always had a half-smile on his face like he was laughing at himself playing the fool. Then one day I saw that smile disappear. It was still there as he finished the first activity of the hour and it was gone as he started the next. It was that sudden. The second activity was taking pictures of the students, one by one, with a polaroid camera. He was supposed to take pictures of each of the students and then talk about these pictures as they rolled out of the camera. He picked up the camera and proceeded to tell the first student how to pose. His head tilted up, his eyes narrowed, and his free hand pointed as, he directed the student with things like "Sit down, cross your legs, look at me, and smile"). He wasn't a teacher. He wasn't an actor. He was a self-assured photographer. And he never returned to

teacher or actor again. Except for occcasional plays put on by the teachers, that half-smile was gone for good.

It looked like it was going to be easy to convert our teachers from SA to NA. Fumble for four months and 'Presto'. But it wasn't. No other SA teachers ever made such a complete and sudden change. The full answer to what was involved took me four more years. Here's what happened.

My wife and I were on a five-day cruise to islands in the Andaman Sea. There were 104 of us tourists, 4 guides, and the crew. We spent each day on a different island and slept as the boat cruised on to the next. It was delightful. Those guides kept us entertained all of our waking hours. I thought of our closest American friends who had visited us 17 years earlier. If they came again we would be sure to take them on this cruise. But they didn't know a word of Thai. How could they understand what the guides were saying? Of course. The same way our NA students understood what our *teachers* were saying in our *classes*—right from day one. The speaking is merely a running sound track to a happening, while the happening is carrying most of the meaning. But notice my use of the words 'students', 'teachers', and 'classes' when I speak of 'students understanding teachers in classes'. That's where my answer was hiding.

It's not that I was deceived by the words. I had always said the students shouldn't *study*, the teachers shouldn't *teach*, and the classes were nothing more than *happenings*. But if these words were so opposite to my meaning, why was I using them? It took this cruise to wake me up.

Here's how it developed. Once I thought of our friends *understanding* (in much the same way our students did), I realized that they would also be *learning Thai* (in much the same way our students did). That's precisely the meaning of 'natural learning': understanding happenings. And if they were learning *a bit* of Thai on a *five-day* cruise, how much might they learn on a *year-long* cruise? Instead of putting 'students' and 'teachers' in a 'classroom', why not put 'tourists' and 'guides' on a 'boat'. I eventually tried to do just that, but now I was looking for something faster and easier. Of course. Simply replace 'teachers' in the classroom with 'guides'. Before we got to the next island, I had hired three of those four delightful guides as NA teachers to start the next term.

I thought back to the magic transformation of those two SA teachers to NA, and now I had my answer. They were *born* guides; and what had looked like a sudden transformation was, instead, a sudden *realization*: "Hey! We're not teachers. We're guides." All the other teachers were born *teachers* and were using the happenings to teach with. *To teach with!* Not to *live* with. That's the big difference. Remember when that second teacher suddenly changed from teacher to *photographer*?

Hiring those guides from the Andaman cruise was the turning point; and now, after 15 years, most of our 'teachers' are *guides*. If only most of our 'students' could be *tourists!* It's a lot easier to put guides in a classroom than tourists. No matter what we say, most of our 'students' are still 'trying to learn Thai'. They're trying to use our classroom happenings to learn with. *To learn with!* Not *to live with,* or *to play with.* That's the big difference. But since *all* of our successes come from the 30% who aren't trying to learn (we've never had a real success who *tried*), we know our basic idea is right. Higher percentages might have to wait until we move from classroom to boat.

Think now of parents with one-year-olds. In fact, put a picture of a mother with her one-year-old toddler in your head as you reread the last two paragraphs. Replace 'guide' with 'mother' ("Hey! We're not *teachers*, we're *mothers* ") and 'tourist' with 'toddler' ("Hey! We're not students, we're toddlers"). Of course most mothers would claim that they're teachers, too. But that's not what they're thinking when they throw the toddler a ball and yell out "Catch!". And that's not what our

second teacher was thinking when he took pictures of the students. It makes you wonder. With no intention to *teach* and no intention to *study*, just how did we ever manage to learn our native language?

Training NA Teachers

Kwan and I became quite close to some of the students in that first NA Thai class at the University of Utah—especially Linda. About two years after we had started our NA course at AUA, she came to Thailand for a visit and we invited her to stay with us. The week before, our 5-year-old niece, Puk, had been staying with us and Kwan had spent a lot of time reading children's stories to her. Well if NA *speaking* is modelled on how we interact with a *1-year-old*, I figured NA *reading* could be modelled on how we interact with a *5-year-old*. So I asked Kwan to read Thai children's stories to Linda in the same way she did with Puk. You know how you would say "Grandma, what big eyes you've got!" to a 5-year-old. Kwan said she couldn't do that. "How can I possibly speak to a grown woman like that?" Well she went as far in that direction as possible, and Linda, a professional language teacher, said it was the most impressive way to learn to read a foreign language she had ever seen.

I said above that when children reach puberty they don't lose the ability to grow languages; they gain the ability to try. That's from the point of view of the child. But now look at the adults as they interact with growing children. When children reach puberty, *adults change, too.* They change the way they talk to them. When Kwan read to Puk, the magic was instinctive. But this magic wasn't there for Linda—not without special forcing. And as it is with *reading* to a 5-year-old, so it is with *talking* to a 1-year-old. We've all got the magic for interacting with the 'age-deprived'. The language-deprived adult can use a similar kind of magic.

Look at how we talk to toddlers. We never talk about anything that isn't right in front of their eyes. We talk only about the situation they're in right then and there. Then we load this talk with exaggerated gestures and facial expressions. Finally we add feeling with our voice: we raise our voice a little and increase our pitch range a little. That's the necessary magic. Look at it from the point of view of the *meaning* being received by the toddler. More than half of the meaning is carried by the situation. More than a quarter by face and gestures. More than an eighth by tone of voice. Words carry the rest. Think of the meaning carried by situation, face, gestures, and tone of voice as Swiss cheese. It has a hole here and there for new words to fall into. And that's natural learning: new words fall into holes that are held and carried by the overall meaning. *The words don't carry the meaning—the meaning carries the words*. When we talk to toddlers, we realize that meaning carries the words—and therein lies our magic. When we talk to language-deprived adults, we think that words carry the meaning—and therein lies the problem.

Think back to the story of Mary in the introduction, when Mary's Thai mother-in-law asked her in Thai "What do you think of Thailand?", and Mary had to get a translation from her husband. Now suppose Mary had brought along her 4-year-old American son from a previous marriage. Can you imagine the mother-in-law asking the little kid "What do you think of Thailand?" Not likely. If the little boy was playing with a dog on the floor, she would talk about what the dog was doing as she pointed, acted, and touched. Why didn't she talk to Mary like that? For the same reason Kwan didn't want to read to Linda like that—not until I convinced her, that is. NA teaching is not instinctive. It has to be learned. But in some cases—like our second teacher taking polaroid pictures—the learning can be fast.

But how can the rest of us learn how to talk to adults who don't know the language? It sometimes takes years. Here's how we use to do it at AUA. I'll block out the main steps using 5-week terms of nine terms per year as the time units.

0. We choose trainees for personality and then put them through these steps.
1. Two or three terms observing expert teaching.
2. One term as a 'third teacher' to a carefully chosen pair of 'lead' and 'assistant.'
3. A few terms as assistant to lead teachers best able to to 'carry' them.
4. A year or more as assistant to progressively 'lesser' lead teachers.
5. A year or more as lead teacher with a real expert as assistant.
6. A year or more as lead teacher with progressively 'lesser' assistants.
7. Presto! Some get it fast. Most take two or three years. Some never make it.

That's how we train our NA *Thai* teachers. They've never experienced the method as students. But what if we had a group of Japanese who had completed our 18-month Thai course and wanted to start teaching a class in NA Japanese? How long would it take to train them? If they had the right personality, it would take no time at all. They would already be experts. 18 months of studying Thai would have put them ahead of our Thai teachers with three years experience teaching it. We can actually train NA teachers of other languages in less time than we can train NA teachers of Thai. The above seven steps would be reduced to one.

0. Right personality.
1. 18 months of NA Thai study.

Materials

Activities

Developing materials had always been my main role in language teaching, and I had been writing structural materials for decades. When I switched to NA it was only natural that I would immediately think of creating NA materials. But just what would NA materials consist of? Not drills and dialaogs to be *practiced*—again and again; but happenings to be *experienced*—once. In fact I soon realized that an experience was the minimal unit of *real* language learning. Anything less—sounds, words, rules, and the like—had no way of getting in.

I recalled my first flash of natural language learning: the Chinese teacher falling from her bicycle 40 years earlier. Four words were spoken: "Don't look at me!" But this was far from a mere sentence to be learned. It was part of a real experi-ence. It was delivered in an embarrassed giggle from an embarrassed face looking up from the ground. It's now 55 years later and I can still see and hear it. Compare this with the same sentence from a book—memorized and practiced. Do you think I could still flash such a sentence 55 years later?

Let me plug this into something I said a page or two ago. By far the biggest part of a speaking experience is carried by situation, faces, gestures, and tone of voice. Words carry less than ten percent. The experience has a hole here and there for the words to fall into, and this is natural language learning: unnoticed words falling into holes that are held and carried like stowaways by the overall meaning. *The words don't carry the meaning—the meaning carries the words.* "Don't look at me!" didn't carry the meaning of that experience. That experience carried *it*—towed it right on into my memory and froze it in place. And similar frozen holes throughout the web of experience

constitute the web of language. Anything less than a real experience could only be stacked in the pantry. Frozen in the web or stacked in the pantry—that's the difference between NA and SA.

In 1945 I knew how effective the bicycle incident was; I just couldn't see how to put it into the classroom. Then in 1985 I witnessed the conversion of our second NA teacher as he took polaroid pictures. *That's how!* So this became the unit of NA materials: planned happenings. I called them 'activities'. In the early years we planned three or four activities an hour chosen from the following 14 types.

1, Classroom procedures: Taking the roll, making announcements, etc.
2. Manipulating objects: Colored blocks, water in buckets, cups, and spoons, etc.
3. Daily routines: Getting up in the morning, making breakfast, taking a bath, etc.
4. Demonstrations: Using a computer, scientific experiments, magicians' acts, etc.
5. Physical activities: Sports, exercise, physical games, dancing, etc.
6. Fun and games: Table games, party games, puzzles, toys, etc.
7. Information about students: teachers talking about the students' statistics.
8. Show and tell: Students bring objects and teachers talk about them.
9. Pictures and maps: Snapshots, slides, picture magazines, etc.
10. Role-plays: Taxi driver and fare, waiter and customer, doctor and patient.
11. Stories: Children's stories, folk tales, comic books, anecdotes, etc.
12 General information: bus routes, weather data, current events, etc.
13. Cultural information about target country: how they eat, dance, bathe, etc.
14. 'Sheltered' subject matter (teaching classes in the target language).

Three activities an hour, 5 hours a day, 5 days a week, 5 weeks a term, 9 terms a year. That's 3,375 activities needed for a year-long course. And these had to be carefully ordered to ensure understanding. Here's an example of an activity that could easily be understood on the very first day.

"Who's the tallest?" from type 7.

One teacher asks the other, "Who do you think is taller, Takiko or Linda?"
"I don't know. Let's have them stand side by side and see."
"So Linda is just a little bit taller. What about Hans?"

And so it goes until you have the whole class arranged in a line by height.

As we choose and order activities, there are two driving forces: they must be un-derstood, and they must be interesting. And the degree of interest must be so all-consuming that the students don't even notice the words. That is, meaning must drown out words (bury them in their holes). The above activity may not appear to be all that interesting, but it is. After all, this is the students' very first experience in a brand new language and they're understanding everything as they participate. The excitement that comes from participating in a new language with complete confidence easily drowns out the words. And with teachers who are more like guides or even clowns, it can be hilarious.

Understanding without noticing the words—that's the name of the game. With children it's literally 'child's play', and little kids aren't even aware of words. But with adults in a language class, it's not easy to keep the students' attention *off* of words. It does no good to tell them not to pay attention to words. We have to trick them. Here are two examples of tricks.

1. One activity is talking about fruits. With a big picture of Thai fruits being sold in the market as a prop, we point and talk. There's constant reference to the different kinds of fruit and the students are busy noticing and trying to remem-ber their names. But it's all a trick. We know that the adult mind is tempted to notice words so we use the names of fruits to keep their attention off of *every-thing else*. Think of all the possible talk between teachers. "What's that?" "It's a …". "Which costs more, … or …?" And all the possible talk with students. "Do you know what those are?" "(Nod, or headshake, or an English name.)" "They're called … in Thai" The students are noticing the blanks in these examples (the names of fruits)—not the sentence patterns that contain them. The fruit names are noticed—and soon forgotten. The patterns aren't noticed—and they're free to enter the 'experience brain' and grow.

2. An especially successful activity is talking about Patpong Street, Bangkok's main girlie strip. All the talk about beautiful naked girls titillates some and infuriates others. But the attention of both the 'titillated' and the 'infuriated' is firmly on the meaning—not the words. Mission accomplished.

Thinking up and ordering the thousands of activities took us several years, and in order to pass all this work on to others, Buzz Palmer and I wrote it up as a book entitled **The Listening Approach:** *Methods and Materials for Applying Krashen's Input Hypothesis* (Longman, 1988). We no longer need this sort of thing at AUA. Our experienced teachers are more like family with toddler. The family surely doesn't prepare a list of thousands of 20-minute activities. But for teachers trying to use ALG on their own, the above mentioned book may be immediately useful while they slowly get the hang of the basic idea—like we did.

As it turned out we didn't need 3,375 activities—that was just our projected planning during our first year. But when we got to more advanced classes, we found that 'Sheltered Subject Matter' (type 14 of the above list) took over.

NA4 and NA5 classes were combined and subject matter ran two terms without a repetition—it just didn't matter that some of the students were 'juniors' and some 'seniors'). Each of the five or six daily hours of this NA4-5 level covered a different subject. Things like Getting Around Town (on business and pleasure), Children's Stories, Easy Adult Stories, Discussions, and News. And NA6-9 classes were combined for four term cycles with each hour covering a different subject. Here's a possible schedule. 9 o'clock: Thai History; 10 o'clock: Thai Geography; 11 o'clock: Thai Politics; 1 o'clock: Thai Economics; 2 o'clock: Thai Laws and Daily Life; 3 o'clock: Thai Buddhism. Different pairs of teachers taught different hours and they planned their subject matter in 4-term cycles as they saw fit. These classes weren't a bit like boring college classes where the purpose is to memorize and test. They had to be of all-consuming fun and interest. A class in Thai Buddhism, for example, might take place on the lawn outside with the students squatted in a circle around a Buddhist monk.

Understanding without noticing words—that's the name of the game. Anything not attached to an experience is worthless. But can we really ignore words?

Vocabulary

In my very first term of teaching Thai at the University of Utah, I felt sure that I had to 'teach' certain key words before I could start on an activity (teach by actions, that is—not translations). One day I wanted to tell the students about Kwan's nose operation and I couldn't see how they could understand without knowing the Thai word for 'operation', which literally means 'to split

open'. I acted out 'splitting open a watermelon' as I said the Thai word. They shrank in horror when I applied this word to Kwan's nose.

Much easier to teach by actions than 'operation' were words like 'continents', 'countries', 'mountains', and 'rivers'. We just pointed at a big world map as we talked. The Thai pronunciation of names like 'America' and 'Asia' made it so easy for them to catch the Thai word for 'continent'. I followed the 'rule of three', meaning that they needed at least three clear instances of the word for 'continent' in order to catch and hold it for a while. After pointing and saying 'taweep America', 'taweep Asia', and 'taweep Europe', I felt safe using 'taweep' by itself.

As we started the course at AUA, the biggest unknown was what to do about voca-bulary. The students were pleading for something they could hold onto and take home with them (even if it were more like a security blanket than homework). They wanted to know what they had 'learned'—at least a sheet of paper with a list of the main words. I was still inclined to act out some of the key words in class as needed, but I sure didn't want to give transcriptions and translations. Anyway, we experimented with several different ways of handling words. Like these.

1. Acting out key words in advance of an activity.
2. Putting key words on the board using a transcription but not a translation.
3. Passing out a list of words with transcription and translation to take home.
4. Reviewing the key words the next day.
5. Passing out a list the next day.
6. Passing out a cumulative list (a running dictionary) as a reference.

Anything that we put on paper had an ordered list of suggestions for how to use it.

1. Best of all, ignore it completely.
2. Next best, use it as a reference as you wonder about an echo in your head.
3. If you must, glance over the words occasionally.
4. But never, under any circumstances, try to memorize or practice.

It took me three more years to finally clear up my uncertainty. I observed classes; I listened to students; and, most helpful of all, I experienced Swatow. The answer I found is best explained with these two words: 'wonder' and 'grow'. Words have to grow—gradually. Experience by experience. And the mechanism of growing in each experience is 'wondering'. The experience is the cheese. But there's a hole in it. A fledgling word floats by and you wonder: 'Might that word fill that hole and take its meaning from it?' Click! Let me expand the two words to five. Experience, hole, word, wonder, and grow. The word grows a new ring of meaning with each experience. Like an onion.

Now let's make sense of all of that with an example from a class in Thai Politics. You start tuning in on the following recurrent stretch of sound after it has run by you five or six times: *nayokratamontree*. Your first step is to recognize it as a stretch of sounds that keeps coming. Your next step is to wonder about it. Then it floats by just as you meet a hole that needs some kind of a person to fill it. Click! Ah, it's a person. But what kind of person? You continue to look, listen, and wonder. It soon falls into another hole that shows it to be an important person. Later, it appears to be a political person. And so on. Every hole it fills adds a ring of meaning: person, important, political. Finally you realize that it must mean 'Prime Minister.'

Now why not just write 'nayokratamontree = Prime Minister' on the board at the start of the class and save you all that time? Because it would then get stacked in the pantry as a memorized unit—instead of glued in the web by wonder to every experience it had ever appeared in. Whenever you wanted to access it for the rest of your life, you would have to go to the pantry. That translation would have killed that word for life. That's the difference between *artificial* language (on the shelf) and *real* (in the web).

So the big question as we started the NA course was "What do we do about voca-bulary?" And three years later I got the answer. "Nothing!" Don't teach words at all. Don't even call attention to them. Just let the students wonder. Just let the words grow.

Reading and Writing

Foreigners living in a Chinese-speaking country soon learn to 'read' the Chinese symbols for 'Men' and 'Women' in order to use the right restroom—even when they can't say or understand the spoken words. Since Chinese uses characters instead of letters, this is easy to understand. But Thai is written with *letters,* and our beginning students at AUA soon learn to 'read' the Thai words for 'Enter' and 'Exit' in order to use our parking lot—even though they don't know they're looking at letters. In both cases the writing is standing for meanings—not sounds.

I've heard tell that the idea of teaching your baby to read got started in the early days of television when babies were seen to be recognizing words in commercials, like 'GULF'—long before they could say the words. This gave some people the idea of teaching their babies to read, and there are stories of babies learning to read whole sentences before they could say them. Obviously if babies can tell the difference between a dog and a cat by what they look like, they should be able to tell the difference between the *symbols* DOG and CAT by what they look like. This is natural reading, and it doesn't depend on learning alphabets. Chinese characters are the clearest example of natural reading.

I learned to read Chinese by natural reading during the war and after 18 months I could read a daily newspaper. I learned to read Thai by alphabetic reading and could 'decipher' any word after 8 days. But after 40 years I still can't 'read' Thai as well as i could read Chinese after 18 months. The reason is that I save a step with Chinese. Instead of going from symbols to sounds to words, I go directly from symbols to words. Natural reading starts with cases like 'Men' and 'Women' in Chinese and 'Enter' and 'Exit' in Thai and moves on to 'being read to'—as the children or students look at large words. Remember how Kwan read children's stories to Linda? This is how we teach our NA students to read. We start after they've been listening to spoken Thai for about 400 hours.

Here are two reasons I was able to buck the world with something as counter-intuitive as 'you learn to speak by not speaking'. 1) I knew toddlers did it, and 2) I suspected that the common belief of losing the ability at puberty was a myth. The same assurance allowed me to push ahead with natural reading: I knew that little kids could do it when given the chance. But notice the full comparison. After learning the spoken languge by listening, speaking emerges. All native speakers in the world attest to this. That's the spoken language. But what about the *written* language? After learning the written language by reading, will *writing* emerge? I have seen no natural model for this. Throughout the world kids learn to speak their native language through exposure and to write it through study. Let me reduce the comparison even further. *Understanding* comes in (naturally) → *speaking* comes out (naturally). *Reading* comes in (naturally) → *writing* comes out (through study).

But notice this. The study of writing one's native language always starts *after they can already speak*. I wanted to put off teaching writing until the students had completed a full year of spoken Thai and six months of natural reading. But this time the pressure was enormous and my convictions weren't strong enough to buck the world with. I brought in my structural course on reading and writing and started it after only a few months of natural listening and reading. I was too weak to buck—and I still am. Even though it's clear that this strucural writing interferes with natural speaking

Measuring Learning

As a student, I loved taking tests. I was so good at it. Throughout 30 years as a student, I usually got top grades. But as a teacher, I hated tests. Tests were one of the reasons I fled university teaching and went to Thailand. Loving tests as a student and hating them as a teacher. Why? It was simply the difference between *grades* and *results*. As a student I cared only about grades, and since tests always led to good grades, I loved them. As a teacher I cared only about results, and since *I* could detect results in my small classes better than *tests* could, I hated them.

Many years later, after I had discovered the difference between artificial and real learning, I understood what was going on. Most teachers were *teaching* artificial, *testing* artificial, and *getting* artificial (that is, *grades*). It was consistent; and there was nothing to make them doubt their teaching. But while I was teaching artificial. I was looking for real (that is, *results*). It was far from consistent since I didn't *find* real results; and everything was making me doubt my teaching. This is what eventually led to my discovery of real learning.

But if tests are for measuring artificial learning, how can we measure *real* learning? Let's look at our model: the toddlers. Of course *you* know how much your little girl knows without testing, but what if *I* wanted to know? I wouldn't give her a test. I would simply ask her age. If you told me she was 22 months, I would know that she understood most childhood talk, could say lots of words, and was just beginning to put two words together into a novel sentence. It didn't matter one bit how smart she was, how motivated, or how hard she had been trying. The only thing that counted was how old she was.

Notice that *I* was the one asking how much she knew—not *her*. And all I had to do was to find out her age. But our NA students *did* ask—all the time. They couldn't say anything in Thai and wanted to know whether it was working. And when they asked "How am I doing?", all I had to do was to find out their 'age'—just like I did with the little girl. "How many hours of class have you had?" And I soon started to get a feeling for what these 'ages' meant in terms of results. Just as I knew what most toddlers of age 12, 18, and 24 months could do, I could tell fairly well what NA students of 'age' 200, 400, and 600 hours could do. And I could even start to match up the results of student hours with toddler months. 600 student hours, for example, produced results comparable to 24 toddler months. (I'm referring to English speakers learning Thai, of course. English speakers learning French might do this in less than 300 hours.)

The next step was to look for a curve that had hours of class along the x-axis and their 'grade' along the y-axis. (The grade would run from 0 for beginner to 100 for native speaker.) This curve would have to start upward from zero and bend to the right as it approached 100. But just how fast would it bend? I needed some point between 0 and 100. I guessed that 600 hours produced a grade of 60 and tried to draw in a smooth curve. Try it. There's only one possisble smooth curve that can start upward from 0, go through this 600-hour point, and approach 100.

But what would the *equation* of this curve be? I felt sure that it would have to be based on the 'growth' constant *e* , which is 2.718. My computer expert suggested this equation: $y = 100 (1-e^{-kx})$, where 100 made a percentage out of the answer and *k* was the 'acquisition' constant (which came out to be .0015). This equation came from an equation for a comparable 'growth' phenomenon in electricity.

Try it out with x = 667 hours (for ease of calculation—since 667 times .0015 equals 1). Now e^{-kx} means $1/e^{kx}$ and in this case e^{kx}=e, so the equation becomes y=100 (1-1/2.718)=63,2%. This is the grade you would get from 667 hours of class. And how long would it would take you to reach a grade of 90%? Just put y=90 and solve for x. It comes out to about 1600 hours. We kept trying this equation on our students by comparing their 'equation grade' with their 'street grade'. (Your 'street grade' is your estimate of how much you *understand* from strangers in the streets.)

Now even though this equation told me more than any test could, it still wasn't completely accurate. I had to start fine-tuning. The first thing was to measure hours of *understanding* instead of hours of *class*. I asked the students to estimate the percentage of classtime activities they understood (*activities*—not *words*). Then I asked one of their teachers, then another, and another (remember, a student could have as many as 10 different teachers in a 5-hour day). They all gave roughly the same answer—students as well as teachers. The difference between 50% and 80% was obvious to everybody—even the difference between 70 and 80. So we multiplied 'hours of class' (*x*) by percent of understanding (*u*) and got 'hours of understanding' (*ux*). (This is Stephen Krashen's 'comprehensible input'.) In the same 100-hour class, a student understanding 60% would earn *60* hours of understanding, and one who was understanding 90% would earn *90*. Our first fine-tuning parameter (*u*) enters the equation like this: $y=100 (1-e^{-kux})$

Let me clarify some of the terminology I'll be using as I proceed. The teachers turn in 'marks' (like *u* and *x*). These 'marks' go into the 'equation' and the student's 'grade' comes out.

The student's percentage of understanding (*u*) was determined by teachers' opinions—not a test. And the student's grade then depended on this subjective opinion. Could this be reliable? Actually, it was uncanny. I calculated a young man's grade at 45%, for example, and then asked him to estimate his 'street grade' (how much he understood in the streets). "Almost half". In another example, I reversed the order and asked a woman to estimate her street grade. "Somewhere around 60%." Then I used the equation and got 62%. And so it went—again and again. As long as they understood that 'percentage of understanding' referred to 'what was going on' and not to 'words', the figures usually agreed within 10%.

But not always. For some students the 'equation grade' was clearly too high (they weren't understanding as much as they should). Something was missing from the equation. There had to be something more to the students' marks than 'how much' they were understanding. We also had to know 'how right' they were doing it. That is, how little damage was being done? You will remember that trying to speak, asking questions, taking notes, and looking up words caused damage to natural learning. But how can we *measure* damage? To fine-tune 'how much', we asked for a *percentage.* But what kind of figures were needed to measure 'how right'?

Take our curve (up from zero, bending to the right, and leveling off to 100) and put it in a box. Then watch what happens to it as we apply two different forces to the box: 'how much' and 'how right'. A lowering of 'how much' (lower understanding) lengthens the box (it takes longer to get the same result). A lowering of 'how right' flattens the box (it squeezes down the result). When 'how much'

falls to 50% understanding, for example, the box stretches the curve out to twice the length (everything takes twice as long), and a 60% grade takes 1200 hours of class instead of 600. And when 'how right' falls to 60%, the box squeezes a 60% grade down to 36 (60% of 60%). Damage is like a weight on the box's ceiling, and 'ceiling' (*C*) becomes our new *parameter*—the new *mark* that the teachers have to turn in.

We measured this ceiling by percentages from a minimum of 60 to a maximum of 100. Anyone doing everything wrong—like *Mary* ("What does that mean?", "How do you say this?", and "How do you spell it?")—would get a ceiling of 60% and keep it for life (the world is full of 60%-ers). Anyone doing everything right—like *Zambi* ('tagging along without trying to speak')—would get a ceiling of 100% and have a chance of ending up native. And anyone mixing *Mary* and *Zambi* would get something in between (my own mixture left my ceiling at 88%—so far above the expected 60 to make me a legend, but so far below my goal of 100 to make me a failure). With these two limits in mind, the teachers would simply estimate a ceiling percentage. And since there was close agreement among teachers, the figures seemed to be quite reliable. We added this parameter *C* (for 'ceiling') to our equation by changing the 100 to *C*. That is, 100 $(1\text{-}e^{\text{-kux}})$ became C $(1\text{-}e^{\text{-kux}})$.

Teachers had to turn in the following three marks at the end of every term for each student: attendance (*x*), percentage of understanding (*u*), and ceiling (*C*). And when students came in and asked "How am I doing?", we would just put their marks into the equation and crunch out the grade. "43%." (For example.) "That's how you're doing." It sure beats testing.

Our equation was getting closer and closer, but something big was still missing. Some students were moving at nearly twice the expected rate. Here's how it came to our attention.

Our early course grew term by term (terms were 5 weeks). In our third term we went from 2 to 5 hours a day for terms of 125 hours. Then we added a new level every term or two—increasing the course to 250, to 375, to 500 hours. We didn't know how long it was going to take for natural speaking to emerge, and we were eagerly waiting and watching. (*Un*natural speaking, of course, came on the first day from the *Marys* in the class.) Then after 500 hours, natural speaking started. First one student, then another. When we reached 13 students, I noticed something. All 13 were Southeast Asians (Malaysians, Indonesians, and Philippinos). Then when our course grew to 750 hours, some Chinese students started to speak. And finally, after reaching 875 hours, some Japanese and Western students joined in.

These Southeast Asian languages weren't related to Thai, and it wasn't like an English speaker learning French or German. I guessed that there were three things involved: similar culture, similar grammar, and similar faces. I'll leave you thinking about this for now and discuss it later. But whatever the reason, a new parameter was definitely needed in the equation.

When our course grew to more than a thousand hours and the number of successes kept increasing, here's what we noticed. The 'linguistically disadvantaged' students (like Westerners, Japanese, and Koreans) reached 78% in 1000 hours. the Chinese got there in 800 hours, and the Southeast Asians got there in 600. We posited the parameter *N* (for 'native language') and assigned the values *1* for the slow-pokes, *.8* for the Chinese, and *.6* for the sprinters. This parameter served as a divisor of *x,* and the new equation became $y = C\ (1\text{-}e^{\text{-kux/N}})$.

It was a thing of beauty—our little wonder. We called it 'Algie' (for 'Automatic Language Growth Equation'). It has served us faithfully for ten years.

Almost. Remember my experience with Swatow Chinese when I discovered 'the terrible fifth'? 'The terrible four' were speaking, questions, dictionaries, and notes. I didn't do any of these things; but I still failed. I couldn't avoid the terrible fifth, *"Don't analyze!"* The teachers could see the four and turn in their ceiling marks. But they couldn't see the fifth; and it couldn't get into our equation.

Max Thai

We completed the fine-tuning of Algie in 1989—the same year I went on the Anda-man cruise. That cruise got me thinking about a better kind of course with a better kind of teacher, and I realized that Algie had been designed only for the course and teachers at AUA. (This is what led to putting *k* at ,0015.) How could Algie be applied to a superior course? And how about lesser courses? After all, it surely wouldn't have fit our AUA course in its first year. And it probably wouldn't fit other schools as they fumbled with our method. They would surely start out less effective than we were now. It made me think about a more general equation that could be used for all natural language learning and serve to compare different types of courses at different places. We needed something in *Algie* that could separate the men from the boys.

I added two more parameters: *s* (for 'situation') and *t* (for 'teachers'). Clearly some situations are more 'memorable' than others. Think of classes in a dormitory instead of a school: many of the happenings *outside* of class, like meals and play, would be more memorble than those *inside* of class. Best of all, think of a cruise or a prolonged trip, where the setting of the out-of-class happenings was always changing. Notice how clearly you remember every day on a trip—even every meal.

The new parameters were added to the *kux* part of the equation giving *kstux.* They had the value *1* for AUA classes, *,9* for lesser situations, and *1.1* for superior ones. A dormitory course at AUA might have *s=1.1,* and a cruise course might have *s=1.2.* Beginning classes at other schools might start out with *t=.7*—which is where AUA teachers were in our first year as we fumbled.

At this point in my thinking, the age-old question flashed. "What's the fastest pos-sible way to learn a language?" I divided *x* (total hours) into *h* (hours per week) multiplied by *w* (number of weeks). *30* hours a week (h) for 5 weeks (w), for example, would give 150 hours (x). Then I considered *maximizing* the three parameters *h* (weekly hours), *s* (the situations in those hours), and *t* (the skill of the teachers in those hours and situations). That is, what's the most hours you can effectively squeeze into a week? What's the best possible kind of situation? And just how good can teachers get? Now maximize these three parameters and solve for *w:* the number of weeks. That would answer our question, "What's the fastest possible way to learn a language?"

Here's what I came up with. The best possible situation? A cruise (1.2). The best possible teachers? Super guides with AUA experience (1.1). The most possible hours a week? I guessed 50 (the brain needs a certain amount of rest). I called it *Max Thai*. Algie tells us that a 6-month cruise would get the tour members up to 90% (a little more than the point I reached after 15 years and stayed at for the next 35 years). But don't get carried away with this. We still don't *have* Max Thai. The market isn't there yet, and the logistics pose a real probllem. The fastest way we've got now to reach 90% takes 18 months. And even then, few students stay that long, and less than half of *them* maintain a ceiling of 100. Still, the few that do go 18 months at a ceiling of *100* usually pass me up. The difference between them and me is indeed that big. Their 18 months passes up my 15 years!

For a more meaningful example, let me make a guess at *Max French* for an Ameri-can. First, look at the native language parameter (*N*). If Malaysian → Thai is .6, I would guess English → French at .4.

Algie tells us to take a 10-week Max cruise or trip around France. But don't pack your bags. We don't even have Max Thai yet, and Max French is a lot further off. And remember that your ceiling (*C*) would have to be 100%—which means you couldn't do this if you had already studied some French. Wouldn't you come to hate the classes that did this to you?

Many readers will be furious at this point with my assigning exact figures to subjective guesses. Check how you feel when you read the following figures. Do you want to scream out "How can you know that?" after each one?

- A certain student understands 72% of all of his classtime activities. "How can you know that?"
- 667 hours of understanding produces 63.2% of language learned. "How can you know that?"
- My own lifetime ceiling in Thai is 88%, which took me 15 years to reach. "How can you know that?"
- English speakers reach 78% in 1000 hours, Chinese in 800, Malaysians in 600. "How can you know that?"
- A 10-week Max French cruise produces 90% language learned. "How can you know that?"

"How can I know?" I can't. I just estimate—or guess. But guesses at reality (based on observations) invite futher inquiry and keep getting better and better. They are a work in progress. An exact measure of ghosts like vocabulary, grammar, and pronunciation based on tests, on the other hand, doesn't even *point* to reality, and it *blocks* further inquiry. Would you test your 4-year-old on these things to find out how much she knew? Or would you just observe her and estimate—or guess?)

And while I'm talking about guessing, let me explain my guesses about the Southeast Asian advantage in learning Thai: similar culture, similar grammar, and similar faces.

Cultural similarities enables you to see a classtime activity in terms of something in your own culture. When Southeast Asians see a teacher act out an episode of bathing in public (using a sarong), for example, they see it through their own experience and thereby understand much more of the accompanying language.

Grammatical similarities help like this. In the subconscious learning of words, nouns are noticed first, then verbs, then modifiers, and, last of all, grammatical tags. But when the sentences of the new language are blocked out similarly to your own, the *function* of the noun or verb in the sentence also gets a subconscious nudge.

And how could your facial features possibly help? People in the streets are more likely to talk to you if you have a Southeast Asian face. They assume you're Thai and able to understand. They avoid European faces.

The Second Generation

I retired in 1995, after 10 years of developing the NA course. This 10 years was clearly a case of 'the blind leading the blind'. I hadn't been through NA learning and neither had the teachers. The whole show was driven by a picture in my head—not by experience. I couldn't help wondering what

it would be like if both supervisor and teachers had been through at least a year of NA. I've told you what I tried to do about this with Swatow Chinese. But it didn't work.

In mid 1988, we completed our first full year course, and two of the students, Paul and David, had maintained a ceiling of near-100%. They were clearly budding successes. A few years later both of them had passed me up and were bubbling with enthusiasm for the magic they had experienced. Paul settled down in Northeast Thailand where Lao is spoken. He spoke Thai to them and they spoke Lao to him (like a Norweigian settling down in Denmark). Paul's *natural* 'NA course' in Lao was even better than his *school* NA course in Thai, and within a few years his Lao was even better than his Thai.

David settled down near Bangkok and kept in close touch with us. In 1994 he expressed an interest in helping us out—just as I was about to turn 70 and was looking for someone to take my place. He was only available half time, but that was enough. I could return a few months every year to check up and give guidance. I jumped at it. He started in January '95 and I left two months later.

As expected, he could see things I couldn't. It was a clear case of the sighted (David) leading the blind (me). The first thing he did was to kick out the structural course—no more SA/NA choice. If you want SA, go somewhere else. (I had always wanted to do this but didn't dare.) Then he did away with terms. Students could start and stop at any time. (Why didn't I think of that?) And he started ALG Japanese.

We had more students from Japan than any other country, and by 1995 we had a lot of Japanese successes who were bubbling with the magic—just like Paul and David. Several of these bubbling successes had the right personality and David was able to start a course in ALG Japanese. This completed my dream of a second generation— a course in which both supervisor and teachers were themselves products of ALG. Our Japanese course soon passed our Thai course (the *t* parameter was at least *1.1*).

The second generation was not only sighted, it was computerized. A computerized Algie is a thing of beauty. Now, when a student walks in and asks "How am I do-ing?", David just punches a few keys and shows him his Algie curve on the screen. Even prints him out a copy. "You're now at 30%. If you resist that occasional at-tempt to speak, you'll be at 35% in 50 more hours and be ready for the next level."

I eagerly continued my yearly visits—but not to give guidance as planned. To learn about all the new wonders.

This is just an introduction to the second generation. We look forward to a book on it from David Long.

Chapter 8
The Window to the Brain: Age 60-75

It may seem strange that a book about language learning could spend so much time on things like Physics, Evolution, and Brain Theory. But this book isn't about any of those fields. It's about science in general. And in order to develop a *real* science of language acquisition (Automatic Language Growth), I had to put it in the context of a *real* science of the brain (The Inner Net) and a *real* science of the universe (The Cosmic Shower). My original title for the book was 'Unblocking Science', and this remains the underlying theme. It's about blocks and how to avoid them. I have to get rid of the blocks before I can figure out how language learning works. Most of these blocks take the form of what I'm calling 'ghosts'.

The fields with the fewest ghosts were the ones that attracted me first: astronomy, chemistry, and evolution. Physics pretended to be searching for reality but was loaded with ghosts: things like mass, energy, light, gravity, and magnetism. And fields like language, psychology, and brain theory didn't even pretend. They could use words like 'words', 'memory', and 'thought' without taking any notice of what these things were made of or where they were located. But then, in 1951, Bernard Bloch asked us "*Where* is language?" And his answer was "It's in the brain." (See Chapter 5.) It's not floating around in a fairyland of abstraction. It's not out there in the airwaves. It's not in our ears. It has substance, and that substance is located in the brain. At the same time, from another direction, some people had been calling language 'the *window* to the brain'. I decided to take my degree in linguistics instead of science to get a better look through that window.

But the *structural* language of linguists and language teachers turned out to be a faulty window. It had us looking for ghosts. We had to assume things like this. Since people are able to acquire a language, there must be something like a 'language acquisition device' (LAD) in there somewhere. We weren't looking at what was there. We were looking for something we expected to find. Notice the crucial distinction. We weren't looking *at*—we were looking *for*. We assumed that everything must have a cause so we gave an unknown cause a name and proceeded to talk about it and look for it. We had created a ghost.

We needed a clearer window, and 'the natural approach to language acquisition' gave it to us. I looked through that window for ten years and what I saw was breathtaking. I called it 'the inner net'.

I had made the crucial first step ten years earlier when I guessed the reality be-hind perceptions, memories, and thoughts (see "Perception' in Chapter 5). The reality for all three was the same neural tree. I saw it grow (a perception), go dormant (a stored memory), and flash (a thought). So when I looked for language learning through that window, I wasn't looking for ghosts (like 'words', 'rules', or 'the LAD'). I was looking at neural connections. Let's take a look in that window.

Neural Trees and Wheels

When I converted from practice to listening as the key to language learning (see chapter 6), I soon realized that perceptions and their neural trees were not enough. The *minimal* unit of natural language acquisition had to be bigger than a perception. It had to be an *experience*. A perception was limited to characteristics like size, shape, and color. An experience added things like 'when', 'where', 'why', and 'how'. It arose from a real *happening* instead of a *scene*. And anything less than a happening could play no part in building languages. Perceptions were fleeting. Experiences were forever. If a picture is worth a thousand words, an experience is worth a thousand pictures.

Here's an example. A student of English can't really learn the word 'book' through translation—not in the sense of natural language acquisition. He can't even acquire it naturally from a *faked* happening where the teacher holds up a book in front of the class and says, "This is a book". You see, the *reason* for the happening is missing. Compare this with the English student seeing you take a parcel into a post office where there was a special rate for books, and hear you say, "This is a book." That would be a real experience. It would have all the *wh*-s. Who? You. What? That special book you were sending to a friend. When? The day after you had told your friend about it on the phone. Where? In the post office near your office. Why? To get the book rate. And the 'who', the 'what', the 'when', the 'where', and the 'why' were all part of the same experience. That single experience would be anchored on all sides. Compare this with the experience of seeing a teacher hold up a book in class. It didn't 'take'. It wasn't anchored on all sides.

But if a *perception* is a neural tree, what is an *experience?* I knew that the sentence structure of all languages consisted of units like 'who', 'what', 'when', 'where', 'why', and 'how' modifying a verb. And I had always diagrammed this structure with a wheel: the verb was the axle and all the *wh's* were the spokes. With this in mind, I looked through that window for an experience and saw a neural wheel. Like the sentence diagram, the axle was an action tree and the spokes were *wh*-trees. So if a *scene* out there builds a weak little neural *tree* in here (a perception), a *happening* out there builds a magnificent *wheel* (an experi-ence). The little trees soon get blown away; the wheels last forever. That's the sort of thing I was looking for through my window. (Actually, this *wheel* was nothing more than a single *tree* with large *wh*-branches. Sometimes I will use 'tree' for both, but more often I will use 'wheel' to emphasize the vast difference in size and permanence.)

Now just what do I mean by looking through a window and seeing trees and wheels? I'm thinking of common everyday things like this.

One day a student came in and complained that he hadn't learned a single new word in class that day. I opened the window with these questions. "Do you re-member what *happened* in class

today?" He remembered everything. "And what about yesterday?" He remembered everything. "What happened the first day of class?" He remembered everything. I looked in and saw those experience wheels piling up like crazy. But he said that he hadn't learned any *words*. Of course he was talking about words he had *noticed* but hadn't learned—words in little trees. He wasn't even *aware* of all the words he *hadn't* noticed—the words in great wheels. The very act of *noticing,* however, had singled out those words and given them their own flimsy little trees that soon got blown away. Unnoticed words remained anchored in their wheel—protected from the winds that blew little trees away. These anchored words weren't remembered as words, to be sure, but they were *there*—just waiting to get out some day.

You see what I mean by looking through that window. For every little thing that happened, I just looked at the neural forest inside. At this point that forest consisted only of neural trees (perceptions) and neural wheels (experiences). There was plenty more to come.

Neural Circuits

One day during our second year of operation, a student returned from a three-month break in his native Australia where he hadn't heard a word of Thai. He said that he had probably forgotten a lot and had better repeat NA 2. I told him that you never forget natural learning. He could take NA 3 and he would find that he was right where he left off. Two days later he came in to see me. "You were wrong, you know. I wasn't right where I left off. I was *way ahead*." I couldn't explain it. Then a few months later another student reported the same experience. Then another. I was mystified.

Finally it happened to me. After I had studied natural Swatow for 8 months, my teacher took a 5-month trip to the States. When she came back I felt like I was on a whole new level. I made this guess. Perhaps it's like eating. You don't grow new flesh as you eat. You eat now, grow later. But if you *ingest* experiences in class or in life, what is it that *grows later?* I took a look in the window and here's what I saw.

As you sit in class trying to understand what's going on, you're constantly *hearing bells ring.* A word that you're juggling to fit into what's happening right now rings a bell in an experience that happened yesterday. Yesterday's experience pops up alongside today's and they're joined by the same word. Different experiences can be connected by similarities. *Connected by similarities.* That was the key.

But where did that connection come from? What was it made of? How did it get there? I pictured a node in one tree resonating with similar nodes in other trees and I saw that resonance somehow create a *neural string* between them. (A node is any point in a tree where branches converge.) The image is as simple as this: similar nodes ring each other's bells and, having gotten each other's attention, join hands. This would serve to connect up every node in the entire forest

that was on the same 'frequency'. For years I pictured a string or wire running from tree to tree through the forest connecting all nodes that rang the same bell.

Then one day I realized that it wouldn't have to be one string going from node to node in some order. It could be more like branching strings leading from each node to all others. Instead of a single string, I saw a *circuit of wires*. I imagined an apple orchard with a circuit connecting all the apples. I turned on the switch for that circuit and, instead of seeing trees—*one by one,* I saw apples—*all at the same time.* Then, from one of those apples, I turned on the switch for *its* tree. I played with the switches. From this tree to one of its circuits to that tree to a different circuit. And I realized. *That's precisely what I do when I think!*

So now we see what it is that continues to grow after ingesting an experience. *Cross connections.* By the time you've grown a new tree, it's already cross con-nected to many others. And it continues to cross-connect that night. And through-out a three-month holiday. All those branches in the forest are constantly sending out their vibrations. And whenever similar vibrations resonate, they jiggle the molecules in the soup into a connecting thread. The circuit, then, is the sum total of all threads of molecules jiggled into place by the same resonance.

But this jiggling up of a circuit of threads of molecules should take seconds—not months. What was it that continued to grow over a period of months. I pictured a network of interlocking rubber bands. Whenever a new one is added or an old one is cut, the entire network is changed. Everything has a pull on everything else. The inner net is constantly balancing out the overall resonance forces of all circuits interacting with each other. Sifting, winnowing, discarding, settling, sorting, reinforcing. The Australian had come back with a whole new and improved net in his head.

Neural strings or circuits had added a whole new dimension to the net. The vertical dimension (the trees) and the horizontal dimension (the strings or the wires of a circuit) intersect at the nodes. That is, from any node you can go either vertically through the tree (as you tour a given experience) or horizontally through the forest (as you ring bells in similar parts of other experiences). Dunking a donut in your coffee, for example, is both part of this morning's breakfast experience (through a vertical connection) and part of other donut experiences (through a horizontal connection).

Electric sparks travel through the net. We call it 'thinking'. You can feel the travelling spark as you think. You feel it move through an experience tree as you recall the details of a memory. Your spark can dart around inspecting different parts of this morning's trip to the office, just like your eyes darted around to different parts of the live happening. But then, at any node, the spark can suddenly jump over to another tree and enter it through a similar node. We say or feel something like "That reminds me…"

We have different ways of talking about the spark as it darts and as it jumps. We *daydream* as the spark *darts* through one experience. Our *mind wanders* as the spark *jumps* to another. It's constantly jumping through long lines of experiences as we *search for words.* (I just flashed the

circuit of all of my experiences contain-ing short, fast movements and jumped through to the word ‘dart’.) Right now you can feel the spark jump as you read. As your spark darts through the tree I’m laying out in your head, it’s constantly jumping to previous thoughts in your forest. That’s what reading and listening are all about: plugging the new into the old. We call this kind of hooking up ‘understanding’.

So here’s how I see the reality behind our mental activity. Vertical connections (the trees) constitute *experience*. Connecting up new experiences to old ones constitute *learning*. The sum total of all horizontal connections (the strings or circuits) constitute *knowledge*. And the moving light that scans this net (the moving spark) constitutes *thinking*.

We can now apply this to language and see what Automatic Language Growth (ALG) is all about. As you experience a happening, a *neural tree grows*. And as this tree grows, all of its nodes *shoot out connecting strings* to old neural trees. And it’s all *automatic*. How different this all is from memorizing words and rules, or from practicing.

With these horizontal connections I had a whole new net. I saw an orchard of fruit trees with its bugs, birds and bees. Each kind of fruit was on a different circuit, as were the bugs, the birds, and the bees. Then I enlarged this orchard to the grand forest that was my entire life. When I thought ‘bird’, the ‘bird’ circuit lit up and I saw at a glance all the birds I had seen throughout my life. The flashing circuit was like a stack of transparencies. Looking through the whole stack at once, I saw the prototype ‘bird’. By sheer preponderance I saw the shape of sparrows, robins, and crows. But on closer inspection I also saw storks, pelicans, and ostriches. ‘Words’ and ‘meaning’ were no longer ghosts. A *word* was a neural circuit and its *meaning* was the stack of transparencies it had selected from my life’s forest. That was a real tingle. After 40 years of maneuvering through that vast ghostland called linguistics, I finally saw something real. *A word.*

Of course a computer can locate all the birds in its forest (file) too, but look at the vast difference. The computer has to search through every tree (sentence) in its file, one by one, and glimpse each bird one at a time. The brain crosses straight from bird to bird and sees them all at the same time. The magic lies in ‘all at the same time’—the stack of transparencies.

By 1992 I had trees, wheels, and circuits. I was on a roll.

Neural Shine

So a word was a string running through my life’s forest and its meaning was to be found in all the experiences it passed on the way. That is, each experience offered an example of how the word could be used, and I was seeing the sum total of all those examples at once as I inspected the string. I savored the idea of strings through a forest for a full year before it hit me. “Hey! Are those strings connecting *words* or *pictures?* Sounds or shapes? How did a *word* get into an experience anyway?” Well the answer was obvious once I had asked the question. It entered the tree just like all the other sights and sounds of the experience. It was just another inherent part of the experience—neither more nor less.

I had been seeing the language part of an experience as something of a completely different type. There were two separate levels: words (what was said) and mean-ing (what happened). But when a toddler has an experience, he doesn't know what stuff is language and what stuff isn't. Not all sounds are language—not even all sounds coming from human mouths. The toddler just builds trees out of sights and sounds. This was one of my major breakthroughs. It was on a par with the day I looked at the perception, the memory, and the thought of a particular kitten and said, "They're all the same damn tree!" Well now I was looking at the action parts and the speaking parts of an experience and I was saying, "They're just different parts of the same damn tree!"

I looked again at my 'bird' experiences. Some of them were pictures only (the birds had occurred in the experience without mention), and these pictures were connected by a string. Some of them were words only (they were mentioned in the experience but not seen) and were connected by another string. But some of them had both picture and word. "Look at that bird!" Could that node have two different strings and thus be on two different circuits? Could we take two different sightseeing tours from it through the forest? That is, could we take the "flying creature' tour (like a thesaurus) and see all the different words used for flying creatures? And then take the 'word' tour (like a dictionary) and see everything that could ever be called by the word?

Two different strings through the same node. At first I was thinking specifically of these two: a dictionary string (everything that was *called* 'bird') and a thesaurus string (everything that *looked like* a bird). That's what it took for me to go from one string to two. But after a year of visualizing two strings emerging from a single node, I suddenly saw *dozens*. A specific node of a specific tree could resonate and connect up along many different lines at the same time. A 'bird' node in a particu-lar tree, for example, could have one line that linked it to all birds, another to all animals, and another to all living things. It could have a line to all nouns, all count nouns, all sentence subjects, all sentence objects, and so on and on. Each of the node's characteristics had its own frequency, and each one of these could seek out its own kind. Think of meeting a woman and immediately hooking her into your forest. You would see all women who looked like her along one line, all those who behaved like her along another, and all those with similar personalities along still another. I proceeded to look for such lines at each node.

I pictured the node as a florescent light bulb standing on its end and considered both the electricity and the shine of the bulb. Like the *electricity* of the bulb, signals were converging into the node from the top and passing out from the bottom as it took its place in the tree. And like the *shine* from the bulb, different wavelengths or frequencies were shooting out in all directions from the sides. As these different wavelengths linked up to form different strings, I soon saw a jumble that looked more like a heap of jackstraws that crisscrossed at all angles. How could this jumbled heap have come about?

I switched from frequencies or wavelengths to the spinning trinos of my cosmic shower (see Appendix) and it all came clear. As I looked at the hundreds of perpendicular lights shining on each other, I focussed on the different kinds of trinos that had been emitted by the different chemistry of the different neural signals. After all, a neural signal consists of molecules, and each molecule emits its own orientation of trinos. The trinos of a certain shine would serve to line up

molecules in the soup in much the same way as the trinos of another kind of shine would line up iron atoms (and thus iron filings) in a magnetic field. Then when two streams of similarly oriented molecules met, they would click together to form a string. And different patterns of trinos in the shine lined up different strings. Hence all the jackstraws.

Suppose somebody said, "Look at that bird", as a bird flew by, for example. That sentence would become part of a tree with the node 'bird' shining forth all the roles it was playing in the happening. Here are two of the many roles of that one node. It shines out the word 'bird' and gets on the circuit of all the birds in the forest. And it shines out its grammatical function, 'object', and gets on the circuit of all the sentence objects in the forest. These are just two of the dozens of jack-straws in its jumble.

The idea seemed simple enough. Just replace *one* cross string with *several*. But it turned out to be huge. Whereas a single cross string could search for words in a way that make a computer's word search look primitive, *multiple* cross strings were in a whole new universe. Word processors had just barely made a start with their grammar check.

The implications and ramifications of the idea are vast. Notice the above example of 'bird'. On the one hand there are strings like noun, count noun, subject, object. You can see that the whole field of linguistics lies here (the units are *circuits*: a word is a circuit, a rule is a circuit). On the other hand there are strings like winged creature, animal, living thing. A whole new field. Add to these examples a dozen other dimensions, and then top it all off with something like this. As you're going through a circuit on a word search, you can get a quick glimpse of all the other dimensions of each word as you pass: its grammar, its connotations, its restrictions in usage, and so on. To explore this idea would take several books. What you see is a fantastically complicated apparatus. *You're looking at the human brain.*

I'll refer to this idea of multiple strings as 'neural jackstraws' when I want to focus their function. And I'll refer to the idea as 'neural shine' when I want to focus on how the jackstraws were formed.

Notice how much better 'shine' can help us understand the Australian on holiday. For three months all the nodes in his budding net were shining on each other seeking the best overall balance of forces as the net pruned itself. Every time a weak string dropped out or a new jackstraw popped in, a new balance came about. I thought of it as 'settling from its own weight'.

Neural Forks

A node of a tree is a neuron where two or more different signals converge (through its dendrites) to form a new signal which it passes on (through its axon). Picture a yellow river and a blue river coming together to form a green river. A neural tree is one massive convergence from leaves to trunk—from parts of a perception to the whole. Just like the yellow and blue river converge to form a green river, so might a signal of a circular shape and a signal of the color green enter the same neuron to form the signal of a green circle. For years this picture of convergence dominated my thinking. Two or more dendrites *in* and one axon *out*. A single perception built a single tree,

and a single happening built a single wheel. But all this time I knew that an axon could branch into the hundreds—even thousands. That green river that was formed from two rivers could fork into many—all of an identical green. For years I had seen only convergence in my neural trees. The idea of *divergence* came as a sudden flash.

Here was my old picture. I saw my hands as two different neurons carrying two different signals: the signal of a *circle* in my left hand and the signal of *green* in my right. Then I saw a marble in front of me as a receiving neuron. I touched the marble with the forefingers of my two hands and saw 'circle' enter the marble from the left and 'green' enter from the right. The marble now carried the signal 'green circle'. That was the picture I had used for years.

Then came the flash. I saw five marbles out there instead of one, and I touched them all at the same time; one between thumbs, one between forefingers, and so on. And there staring up at me were five identical green circles instead of one. Two signals, one from each hand, had *diverged* through my fingers and then *converged* into five identical signals. I rushed on.

An axon can have *hundreds* of branches (hundreds of fingers). If neurons *A* and *B* each had 100 branches and only one tenth of them managed to come together into the same neuron, there would still be 10 identical copies of the neuron *AB*. But wait. This ten-fold increase could take place at each level of convergence, and a wheel could have six to ten levels. Just look what that would mean. Every time you experience something it could get recorded in *a million copies!*

Before I consider the implications of massive copying, let me tell you about another experience. I was talking with a friend in my office one day when I got a phone call from my wife. After I hung up, my friend asked me what she had said, and I told him she was coming to see me. About half an hour later we were talk-ing about how my wife and I mixed languages, and he asked, "By the way, when your wife phoned and told you she was coming, did she tell you that in English or Thai?" *And I couldn't remember!* I could easily remember *what* she had said, but I couldn't remember *what language* she had said it in. You see it could have been either one equally. While it was words that had entered my ears, they immediately converged into a level of meaning. And having carried their message, the outer neurons cleared for further use while the meaning remained at a deeper level.

Instant clearing at the shallow levels and massive copying at the deep levels. What did this do to my decade-long picture of a neural tree that grew (a perception), went dormant (a memory), and flashed again later (a thought)? For starters, it ex-plained something I had always left unexplained: "perceptions soon fade; experi-ences are forever." But then the ghosts of short- and long-term memory crossed my mind. And the answer was clear. *The difference between these two ghosts lies only in the number of copies.* The single copy of a phone number (short term memory) will last only three seconds while you dial it. An experience with thou-sands of copies (long term memory) will last a lifetime. Neurons are constantly dying off, to be sure, but at the

age of 90 you could still have 7,500 copies left from a 10.000-copy experience that happened at age 20 (even if you have trouble remembering your own name!).

I started out with vertical trees and horizontal strings. This served to point out the difference between experience and knowledge and got me thinking in the right direction, but it didn't come close to explaining the complexities of the human brain. *Then I went multiple.* I added *shine* to the strings and *forks* to the trees and beheld the human brain in all its complexities. Well, not all.

Neural Lattices

So far the inner net allowed only for neural trees of *actual* perceptions and experiences. Things that actually happened in our life. But of course we can think of things that we never experienced. The inner net must be able to put together new thoughts. It does this with *neural lattices.*

Here's an example of a lattice. Picture a hundred words in a column down the left and 26 letters in a column down the right. Then draw lines from each word to all of its letters. That maze of lines is a lattice. You can now put together new 'words' by combining letters in new ways. Just work the lattice backwards. (Of course the ordering of letters would have to be handled in some way.)

Now I'm going to make a lattice out of experiences instead of words. Just as a word consists of so many letters (in a certain order), an experience consists of so many nodes (in a certain arrangement). Picture a hundred experiences in a column down the left and 26 nodes in a column down the right, and then draw lines from each experience to all of its nodes. Now just as the *word* lattice is able to build custom-made words by working backwards, this *experience* lattice can build custom-made experiences. All you have to do to create new experiences is to regroup existing nodes. We call this 'imagination'. And just as we can imagine new words, we can imagine new happenings. How does this work?

I'm going to define the ghost 'imagination' by using the ghost 'think'. Earlier I defined 'thinking' as a spark moving through neural trees and circuits. But we can also think of 'seeing' as a spark moving through our surroundings. And either way, attention 'in here' or attention 'out there', a neural tree grows. And sometimes we might not even be sure whether that neural tree is 'real' or 'imagined'. Anyway, this should help explain what I mean by 'built in the lattice'.

So here's our brain model. Trees (perceptions), wheels (experiences), circuits (words and knowledge), shine (multiple cross grouping), forks (multiple copying), and lattices (imagination). We can see all of these things at work in language acquisition. And now we can see them all at work in the brain. But just where in this wonderforest does *speaking* come in*?*

Loops and Neural Mifs ('thermostats')

William Powers' control theory explains behavior—and thus speaking. Reread the section on 'Behavior' in chapter 5. All you need in order to say anything is the right feedback loop passing through the right reference signal. The loop is the speaking situation, and the reference signal is a mental image of what you want to say. When this image flashes, it works like a thermostat. Just like the furnace tries to match the thermometer to the thermostat, so does the mouth try to match the spoken word to the flashing mental image. It's just like copying a picture. You keep looking back and forth from model to emerging picture.

In the section on 'Neural Circuits' above we defined the reality behind the common ghost we call 'thought'. A thought is the playback of a stored memory. Now the mental image of what you want to say (Powers' 'reference signal') is simply a thought that is being used as a reference signal. It's a 'speaking thermostat'. We're going to call it a 'mif' (for mental image flash). Once you've assembled the right mif, the mouth takes care of itself. Let's compare the two loops: the heating loop of the thermostat and the speaking loop of the brain.

The heating loop runs round and round from the furnace, to the temperature out there, on to the thermometer, then to the thermostat, and back to the furnace— round and round. It's a closed feedback loop in which the furnace controls what the thermometer registers. It keeps closing in on the setting of the thermostat as the furnace tries to match thermometer to thermostat. If we change the setting of the thermostat, it's a whole new ballgame.

The speaking loop runs round and round from the mouth to the sounds out there, on to the ears, then to the mif, and back to the mouth—round and round. It's a closed feedback loop in which the mouth controls what the ears register (you're constantly listening to, and monitoring, the sounds you're making). The mouth keeps closing in on the mif as it tries to match the live speech to the mif. If we change the mif, it's a whole new ballgame.

Compare 'the mouth controls what the ears hear' with 'the index finger controls what the ears hear' as you pick out a tune on the piano. Just as the finger is trying to get the right tune (the one in your head), so is the mouth. The feedback speed of the mouth control is just so much faster that you miss the fact that it, too, is 'playing it by ear'.

The speaking mouth is playing it by ear. This is the crucial point to the whole argument. Compare this with 'the reaching hand is playing it by eye' as you pick something up. Whenever you start to pick something up, the mif is 'hand grasping object', and the hand is trying to give you a live picture of 'hand grasping object' to match it. Now when you start to *say* something, the mif is a certain sentence in your head, and the mouth is trying to give you a live sentence to match it.

I used to think that the mouth of the expert speaker was behaving like the fingers of the practiced pianist; and I based language learning on practice. I now see (thanks to Powers) that the mouth behaves more like the index finger of the hack-er hunting for a tune in his head; and I now base

language learning on listening. Notice that you can't sing "Mary had a little lamb" without first flashing its mif. There's no other way. And notice how you got that mif in the first place. Through listening—not practice or memorization. Here, in a single sentence, is the secret to ALG speaking. *Listening is the only way to sharpen the mif, and the mif offers the only way to natural speaking, hence you learn to speak by listening.*

The mif is simply a neural tree. That tree could have grown directly from an experience in which the desired sentence occurred in a similar situation and you were simply echoing it. But it more likely came through searching for the closest model that existed in your net and then fine-tuning it in the lattice (most of our sentences are new—not echoed).

Search and fine-tuning. That's how we speak. The mif for a single sentence can be assembled in less than a second; but the details of what takes place during that second could fill a book. The complications are staggering. But as you become familiar with the whole picture (trees, circuits, jackstraws, and lattices), you can glimpse that spark as it darts and jumps around to fix you up a tree to speak with. Sometimes the jumping spark is slow enough for a clear glimpse. Just look for it the next time you're going "uh…uh…uh" in mid sentence as you run into difficulties putting together your mif. And as you glimpse, you may well wonder, "Just where did that speaking machinery come from?" But now you know the answer. "Cascades of happenings without any conscious thought or any attempts to speak. Everything else is automatic growth."

Compare, now, the *reality* of language acquisition with the *ghost*.

The reality is *cascades: the secret to automatic language growth.* That's the reality *outside* the head. The reality that I see *inside* the head, through my window, is things with substance like neural trees, strings, lattices, and loops.

That's the reality. Now look at the ghost. The ghost is the expression 'language learning' and everything it usually includes. I use to look through a lesser window and imagine things that had no substance. Things like words, rules, memorizing and practice. And I followed those ghosts all the way to rock bottom.

Now I can see the reality. It not only makes me tingle. It also produces speakers of Thai that can do things in a few years that I couldn't do in fifty.

Chapter 9. Reality.

Throughout my story, from age 3 to 75, there was a common thread: 'reality'. The word defined *itself* when I told of my father using an orange and a lamp to explain night and day. The reality didn't reside in the *perception* (sunrise and sunset). It resided in the *model* (orange and lamp). Another example was 'cold' (the perception) and 'slow moving molecules' (the reality). Whenever I came across this kind of reality, I got that special feeling I've been calling 'tingle'.

Right from age five I had become some kind of reality nut: I was always searching for what might really lie *behind* what I saw, heard, and felt. But later I found out that there was something far more misleading than these perceptions. It was *words.* 'The rising and setting sun', I could at least *see*. And 'cold', I could at least *feel*. But things like 'God' and' 'gravity', I couldn't even *imagine*. They were ghosts. The physicists told me that the earth was using the ghost of gravity to pull the apple to the ground. I *winced*. But the day that I saw the apple getting pushed more from above than below (the earth having blocked out some of the pushers from below), I *tingled*.

Notice the three levels. Reality, perceptions, and ghosts—carried, respectively, by models, sensors, and words. Both reality and ghosts are outside of our perceptions, so what's the difference between them? They both have to *start* with perceptions, of course, since perceptions are the brain's only contact with the outside world. But they take different routes. Let's investigate.

The real power of the brain comes from perceptions of *happenings*—not *pictures*. Pictures have shapes, sizes, and colors. Happenings have the '*wh's'* (who, what, where, when, why, how, and how much). We've got a special word for perceptions of happenings. We call them *experiences*. Experiences persist in the brain for a lifetime; pictures can fade in days—even minutes. So if our reality (things like trinos, atoms, and the solar system) and ghosts (things like memory, energy, and truth) are to be lasting, they must both arise from *permanent* perceptions. That is, experiences. (Notice, for example, that this excludes anything *memorized* as well as most things learned in school! And herein lies a whole new book.) And now we want to show the different routes taken from experiences to reality, on the one hand, and to ghosts, on the other.

Reality comes from *guesses* at *recombinations* of experiences (we experience billiard balls bouncing on a pool table and recombine these movements into molecules bouncing in our coffee). Words, on the other hand, arise from *intersections* of experiences (we experience a bouncing billiard ball and a spouting geyser and intersect them at their 'sudden movements' to create the ghost we call 'energy'). *Recombinations* vs. *intersections*. Not very helpful, I'm afraid. Here's another pair. *Substance* vs. *abstractions*. Or, once you're completely at home with my theory of the brain, the clearest dichotomy of all is *trees* vs. *circuits*.

But the easiest way to see the difference is simply to ask the '*wh's'* listed above. Try these questions out on *molecules* and *thoughts*. What are they made of, what do they do, how big are they, where did they come from, where are they located, how did they get there, and the like. Clearly, 'molecules' answer a lot more of these questions than 'thoughts' do. Molecules are real; thoughts are ghosts.

Of course I didn't need any of these words for myself; that is, recombinations, substance, or trees. I felt the difference in my gut. Reality made me *tingle,* while ghosts made me *wince*. Reality, in fact, was like a drug addiction. I was always looking for it, and when I found it I felt high. It came to be the main driving force of my life. Looking for the reality behind perceptions and ghosts. And this is the subject of my story all the way from age 3 to 75. My obsession with reality.

I spent most of my life dealing with one particular ghost: the learning of language. What was the reality behind *that*? Presumably, 'language learning' has to do with *language* getting into the *brain*. I didn't expect anything as simplistic as *plug into socket*, of course, but I did expect some kind of *substance* somehow *getting into* some kind of *substance*. So all I had to do was to find the *substance* of language, the *substance* of learning, and the *substance* of brain.

I turned to the experts. But the *linguists* didn't know what the substance of language was. They could only talk about things like words and rules—no substance there (What's a rule made of?, What's the shape of a word?, etc.). And the *educators* didn't know what the substance of learning was. They could only talk about things like memory and habits—no substance there either (What's the shape and size of a memory?). The *brain physiologists* sometimes gave a nod toward substance with their neurons, synapses, and areas of the brain, but that didn't even come close to what I wanted. I was looking for *stuff into stuff,* and everyone was relying mostly on ghosts. It looked like I'd have to find this *stuff* for myself.

It wasn't going to be easy. I soon saw that the stuff of brain action was to be found in chemistry, and the stuff of chemistry was to be found in physics. The plot thickened. It now covered physics, chemistry, linguistics, and brain. Chemistry was doing fairly well with *its* stuff, but the other three subjects were drowning in an ocean of ghosts. *And their experts didn't even know it!*

The reason they didn't know it was that they couldn't distinguish between *words* and *things*. Without batting an eye they were asking questions like "What is consciousness?" Of course I assumed that they meant something like "What is the reality behind that ghostly area we refer to as 'consciousness'?" But no. They were trying to answer the question with other ghosts—not reality. 'Being scientific' seemed to refer to 'how skillfully they could juggle their ghosts'. Or "how many ghosts they could assemble on the head of a needle". The juggler might imply things like this: "I may not know what 'consciousness' really is, and I may not know what 'thinking' really is, but just watch me juggle them. *'Consciousness* consists of *thinking* about *thinking'*." And all of them were doing it! Even the greatest! They were all jugglers! *And they didn't even know it!*

Of course this is what we would expect from linguists, psychologists, educators, and brain specialists. They don't even know what I'm talking about. But what about the venerable physicists? They weren't just *juggling* their ghosts; they were also *measuring* and *calculating* them. Now *measuring and calculating* may sound a lot more scientific than *juggling*. *But calculating ghosts?* Here's how it goes.

They see something happen: an apple falls.
They explain it with a ghost: *gravity*.
They measure the happening: how fast the apple accelerates.
They find an equation: $g=m_1m_2/r^2$.

Then they make Great Leap 1. *They apply this equation to the ghost!* What could that possibly mean? Some kind of *force* in the *mass*? But force and mass themselves are ghosts. Ghost in ghost again—like 'thinking about thinking.' You see what I mean by juggling ghosts—and even *calculating* them.

But then comes Great Leap 2. Since math can now 'explain' gravity while the mind can't, *they put math over mind.* "The human brain is limited, but mathematics is forever." They had invented math to tell them 'how much' (which the brain couldn't do by itself). And that was a tremendous invention. But now they were using it to tell them 'how' (which *only* the brain can do).

Compare this with the early animists.

They see something happen: the trees are bending to the south.
They explain this with a ghost: the God of the North Wind.
They 'measure' the happening: how far the trees bend.
They find a correlation: the stronger the wind the further the bend.

Then comes Great Leap 1. *They apply this correlation to the ghost.* The madder the god, the harder he blows—or some such thing. Were the physicists really doing any better? Compare 'some kind of *mood* in the *god*' with 'some kind of *force* in the *mass'*. They're both cases of 'some kind of ghost in a ghost'.

Then Great Leap 2. Since the god could now 'explain' wind while the mind couldn't, they put their god above mind. "The human mind may be limited but the gods are forever."

Physicists came more and more to look for reality in equations. Ponder that. "Looking for *reality* in *equations*." If the equation said '5 dimensions', it must be *real*. If the equation said 'infinite mass' in 'zero space', it must be real. If the equation said 'time contracts', it must be real. The puny *brain* would either have to stretch up to it or give up and leave it to the big guy: *math*.

What they've done is to replace 'guessing' with 'trying to imagine'. (For 'guessing' think of something like "What if the earth were round and spinning?" And for 'trying to imagine' think of something like "What could 5 dimensions possibly look like?") That is, they replace *models* with *ghosts*. In my view, guessing is the only source of models, and models are the only way to understand reality. But now *they were actually looking for reality in equations!* Equations are for telling you *how much,* dammit! Not *how.* I couldn't stand it. I had to do something.

Here was my first step. I put language learning on hold, quit my lifetime job in Thailand, and returned to the States to study physics. Two classes a day for four years. (I wasn't really 'studying' in the usual sense. While *they* were teaching me how to *measure* the ghosts, *I* was looking for

the *reality* behind them.) And after four years of this 'study' followed by twelve years of thinking, I just may have found the reality I was looking for.

My second step was to look for the substance of language and brain. I was already way beyond 'study'. I needed something else. I needed a 'laboratory'. But where could I find such a thing? I knew of only one place. My old position at AUA in Thailand. I went back and started up a course in natural language learning. For 10 years I observed *natural language* entering the *brains* of 5,000 students and myself.

Some people called it *determination*—even *dedication*. What with quitting my lifetime job at the age of 55 to study physics *for four whole years*. Spending *10 years* fighting the whole world with crazy ideas like 'you learn to speak by not speaking'. With *over 5,000 students!* Spending *2 hours* a day *for 8 years* listening to Swatow Chinese—just to see what would happen inside my head. *Determination?* Do we marvel at the determination of the alcoholic who goes on a six-month binge?

I not only loved every minute of the binge, but I actually did find a kind of reality. I hadn't expected to find one model that would cover them all: physics, chemistry, language, and brain. But that's what I got. My model consisted of only the barest framework, to be sure, but this framework showed how everything could fit together—even *flow* together from level to level. It wasn't *four* models; it was *one*. It would take a generation of scholars to flesh it all out, but my excitement came from seeing the *organization* of it all. The *skeleton*—not the *flesh*.

———————

The model is very broad—something like a model of *everything*. But let me first focus directly on the language-learning part. What are the units? What are they made of? How big are they? Where are they located? How did they get there? I finally found the answers. *Language consists of neural circuits running through a forest of neural trees.* And *learning is simply a matter of how they got there.*

Let's look at the circuits and trees as the English language entered my head. How did the *trees* get there? They *grew* there. Every experience of my life had *grown* its own tree in my forest, and some of those trees contained bits of English talk. That's just the nature of the brain: happenings enter eyes and ears and grow trees.

And how did the *circuits* get there? They *grew* there. When the same unit (like a certain English word) occurred in different trees, a wire soon grew to connect them. This put all similar things on the same circuit. That's just the nature of the brain: 'resonating vibrations' grow neural connections.

> [Picture a wire running through a forest connecting all pinecones. Switch this circuit on and all those pinecones light up at the same time. You can see them all in one quick glance, and if one of them especially 'catches your interest', you can briefly light up its tree for a quick look. (Think of yourself standing in this forest with a flashlight.) This is precisely what you feel happening when

you search for the right word as you speak. "Shall I use 'a few', 'several', or 'some'?" You just light up the circuit of 'indefinite small number', take a peek at some of the trees for each, and choose the one that comes closest to your present thought. Notice, also, that every new pinecone that grows adds a new unit to the circuit. Circuits keep growing forever.]

Trees and circuits. That's what the brain consists of. The trees constitute our 'memories', and the circuits constitute our 'knowledge' (by cross-connecting the trees at their similarities). Language is nothing more than a subset of this forest. The trees provide a complete set of all instances of language use throughout our life (like the linguist's *corpus* that he collects to analyze a language). And the circuits provide something like a search engine that we use to think and speak with.

Here's another view of how the *trees* grow. *Cascades of happenings roar in through the head—growing a forest of neural trees. We call them 'experiences'.*

And here's another view of how the *circuits* grow. *A shower of trinos blows through the forest—spinning a web of connections. We call this 'knowledge'.*

The English language that grew in my head consisted of all the trees containing English talk, together with all the circuits running through them. And I hadn't *learned* it. "It just *growed"*.

[Did you notice that 'language' is not something distinct from 'experience'? It's simply a part of it. Not a *kind* of it, but a *part* of it—and this distinction is crucial. This thought came as a flash one day and gave me a whole new vision. We don't *think* meaning and *translate* it into language, as I had always supposed. Spoken sounds are just another part of an experience, and all the parts are woven into the same fabric. *The same fabric.* There isn't one fabric of meaning and another of language. As we think through an experience, we find words *there*. Right there in the experience. Not on some parallel level. (The experience of seeing a drowning man yell 'Help!' contains the *word* along with the *thrashing arms*.) There's only one fabric of experience. So wherein lies the difference between meaning and language? It's in the *circuits*—not the experiences. 'Meaning' cross-references experiences in one way, 'Language' in another. And even that distinction isn't always sharp. Notice the circuit of 'indefinite small number' above, and the circuit of 'surprised disbelief' below.]

I had found my answer to the reality of language learning, and I couldn't resist playing with it. And I do mean 'play'. Whereas the *finding* tingled, the *playing* was sheer sport. Here are three examples of what was going on all the time.

1) When I found myself going 'uh..uh..uh' as I talked (not just 'uh', mind you, but 'uh..uh..uh'), I felt circuits flashing through my forest like crazy—searching for words. I assumed that such a search took place with every word I said (something like the ultimate search engine I mentioned above). But only when I *hesitated* was the search slow enough to catch. (Look for it next time you go 'uh..uh..uh'.)

2) When I heard three-year-old Joey use an intonation of 'surprised disbelief', I saw him flash through his 'surprised disbelief' circuit (like the pinecone circuit above), find an instance of his big sister showing 'surprised disbelief', and imitate it (facial expression, intonation, the lot). He hadn't *learned* the intonation—he just looked where the spotlight of the moment was shining,

found it in a tree, and copied it. (You see, copying his sister in the memory is not much different from copying her live. Like the memory, the 'live' perception is the neural tree that the perception forms in the head.) This sentence might serve to sum up the entire book. "He hadn't *learned it*—he just *looked it up and copied it*—and the appropriate spotlight was determined by the very reason for the search."

3) When I saw people chatting, I tried to trace the action from one person's net to another's. One day I was at a cocktail party where a group was exchanging snake stories (this was in *Thailand*). A tree flashed in the net of Mr. A, went through his language circuits to assemble sentences, traveled through the air, entered the net of Miss B, passed through her language circuits to create pictures, lit up her own snake circuit (like the pinecone circuit) where she found her favorite snake story, then on through language circuits to sentences, and then out. And so on with C and D as we sipped our cocktails. While all the others were seeing snakes, I was seeing the train of flashing neurons as it ran through the group. It reminded me of the bouncing ball in a sing-along. The ball bounced around in one head, then jumped to another, and on through the whole group. Each head was a musical instrument, language was the conductor, and I was a reality freak in the audience.

Those were examples of me playing with *language*. But what about *learning*? That's where my 'lab' came in.

As I watched language entering brains for those 10 years, I played my game. I focussed on the neural trees that were shooting up with every new language experience. Then I shifted to the circuits and saw sparks shooting out from the trees in all directions—like goal-seeking shrapnel. When I was watching the learning in *others*, I *visualized* those bursts of neural growth in my imagination. But when *I* was the learner, I *felt* them in my head. And the feeling was much more illuminating. When I heard a Swatow word in a new situation, for example, I felt bells ring in other trees of my forest. (Hey! That's the word I heard last week when we were talking about so and so.) Each ring of a bell was a piece of shrapnel finding its goal and hooking up. The word 'word' had always been a ghost, but now I actually felt its substance. It was a neural circuit that continued to grow with every new experience that carried it (like the pinecone circuit kept adding new pinecones as they appeared). Its meaning was the sum total of all those experiences, and when it flashed, I glimpsed them all at the same time. It was like looking through a stack of transparencies and seeing the weighted average: a 'prototype'.

But enough of this play. Let me return to the language-learning part of my 'model of everything'. It was this.

Language consists of neural circuits running through a forest of neural trees, and learning is simply a matter of how they got there.

And now I know how they got there.

Experiences coming in caused trees to grow <u>up</u>, and resonating vibrations caused circuits to grow <u>out</u>. 'Up' and 'out': the two different dimensions that account for the magic of the human brain.

It was 'The Secret to Automatic Language Growth.' And it filled my requirement of 'stuff into stuff'.

———————

Of course I have every right to make such guesses about language learning. It's my field. But what about the rest of my 'model of everything'? How dare I venture into physics, chemistry, and brain?

I dare because these other scientists are more often dealing with *words* than *reality.* And words are *my* business—not *theirs*. In my view, all professional scientists are handed the ghosts of their trade during their training. And those ghosts are hiding in words—like 'consciousness' and 'gravity'. These words are simply accepted without question as part of the 'reality' being investigated.

That needs repeating. *Words are accepted as part of reality.* From the very first day of their physics class students are fed the 'reality' of gravity running the universe. Then later in their careers they ask things like "What is this *thing* called gravity?" instead of things like "Why does the apple fall?" They're questioning the *ghost* instead of the *happening*. (Try this, just for fun. Replace 'gravity' with 'God' throughout this paragraph.)

And that's why I dare venture. The very skeletons of their professions are made mostly of ghosts, and those ghosts are hiding in words. And words are my business. Somebody's got to step up and say, "Excuse me, your ghosts are showing."

I repeat the absurdity. "We accept the 'fact' that gravity *is;* that is, there *is* such a *thing* called 'gravity'. Such a *thing*. All we've got to do is to figure out *what that thing is*." Focus in on the words 'that' and 'what'. "We accept *that* it is, but we don't know *what* it is." In other words, we accept a unit that might not even exist in reality and then proceed to *study it*. Notice the animists again. "We accept the fact that 'the god of the north wind' is; that is, there *is* such a *thing* called 'the god of the north wind'. All we've got to do is to figure out what that *thing* is." The animists did it *then*, and almost all scientists do it *now*. Let's take a quick look.

Notice the physicists. Without ever wondering what *dimensions* might be, they confidently claim that there must be five of them—or ten! Five *what*? Five *ghosts*.

Notice the brain physiologists. Without ever wondering what *memory* might be, they confidently claim that there are two main kinds: long term and short. Two kinds of *what*? Two kinds of ghosts.

Notice the linguists. Without ever wondering what *words* and *rules* might be, they confidently claim that language is composed of them. Language is composed of *what*? It's composed of *ghosts*.

Notice the language teachers. Without ever wondering what *learning* is, they confidently claim that you've got to use it to get those words and rules. Use *what*? Use a *ghost*. To get *what*? To get *ghosts*.

And they're all doing it. *Accept the ghosts and then study them.* Yes, I dare venture. I *specialize* in words. They're my business. Below I offer the skeleton of a model of *everything*. It shows how infinitesimal billiard balls (trinos) can combine to form the substance that speaks (mifs), and it does this in 15 steps. From *trinos* to *mifs* in 15 steps.

The first 5 steps are listed below under *physics*, the next 5 under *chemistry*, and the last 5 under *brain*. But this is only for ease of locating them in the book. They're actually just 15 steps of a single progression.

Physics	**Chemistry**	**Brain**
1. Particles (trinos)	6. Atoms	11. Neurons
2. Spins	7. Molecules (fits)	12. Experiences (trees)
3. Deflections	8. DNA (zippers)	13. Knowledge (circuits)
4. Accelerations	9. Assembly lines	14. Imagination (lattices)
5. Nuclei (stacks)	10. Survival (wins)	15. Reference signals (mifs)

Physics. See Appendix for details.

1. Particles (trinos). A trino is a minute particle moving through space at the speed of light. In size, a trino is to an electron as an electron is to the earth—or the solar system. Think of gravitons in conventional physics.

2. Spins. There are three kinds of trinos: no spin (n-trino), right spin (r-trino), and left spin (l-trino). An n-spin 'delivers' *gravity*, while r- and l-spins 'deliver' *electric* charge. Think of neutrinos, for a start, but then proceed in my way.

3. Deflections. This refers to hits on trinos in *flight* (like *gravitons, neutrinos,* and *light)*, not to hits on trinos in *orbit* (like *electrons, protons,* and *neutrons)*. Trinos can hit each other only at 90^{o} (the need and reason for this assumption are given in the appendix). When an n-trino gets such a hit, it swerves to the side as it tries to hold its course. It squeezes against companions that are going its way (and thus stationary relative to it) and bounces back and forth between them—like a car swerving back and forth in its lane. Better still, picture pulling a toy boat by a string and then tweaking it on its side as it goes. The hit has turned the path of a straight line into that of a sine wave. Think now of tweaking a graviton to form a photon.

But when a *spinning* trino gets hit, the hit *turns* instead of *pushes*. This is nothing more than a guess into the nature of spinning trinos. The hit serves to turn the *axis* of spin, and the trino goes into orbit as it continues to get hit. (Think of a car with its steering wheel locked in a turn.) Its nature is simply to go where it's pointed—and the *pointing* keeps *turning*. Whereas the no-spin

trino gets *sideswiped*, the spinning trino gets *broadsided*. A similar thing happens to the earth as it keeps getting hit from the side opposite the sun. Its original path combines with constant hits from the side to form its orbit. (Before reading the next section consider this: broadsiding = mass.)

Notice again. A hit on a *non-spinning* trino creates a *sine wave*. A hit on a *spinning* trino creates an *orbit*. The orbit of an r-trino is a proton. The orbit of an l-trino is an electron. And an orbit containing one of each is a neutron.

4. Accelerations. This refers to hits on trinos in orbit. When trinos in flight (n-, r-, or l-) hit trinos in orbit (the trinos in electrons, protons, or neutrons), they push. The biggest part of physics lies in this step: mass, energy, gravity, electricity, and magnetism. They're all instances of trinos in flight hitting trinos in orbit.

Notice, here, the reality of 'mass' and 'energy'. The constant broadsiding mentioned above not only produces an orbit, but it also serves to hold that orbit in place. A hit when a trino is on *this* side of its orbit is soon countered by an equal hit when it gets to *the opposite side*, and it *wiggles* in its orbit but doesn't *go* anywhere. Mass is simply a measure of equal oppositions. And *energy* is a measure of *unequal* oppositions. An opposition of 100/100 gives a mass of 100. An opposition of 100/99 gives a *mass* (a *resistance* to acceleration) of 99 plus an *energy* (an *acceleration*) of 1. But notice that push number 100 doesn't know when it's mass and when it's energy. It's us that insist on the difference. With this in mind, try to visualize $e=mc^2$ before you read on. Give up? M is the cross section being bombarded by c against c. The *speed* of the bombardment is 2c, and kinetic energy is proportional to the *square* of the speed.

5. Nuclei (stacks). An electron and a proton chasing each other is something like a dog chasing its tail. The eyes and tail of the dog form an *orbit,* while the electron and proton form a *hydrogen atom*. Both are the result of *chase* plus *lag*. A similar chase takes place between the r-trino of a proton and the l-trino of a neutron. Careful examination shows that this chase will lock the proton and the neutron together.* This produces the *deuterium* nucleus (hydrogen-2). Then, as more and more protons and neutrons join in the chase, they stack up to form higher nuclei. And when a stack gets too high, 'the snake bites its tail' to form a donut. In higher nuclei there are also neutron/neutron locks that are twice as strong as proton/ neutron locks. The former pair has *two* r/l locks; the latter has *one*. The neutron/ neutron lock couldn't exist by itself, though. It would be so powerful that it would tear apart the puny weak force that holds neutrons together in the first place. This would result in two hydrogen atoms.

*To picture the proton/neutron lock, position two quarters (a proton and a neutron) half a circumference apart and consider the 'pull' caused by *chase* plus *lag*. The proton's *r* and the neutron's *l* 'pull' on each other. But, being half a circumference apart, they throw out their 'pull' when they're on one side of their orbit and catch the other's 'pull' when they're on the other. Think of two jugglers interchanging their pins.

Chemistry. See the DNA section of Chapter 5 for details.

6. Atoms, The r-trino of a *neutron* in a proton/neutron lock is 'unused', and it proceeds to 'attract' a free electron outside the stack. This electron goes into orbit around the stack as it continues to fall toward it and miss. A stack with a pattern of electrons chasing it constitutes an atom.

7. Molecules (fits). A *bulge* (electron orbit) of one atom can fit into a *niche* (space between orbits) of another and they snap together to form a molecule.

8. DNA (zippers). Originally, the snapping together of atoms to form molecules was largely a matter of chance. With so many atoms of hydrogen and oxygen bouncing around, it didn't take much to get them together. But the chances of a large molecule falling together were small, and the chances of a *repeat* were infinitesimal. This changed with the appearance of a two-stranded molecule that could unzip and allow both halves to refill their gaping fractures with bits from the surrounding soup. Each half of the zipper acted as a template (more accurately, a selective magnet) that could assemble a zippermate and thus complete two perfect copies of the original molecule. The molecule had reproduced itself. Crystals offer the simplest version of this idea, but DNA shows how far it can go.

9. Assembly lines. What I called 'falling together' above is better described by 'wind and niche' (a tumbleweed keeps blowing until it gets caught in a niche that fits). In much the same way that the DNA molecule reproduces itself, it can also assemble *proteins.* And protein molecules can serve to assemble, in turn, all kinds of other molecules. In this way, my DNA can orchestrate the clicking together of *me.* ('Assemble' isn't really the right word—it implies purpose. The molecules simply have exposed niches. Hundreds of different tumbleweeds might blow right past until one that fits gets trapped in the niche.)

10. Survival (wins). The DNA molecule often gets damaged by cosmic rays or other random events, and it proceeds to assemble a slightly different product (or 'body'). If such bodies have to 'eat' to survive, the damaged ones are more likely inferior and unable to compete with the original ones for available 'food'. They are thus more likely to 'die' before they 'reproduce' themselves, and the change from the damaged DNA molecule is lost. (My damaged DNA molecule might produce children that can't detect light, for example, and they will have less chance of living long enough to pass this new trait on.)

But one in a billion damaged DNA molecules might actually turn out a *superior* body that can outperform the original, and it's the *original* that eventually loses out in the competition to survive. (My 'damaged' DNA molecule might produce children that can detect *radio* waves as well as light waves, for example, and then use this advantage to get more than their share of the food supply.) 'Bad' accidents lose and die out. 'Good' accidents win, survive, and replace. This is Darwin's breakthrough. So simple. So obvious. Yet it adds a *positive direction* to *random change*. And therein lies the crux that eliminates the need for an 'intelligent' act: *positive direction* from *random change.* It's like a cascade. There is no actor. (Like my 3-year-old realization: "I wasn't doing the thinking; the thinking was doing me".) There is no purpose. (Like that wonderful expression: "Shit happens.") So what is it that determines that positive direction? *Survival.* The direction is defined by whatever survives the cascade. *One in a billion* 'good' accidents is very rare indeed, but

over a period of *a billion years* the process can actually produce the human brain. And it's all *by accident!*

The Brain. See Chapter 8 for details.

11. Neurons. As the products from lucky accidents get better and better, a neural network eventually comes into being. It's so successful it continues to outperform and thus outlive its lesser cousins.

12. Experiences (trees). An experience builds a neural tree in this network.

13. Knowledge (circuits). Similar nodes in different trees resonate (emit similar trino-streams that find each other) and jiggle molecules of the soup into connecting strings. In this way all similar nodes get wired into the same circuit.

14. Imagination (lattices). Just as letters from *existing* words can recombine to form *new* words, so can nodes of circuits recombine to form new trees.

15. Reference signals (mifs). A *mif* (mental image flash) is a neural tree built in the lattice. It works like a thermostat to monitor behavior. For speaking, it's the sentence that flashes in your head as you prepare to say it. The *flashed* sentence is the thermostat setting. The *spoken* sentence is the complying thermometer.

'From trinos to mifs in 15 steps.' When physicists speak of a theory of everything, they're thinking only of their four basic forces. But this really *is* a theory of *everything.* Where did it come from? It wasn't a brilliant flash in *my* head, that's for sure. *My* head just served as a receptacle for the following seven ideas to mix in. *And there they mixed for over 20 years!* Like the bouncing atoms of hydrogen and oxygen falling together to form water, all it took was a 'spark' to bring these ideas together to form my 'theory of everything'. Five of these ideas were flashes in five brilliant minds, and two of them were the results of painstaking work by dedicated groups. I'm incapable of such brilliant ideas or such painstaking work myself, but I do experience occasional 'sparks'. I just take what they give me, season it with a spark here and there, and enjoy. Flash, work, and enjoy. Let me give credit.

1. Copernicus and the solar system. Copernicus didn't directly provide any of the 15 steps, but his kind of thinking got the whole thing going—for *me,* anyway. I'll call it step number 0: *We are not the center of the universe.* And I don't just mean our *earth*. I mean our *minds* as well. Just as we use to see the universe revolving around our earth (pre-Copernican astronomy), modern physics still sees the universe as revolving around our minds. For example, Stephen Hawking says that we should cut out all the features of the theory that cannot be observed, and John Wheeler says that a universe without an observer is not a universe at all.

2. Mr. Gravity of about 1750. Richard Feynman doesn't even tell us his name. He just said that this man was the first of many. I mentioned the idea above when I spoke of the apple getting pushed more from above than below. It's a case of shielding portions of the 'cosmic shower'—like a *shadow*. Why was such a brilliant idea immediately dismissed? The blinders of physics wouldn't let it in, that's why. "The earth would be slowed in its orbit as it got hit more from in front than behind," they said. I didn't have their blinders and was able to take this brilliant flash and run right through the first five steps listed above.

3. Charles Darwin and 'natural selection'. Darwin's flash gave me step 10 (Survival). But it's far more pervasive than that. In a way, this idea holds the whole theory together—especially steps 8-15. It's simply the result of a random change followed by a duel to the death. I rank Darwin just ahead of Copernicus and Mr. Gravity in my big three.

4. The DNA story. Jim Watson and Francis Crick started it, but the whole story was filled out by many others.

5. David Hubel and 'neural trees'. Hubel was the one who first caught my attention, but the painstaking work was done by lots of people.

6. Stephen Krashen and 'natural language acquisition.' This was the idea that changed my professional life. It can be reduced to this. 'Don't *try*; *let*.' Or 'language isn't *pushed*, it *falls'*, to reapply the Darwin principle. 'Instead of *studying,* you just experience happenings in the language—it's like being caught in a *cascade*. You don't do anything; it's does you. And instead of *trying* to speak, you just let it *emerge*. (I had it right at age 3 when I thought, "I'm not doing the thinking, it's doing me." It was my 10 years of developing Krashen's idea that led to steps 12 through 15.

7. William Powers and 'control theory.' I had based language learning on practice throughout my professional life. It was Powers' idea that busted this ghost for good. Krashen had said that 'speech emerges'. Powers showed how. The key to behavior is his 'reference signals'. This is what I've been calling 'mifs' (step 15).

Now suppose you put all of these ideas in the head of a reality freak who was just aching for a 20-year binge but not smart enough to make his own stuff. What would you get? 'From trinos to mifs in 15 steps,' that's what. It'll happen every time.

But are these 15 steps 'right'?
Of course not. We can never know what's really there. These ideas are simply a model that I'm using to think with.

Do they 'work'?
Not always. I keep finding holes myself—even as I write.

Then what good are they?
They're going in the right direction. Like evolution, they have constraints that are self-corrective. Unlike ghost-based theories, any new guess we make to explain a certain point must become part of the overall scheme. If a new guess explains one point but destroys another, it can't survive. Compare successful *accidents* of evolution with successful *guesses* of theory building. The new accident or the new guess must improve the overall scheme in order to survive.

The whole book is devoted to showing that my ideas, as faulty as they may be at times, are moving in the right direction. But the purpose of this overview is simply to give a *feeling* for what the book is trying to do—not the *details*. For this, I'll just call up some of the more obvious examples of three different kinds of evidence. 1) Clearing ghosts, 2) explaining mysteries, and 3) achieving practical success.

1. Clearing Ghosts

The following examples are chosen for ease of explanation. Gravity, for example, can be explained in two or three sentences, while electricity would take more than a page. But for clearer explanations of all of them, you should refer to pertinent parts of the book.

Mass and Energy. Electrons, protons, and neutrons are orbiting trinos that are held in orbit by hits from the outside (the cosmic wind). When you hold a billiard ball with equal pressure from thumb and forefinger, it's held stationary in place; and the greater the equal pressure, the more tightly it's held. Mass is a measure of how tightly it's held. Now if you increase the pressure from the thumb or decrease the pressure from the forefinger, the ball will move in the direction of the forefinger. The *difference* is a measure of *energy*. Mass is *opposed* hits that *hold* it in place; energy is *unopposed* hits that *move* it.

Kinetic Energy. As long as an orbit is being hit equally from all sides, the orbit will be circular and it will stay in place. The unopposed hit mentioned above (the acceleration) doesn't *move* the orbit; it simply *changes its shape* from *circle* to *pear*. And the narrow end of the pear then gets less 90^o hits from the headwind than the broad end (see illustrations in the appendix). The prevailing wind that was holding the circle in place now holds the *motion* in place, so to speak. The continued motion isn't caused by a ghost (the 'kinetic energy' of conventional physics). It's caused by the prevailing winds of the cosmic shower. The acceleration merely streamlined the orbit in the direction of its hit. It's the unequal hits from the *wind* that continue to move it. The secret lies in the 'fact' that trinos hit only at 90^o. And notice that the guess of the 90^o hit wasn't made just to explain kinetic energy. It's a good example of a successful guess that continues to survive the test of the entire scheme.

Notice again. The unopposed hit changes the *shape* of the orbit while the prevailing cosmic wind causes the *motion*. This explains Galileo's famous principle: 'without friction, motion is forever'.

To determine the kinetic energy of any orbit of trinos, just inspect the shape and direction of the pear. And notice that any new acceleration on any part of the pear simply serves to reshape it.

Gravity. An apple in open space would get hit equally from all sides. But with the earth nearby, some of the hits coming that way get strained out. The unopposed hits from 'above' become energy, and this is what pushes the apple toward the earth. (In keeping with the section on kinetic energy above, 'push' is a short way of saying 'shapes the appropriate pear'.)

The Weak Force. The neutron consists of an r- and an l-trino across from each other in the same orbit. They pull on each other, but due to lag, the mutual attraction does not come from strong 90^o hits (which is about 10^{38} times as strong as gravity). This greatly reduced electric force between r- and l-trinos is the 'weak force' (which is about 10^{25} times as strong as gravity).

The Nuclear Force. The proton and neutron in a deuterium nucleus are held together by the electric force between the r-trino of the proton and the l-trino of the neutron plus the gravity beams of 3671 r-trinos. (Gravity 'beams' may be as much as 10^{20} times as strong as the usual gravity 'flicker'.)

Experience and Knowledge. An experience is the neural tree built by a happening. Knowledge consists of circuits connecting similarities between experiences.

Thinking. Electric sparks traveling through the net of experiences and knowledge constitute 'thinking'. It's like the bouncing ball in a sing-along. Or like flashing a flashlight around in a forest.

Memory. A *stored* memory is simply an experience tree. A *recalled* memory is an experience tree that has been lit up by a flashlight (thinking). Some trees, like perceptions of pictures, exist in only a few copies and soon die out. These are *short-term* memories. Others, like perceptions of happenings, have thousands of copies and can last forever. These are *long-term* memories. At the rate neurons die, 90 years later there could still be 750 copies left from an original 1,000.

Words. A word is a circuit that connects similar nodes of experience trees. (This is a short definition. For a more complete definition, see the section on 'How can children learn …' further on.)

2. Explaining Mysteries

As before, the following examples are chosen for ease of explanation.

Why isn't the earth slowed down by the 'wind'? Most of the mysteries discussed below are left unexplained by physicists and are used as evidence of the limitations of the human brain. But this one was no mystery. They simply dismissed it. They said that the earth isn't slowed down because there *is* no wind. Since I accept the wind theory of gravity, it *was* a mystery to *me*, and had to be explained. Like this.

As the orbit (the electron, proton, or neutron) moves faster and gets more hits from the front per nanosecond, the pear's small end gets narrower and receives less of them. The balance is perfect. The more due to *fast*, the fewer due to *narrow* (see illustration in the appendix). The earth is composed of pears pointing in the direction of its motion (that is, they all have this *component* in addition to all of their other shaping components.)

Why don't orbiting electrons crash into the nucleus? (I take 'atomic orbit' to mean 'back and forth', not 'round and round'.) The electron is flipping as it falls to the nucleus, and the spin and fall are in sync. As the electron approaches the nucleus, it is *edge-on* and is thus getting minimal pull. Its momentum exceeds the pull and it coasts right on past. But as the electron's flip continues and it approaches an orientation that is *face-on* to the nucleus, the pull gets greater and greater. This pull checks the momentum and starts pulling back. To get a picture of the acceleration back and forth, just look at the pendulum of a grandfather's clock. Now see the end of the pendulum as a flipping coin that is edge-on at the bottom of the swing and face-on at the ends.

How can light behave like both a particle and a wave? A photon is a non-spinning trino that got jolted free from the electron in which it was stowing away (see appendix). The jolt gives it a transverse acceleration proportional to the strength of the jolt. This acceleration changes the straight-line path into a sine wave. A photon is a graviton that has been tweaked from the side. That's the *particle* of light. But what about the *wave?*

Jolts often come from rhythmic happenings, like electrons being jostled in a pulsating force field. Picture the drops of water dislodged by rhythmic flicks of a wet towel or by the rhythmic release of your thumb on a nozzle. Watch the groupings of water drops as they leave the hose in evenly spaced batches. Now imagine the drops moving as squiggles instead of lines and measure all the forces they release as they hit a wall. The *batches* carry *waves of pushes* that push from the side instead of straight ahead. The whole event is a *longitudinal wave* of *transverse particles* (the *transverse pushes* coming in rhythmic *longitudinal batches).*

How can an electron behave like both a particle and a wave? An electron 'emits' only l-trinos (see appendix for the source of these trinos) and it's always flipping like a coin—an automatic reaction to the orbiting motion of the electron's trino). Think of trinos coming from a coin flipping in front of you and notice that you receive a lot more of these trinos when the flip is face-on than when it's edge-on. These trinos come at you in rhythmic waves—like the 'waves' of water produced by a rhythmic release of thumb on nozzle.

Now watch an electron moving towards two holes in a wall. The rhythmic waves of l-trinos will move ahead of the electron and go through the holes as waves. These waves of l-trinos will then hit a second wall with the distribution of waves and rebound as waves of *r*-trinos. (Watch a left spin rebound from a wall, then get behind it as it comes back and watch it spin *right*.) When the electron later passes through one of the holes, it will be met by waves of r-trinos (its own l-trinos coming back). And these r-trinos will pull it to the points they came from. That is, to those points with wave-like distribution on the second wall. A shower of electrons will thus hit the sec-

ond wall with the distribution of waves, not particles—no matter which hole they passed through. *The trinos move as waves; the electrons move as particles pulled by waves.*

How can protons exist together in the nucleus? Recall what I said above about stacks of protons and neutrons in the nucleus. Just picture two football players passing their footballs to each other as they run in opposite directions on parallel lines. You can imagine a spacing and timing such that they would each pass their ball to the other at right angles to their run. It's all a matter of 'lead'.

The *r* of a proton and the *l* of a neutron are like these two football players. They're just passing their 'pulls' to each other from parallel orbits (visualize two parallel quarters). Now add the following two points to the comparison. First, the footballs and the passers would be moving at the same speed; and second, the players can only pass and receive at right angles to their run. Try this. Put a plus and a minus on opposite ends of one quarter and a plus on one end of another. Then space the quarters half a circumference apart with plus above plus and watch the neutron's minus and the proton's plus repeatedly pass footballs to each other as they go round and round.

This passing and catching of 'pulls' is the biggest part of the nuclear force. But what about the footballs from the *neutron's* plus? Because of the timing they never reach the proton's plus. There's nobody on the field to catch them and they go off into the stands. This 'pull' gets caught by an outside electron which then proceeds to chase the quarters and continues to receive passes from them—just like a dog chasing its tail. That is, it falls into an atomic orbit around them.

What determines the life span of radioactive nuclei? I think the story of sodium-24 (a radioactive nucleus made by artificial bombardment) changing to magnesium-24 is especially clear.

We bombard ourselves up a sample of sodium-24 and watch what happens. Electrons start popping out all over; and after 15 hours, half of the sample remains as sodium-24 while the other half has changed to magnesium-24. The only thing that separates Mg-24 from Na-24 is one little *l-trino* in one of the sodium neutrons. It's already teetering and ready to go. Let's watch as it teeters.

The *l-trino* of that neutron is held in place by the sum total of all the forces of the nucleus and surrounding electrons. Look at the sources of the various forces that act on it. The dancing electrons out in the atomic orbits are sending it an ever-changing mixture of forces *as they dance*. The writhing hoop of the nucleus is sending it an ever-changing mixture of forces *as it writhes*. And our little *l-trino* is receiving this kaleidoscope from a different angle every instant that it *swooshes* around in its neutron. The dancing, the writhing, and the swooshing are all independent, and the different combinations of these forces at any given instant are both infinite and random (for all practical purposes). But the electron was already teetering and sooner or later there would come, from among that infinity of random forces, a certain combination that would knock it out of its neutron and into an atomic orbit. *Pop!*

On an average it takes about 15 hours, but it could have happened in a nanosecond and it could have taken years. It just depends on the *odds* of getting the right step of the dance, the right bend of the writhe, and the right point in the swoosh coming together at the same time. Think of bumping into someone on the dance floor. It will happen some day—but when? It just depends on the odds of all the contributing factors coming together at the same time. Of course some dancers are more 'radioactive' than others.

How can mass increase with velocity? The answer comes from the idea of *Doppler mass*. Let's see what that means. Mass was defined above as 'opposed hits that hold an object in place'. Think of it like this. Trinos hitting from opposite directions take each other out and leave holes in their respective trino streams—like beads being knocked out of their string and leaving empty spaces. Holes are like shadows. Our own shadow is the hole we make in the rays of light that hit us. With our shadow in *front* of us, we feel the sun at our *back*. And with the earth's hole *underneath* us, we feel the gravitational push from *above*. We can thus measure an object's mass by the number of holes it sends us; that is, by the number of empty spaces in the string of beads coming at us. Remember now, for every string of beads with holes coming this way, there is a string *without* holes coming the opposite way. And the force we feel is 'bead against hole'. The earth is sending us lots of holes, and the number of those holes is a measure of the earth's mass.

Let's measure, in our heads, the mass of an electron—first at rest and then as it approaches us. Suppose that when the electron is at rest, it sends us one little hole every nanosecond. We can say that its mass is one hole per nanosecond.

Now look what happens when this electron comes towards us at high speed. After one hole is created and comes our way, the next hole has less distance to travel and arrives early. Let's say we're now receiving holes at the rate of *two* per nanosecond. But that's exactly what we would be getting from *two* stationary electrons. The *apparent* mass has doubled. It's the same phenomenon as the pitch of the whistle from an approaching train or the color of the light from an approaching star. It's Doppler mass.

The physicist measures the holes in the *shower*—holes that *arrive* at two per nanosecond. He's got relativity problems. I measure the holes in *reality*—holes that are *produced* at one per nanosecond. And how do I do this? I measure the *model* in my head. I don't find any increase in the mass of the electron—only in its effect on *me*. *And,* as Copernicus says, *I'm not the center of the universe.*

Here's the underlying fact that explains most of relativity. Trinos are our only contact with the universe out there. They're the only things that can get to us. Whenever we think we're seeing and measuring things out there, all we're really seeing and measuring are the trinos they send us. That sentence is key to everything. *All that we're ever seeing and measuring are the trinos they send us.*

As with Doppler mass, once we guess the reality behind time, we will be able to explain 'time slowing down or speeding up' as Doppler time.

How can children learn all the complications of language in such a short time? Noam Chomsky gives his famous answer. "Language is innate." That is, all kids are born with the basic structure, and different languages just fill in different details. But this is so obviously true that saying it can give the wrong impression. *Of course* all humans are born with the same kind of brain that human language *evolved* in. (The brain with the 'wh' rooms; the brain with neural trees and circuits.) Any human language that enters the head thus finds a perfect fit and falls into the waiting slots (assuming, of course, that it comes in as part of an experience). Non-human languages would just blow on by.

Let me give a more meaningful answer to the question. Here's a crucial sentence I used earlier to sum up how three-year-old Joey managed to use an intonation of 'surprised disbelief'. "He hadn't *learned it*—he just *looked it up and copied it*—and the appropriate spotlight was *determined by the very reason for the search."* Let me take the sentence part by part.

1. "He hadn't learned it." So let's get rid of the ghost 'learn' and ask how children *grow* languages so fast. And while we're at it, let's try to get rid of that overriding human bias and compare this with "How can a seed grow a flower so fast?"

As complicated as the process is (for both flowers and languages), it all boils down to 'wind and niche'. With *seeds*, the 'wind' (water, sun, and soil) blows through the seed's characteristic 'niches' (its DNA), and the flowers just fall together. With *languages*, the 'wind' (experiences) blows through the brain's characteristic 'niches' (its neural trees and circuits), and the language just falls together. The children don't *learn* those unknowns created by linguists (like 'words' and 'rules') any more than seeds *learn* those unknowns created by botanists (like 'germinate', 'sprout', and 'bloom'). Children, like seeds, can respond only to *reality*. They see something happen, and a neural tree grows.

2. "He just looked it up and copied it", But out of the millions of trees he had grown, how did he 'find' the one he 'wanted'? It's clearly not enough that the children grow a neural tree for every experience. They also need something like a search engine. Their present 'need' has to lead to the 'appropriate' tree. But this is so much clearer if we put it all in the passive voice (remove 'he' from the subject position) and get rid of those ghosts in single quotes ('find', 'wanted', 'need', 'appropriate'). This is the insight I had realized by age three when I thought, "I'm not doing the thinking; the thinking's doing me." Anyway, it's done with circuits. And the circuits, like the trees, aren't learned. They *grow*. Every node of every tree sends out characteristic rays of trinos. Like rays resonate and jiggle molecules of the soup together to form the wires of a circuit. While every neural tree is growing, it is also hooking into the rest of the forest. And every part of every tree can then be accessed from any other similar part in the forest.

3. "The appropriate spotlight was determined by the very reason for the search."

What's the reality behind the word 'reason' here? Compare 'seeing' and 'thinking'. Of all the things that are going on 'out there', some of them are 'noticed' (they enter our eyes). Of all the things that are going on 'in here' (sparks dashing around through our forest), some of them are 'noticed' (they enter our neural lattice). And just as things that are noticed 'out there' proceed to grow a tree, so do things that are noticed 'in here'. We call the former trees 'perceptions' and the latter trees 'imagination'. But they both consist of nodes and circuits. Imagination trees just eliminate the outermost level: the eyes. From there on, the makeup of perceptions and imagination is identical. Sometimes we even 'imagine' an outer level for imaginations when we speak of 'the mind's eye'. The tree of the sister's behavior was a *perceived* tree. The tree behind Joey's 'planned' behavior was an *imagined* tree. But both trees had a similar node: 'surprised disbelief'—and, like all similar nodes, they hooked up. And so we see how *"the appropriate spotlight was determined by the very reason for the search."*

Here's the full story of Joey's use of that special intonation. Something *was seen* (his sister talking) and a neural tree grew. Something *was thought* (himself talking) and a neural tree grew. A circuit then grew to connect similar parts of the two trees, and the intonation was copied from the former to the latter. In this way it became part of the mif that was needed to speak with. Only one step remained, and that step had been provided for way back in Joey's 'babbling stage' when the machinery was built that could 'turn a mif into speech'. Now all the necessary steps were in place, and Joey spoke his sentence with the 'desired' intonation. Stephen Krashen summed all of this up in two words: "Speech emerges."

The example of Joey's intonation points to a whole new vision of linguistics. A word appears in a happening, becomes a node in a neural tree, and proceeds to make connections in dozens of different directions at the same time. The field of the new linguistics lies in those 'directions'. The nature of this complex circuitry will emerge as we develop the new linguistics, and I won't even guess at it now. Instead I'll use some of those 'unknowns created by the old linguistics' (their ghosts) to point to (not explain) what I mean.

> A 'bird' node in a particular tree (like "Look at that bird") could have one line that links it to everything with the same *sound*, another to everything with the same *meaning*, and another to everything with the same *grammar*. But it goes much further than this. There could be one line connecting it to all winged animals, another to all animals, and another to all living things. There could be a line to all nouns, all count nouns, all sentence subjects, all sentence objects, and so on and on. Each of the node's characteristics has its own frequency, and each one of these could seek out its own kind and hook up with it ('build associations'). Think of meeting a woman and immediately hooking her into the forest of all the women you know. You would see all women who looked like her along one line, all those with similar personalities along another, and all those who behaved like her along still another. Compare the woman's looks with the word's sounds, her personality with the word's meaning, and her behavior with the word's grammar.

Now let's look at another episode in the daily life of little Joey as a more detailed example of how trees and circuits grow.

Picture this. Little Joey has just done something bad and his older sister tells mom, "I saw him do it." Look at the size of the tree that grows in his head. It's got all those powerful '*wh'* branches. *What* did he do? *Where* did it take place? *When* did it happen? *Who* was in the room, and exactly *where* in the room were they? *What* did his sister say? *What* was her tone of voice, her facial expressions, and actions? *What* did mom say and do? It's all in the tree. And much more.

But now focus on the nodes as they grow circuits. The tree is composed wholly of perceptions that converge successively at nodes (see 'Neural Trees and Wheels' in chapter 8). Keep your eyes on those nodes as they shoot out *feelers*. The sheer number of the creeping feelers makes the tree itself seem small (for every line of the tree growing *up and down*, there are *dozens* of lines growing *out*, see 'Neural Shine' in Chapter 8). But now add *this* to your picture. That tree had been branching off into thousands of copies as it was growing (see 'Neural Forks' in chapter 8). And every one of those copies had been shooting out its own mass of creeping feelers. That one little experience had taken just a few seconds, but it had ignited a fireworks display the size of a city. It boggles the mind. It *is* the mind.

Let's now zoom in on a single node of a single copy and take a look. We start with the node 'what the sister said'. We then focus further down on the node 'saw' and watch its feelers creep—especially the feelers for sounds, meaning, and grammar. The word's *sounds* quickly join a circuit that includes 'see-saw-seen' as it passes through other trees. Its *meaning* is simply the 'part' it plays in the happening, and the feeler for that particular part proceeds to link up with all similar parts in the forest (all other instances of 'seeing', like 'look', 'notice', 'watch', and 'stare'). Finally, its *grammar* consists of circuits that include all words that *behave* similarly. Not just the class of *verbs*, but also *sub-classes* all the way down to those verbs that can appear in the construction 'I *saw* him do it' (like 'heard', 'made', and 'let'), as opposed to constructions like 'I *told* him to do it' or 'I *said* he did it'. That single node of that single copy has vertical connections that anchor it in its tree: 'Joey's awkward experience'. But now we're focussing on the feelers—the *horizontal* connections. Those feelers are driven by 'resonance' as they shoot out 'in search of' similar 'vibes' to establish 'associations'. *That particular use of the word 'saw' very quickly gets wired into the circuitry that is 'Joey's language'.*

Now let's return to our question. How can kids learn a language so fast? Steven Pinker gives his answer in chapter 9 of his book **The Language Instinct.** He gives the example of 'The big dog ate ice cream', and he marvels at the 'amazing power' whereby the child could *learn* three rules and five words from this single sentence in context. "But amazing power is what the real-life child needs to learn grammar so quickly," he says. Compare *his* 'amazing power' with *ours:* a thousand copies of a detailed happening in which every node connects up with everything similar in the child's entire life. For the rest of little Joey's life, that experience—along with that sentence—will be *on file* to be used 'as needed'. The 'amazing power' lies in the breadth of that file and the speed with which it can be accessed.

Here's what I think happens when we set out to say something. First we 'picture' a happening that we want to 'put into words'. It may be a happening that is already stored in our forest (we're relating an experience) or it may be one that we 'imagine' (one that we have assembled in our lat-

tice). Then once we have a picture lit up in our heads, a spark proceeds to shoot through the circuitry looking for similar pictures—together with the speech they contain. We take a word from one picture, a pattern from another, an intonation from another, and so on—as we assemble our sentence. The search is usually so fast we aren't aware of it (Joey went straight to his sister's intonation in a split second). But not always. Sometimes we can feel ourselves grope. Think of a *delayed* search in understanding: the 'double take' (as in the joke, "A man walked into a bar….. He should have seen it coming"). Think of a *delayed* search in speaking: the 'uh..uh..uh' phenomenon. And think of a *delayed* search while offering native speaker's judgment (Can you say "I saw him do it"? Yes. "I saw him to do it"? No. "I helped him do it"? Yes. "I helped him to do it"? Uh...). What we can occasionally detect in slow motion is normally too fast to catch. Think of a spinning wheel. We don't even know it *has* spokes until it slows down.

3. Practical Success

Our model for language learning was based on how toddlers do it. Then we had to show that adults don't lose the magic and we found people like Zambi. Next we asked what toddlers and Zambi had in common and found these two things. (I've referred to them elsewhere as Zambi's two rules—or secrets.)

1. At least a year of experiencing real happenings in the language.
2. With attention only on the happenings—not the language.

And when I looked through a lifetime of watching people learn languages, I found that the closer they came to these two rules, the better they did. (Look at the various 'cascades' described in chapter 4.) We can reduce the two rules to a single motto. *Exposure Without Thinking.*

Toddlers can't go *wrong* (they *can't* think about the language), and *study* can't go *right* (thinking is the very *substance* of study). So what happens to all those adults who don't study but are exposed to life in the language? How do they manage to mess things up so badly? They usually *think*, *ask*, and *try to speak*—that's how.

Look again at the stories of Zambi and Mary in the introduction. Zambi almost *had* to succeed (she *couldn't* ask or speak). And Mary almost *had* to fail (she couldn't *keep from* asking and speaking). The question is, then, can we *plan* Zambi-type situations and put them in a classroom? That's what chapter 7 is all about. We tried to do this for over 10 years at AUA. How did we make out?

First we should ask how we can *tell* how we made out. Traditional testing only tests what we learn by thinking. But Zambi didn't learn by thinking. She learned by *growing* (and we wouldn't even think of testing *her*—any more than we would think of testing a three-year-old). And how can we tell how well something has grown? We *look at* it. If one of two rose bushes has grown better than the other, it's easy to see. And when it's too close to call, an expert *observer* might be

needed. But not a *test*. Well I happen to be an expert observer for high levels of competence in Thai. I've got an internal meter that can measure it. Let me tell you about it.

I found long ago that whenever I was in a Thai-speaking group together with other foreigners, I could easily tell whether they were better or worse than me. When I could see what they were trying to say, I would be flashing my own internal speaking (*mifs)*, and I could easily see how my mifs compared to theirs. Was I faster or slower than them? Better or worse? Of course anyone could do the same thing for their own range. We've all got such a meter. It just happened that *my* meter was on a crucial dividing line. Here's how this came about.

In 1949, I set out to prove the Army Method of learning languages: *Practice until you get it perfect and then immerse yourself in the country for a year*. That's what they told me, and that's what I set out to do. Being a linguist and learning from a linguist, I was able to practice to perfection. And not for 1 year, but for 4! Then I immersed myself in Thailand. And not for 1 year, but for 40! I may have the dubious distinction of being the world's best at doing the wrong thing. And that's the crucial dividing line I'm talking about. If I was indeed the best at doing it wrong, then anyone better must have been doing something right.

For over 20 years I sat on that dividing line at the linguistic center of Thailand, and I observed hundreds of foreigners speaking Thai. Some of them had studied in the *big* courses (like FSI in Washington or DLI in Monterey), and a few of *these* had stayed on for years. Some had taken the little courses (like Peace Corps, AFS, and Mormon missionaries), and a few had stayed for years. Some had lived in Thai institutions (like a Buddhist temple or a Thai boxing camp) and stayed for years. Most of AUA's teachers of English had married Thai men and had moved to Thailand permanently (like Mary). And, finally, many had just picked Thai up in the streets. For over 20 years all such foreigner talk registered on my meter. And whenever the meter showed 'better than me', it rang a bell. My bell was the perfect measure of high level competence. And here's what I found.

If I define a 'student' as someone who studied the language for over a hundred hours, I can safely say that no 'student' ever rang my bell. Even after decades of immersion. But many *'non-students'* did. While I may have been the best '*student'* of Thai, I was far from the best 'foreign *speaker'*. Here's what's happening. As long as we insist on looking for the best way to *study* a language, I had proved my way was best. But why should we be looking for the best way to *study* a language? Surely we're more interested in 'better language *use'* than 'better language *study'*. (So obvious, and yet it had me deceived for over 30 years.) Anyway, every time I heard a bell, I came to assume this. The speaker had been through little or no study followed by large amounts of listening with little or no speaking (like all children). That was my assumption. And whenever I was able to check this out, I was right (see the cascades of chapter 4).

Back to the question. After trying for 10 years to emulate Zambi, how did we do? Let's leave it up to my bell. During my 30 years of teaching to 'Marys', I never had a single student who passed me up. But after 10 years of teaching to 'Zambis', I see them passing me up all the time. When I go back to AUA for a visit now, I hear bells. And I take each 'bell' to mean 'success'. So

it's clear that our method *can* work. It just has to be done *long enough* and *right enough.* The only questions now are 'how long' and 'how many'. That is, 'how *long* does it take to succeed?' And of those who continue long enough, 'how many are able to do it *right* enough?'

How long? Our first success story came in 1988 when our course had grown to a full year. He was the first 'student' to pass me up. It took him about 5 years (one year of class plus 4 years of partial immersion). The most recent success story that I noticed was in 2001—after our course had reached new heights. It took her 2½ years (1½ years of class plus 1 year of partial immersion). And this is the current state of the art: 2½ years.

Remember now, I'm talking about a level *above me*. Her 2½ years had overtaken my 40! Notice also that my 'bell test' could only come at some time after a student had finished our course; that is, after a certain amount of immersion. It just so happened that the two people mentioned above worked in our department after their course and we were thus able to observe their immersion.

How many? Our real successes are limited in number. Of the thousands who have attended our classes, as of 2001 less than a hundred had reached 1800 hours, (Don't be put off by the number '1800 hours'. The same stage for an English speaker learning French could be reached in about 800 hours. See 'Measuring Learning' in Chapter 7.) And that's not because they got tired or gave up. Most of them loved the classes and hated to leave. It's just the nature of our market. Most students have neither the time nor the need to go all the way. So if we want to measure our success rate, we'll have to look only at those who stayed *long* enough and see how many of *them* were able to do it *right* enough. And we've defined 'doing it right' to mean 'not thinking about the language'.

> Let me clarify the source of this damaging factor—this 'thinking about the language'. There are two main kinds of 'thinkers'.
>
> First, there are people who, like me, can't *keep* from thinking about the language. (How can a *linguist* hear a new language without noticing interesting things about it?) The best we can do is to make the happenings so overpowering that they drown out the language. This sometimes happened even to me. When the two old ladies from Swatow got mad and started screaming at each other, for example, I certainly wasn't analyzing Swatow as I tried to calm them down.
>
> And then there are the students who just can't resist trying out the language in the streets before it comes by itself—and our evidence indicates that 'thought-up language' causes lasting damage. But how can we keep them from speaking in the streets? Here's one way. Teach Thai in a place like Monterey or Washington instead of Bangkok.

So the question is this. Of those who have been through at least 1800 hours of our course, how many were able to keep from thinking about the language? Our guess is about one-third. So, presumably, if we had one of those big courses where all students were there for the duration, one-third of them would *succeed*. This means that after a year and a half of the course, followed by a year of partial immersion, they would be doing better than *any* amount of traditional study with *any* amount of immersion has ever managed to produce. And what about the other two-thirds? They would be speaking as well as their traditional counterparts but their understanding would be far better.

Let me end this chapter on Reality with this. I looked behind our success and found mifs. I looked behind mifs and found neural trees made in neural lattices. And I kept looking in back of step after step until I got to trinos. From mifs back to trinos in 15 steps. Therein lies the reality behind language learning.

And where did this discovery come from? Brilliant flashes in five great minds; painstaking work from many dedicated people; and a few sparks as a reality nut played around with it all. Flash, work, play, and spark.

Appendix
The Cosmic Shower

This appendix takes up where the section on physics in Chapter 5 left off. It starts off with some points to help follow the presentation and then proceeds on to my answers to 11 basic questions.

Trinos and Trons

The first thing to get used to is that there is nothing in the universe except those little specks, and they all have exactly the same size and speed. If they move straight ahead (like the 'i' in 'trino'), I call them 'trinos'. If they move around in circles (like the 'o' in 'tron'), I call them 'trons'. Trinos are our only contact with the universe out there. They're the only things that can get to us. Whenever we think we're seeing and measuring trons out there, all we're seeing and measuring are the trinos they send us. That sentence is key to it all and bears repeating. *All that we're ever seeing and measuring are the trinos they send us.*

Spin

Right and left spin always have something to do with plus and minus electricity. Get used to it. Whenever you see an *r* or an *l*, it's got to do with the electric force. The trinos that come to us can have right spin, left spin, or no spin at all; and I'm going to call them *r-trinos*, *l-trinos,* and *n-trinos.* The *r's* and *l"*s bring us their spin (electric forces), and the *n*'s bring us only their push (gravity).

The same three kinds of trinos can go around in circles and comprise *r-trons*, *l-trons*, and *n-trons*. An *r-trino* in orbit is an *r-tron* and the whole orbit is a proton. An *l-trino* in orbit is an *l-tron* and the whole orbit is an electron. An *r-tron* and an *l-tron* in the *same* orbit constitute a neutron. *N-trinos* can only enter orbits as passengers. They are *n-trons. R-* and *l-trinos transport* electricity (along the 'i' in their name), *r-* and *l-trons contain* electricity (inside the 'o' of their name). All this loose talk is only to help you get a handle on the new terminology. And you shouldn't necessarily try to find equivalents for these trinos and trons among the units in conventional physics.

The Photon

When spinning trinos get hit from the side, their axis turns and they go into orbit. But when an *n*-trino gets hit from the side, it *careens*, *bounces,* and *oscillates* as it moves ahead. It becomes a photon. So how does an *n*-trino get into orbit and become an *n-tron*? It simply falls into the ready-made orbit of an *r-* or *l*-trino and proceeds to get the battering of a trino out of its lane. One final note. While trinos and trons all move at *c, orbits* can stand still or move at any speed up to *c*.

Lag
It takes time for the force carried by a trino to reach us. A trino will 'pull' us in the direction it came from, even though the source is no longer there. The earth, for example, is being 'pulled' to where the sun was nine minutes ago.

Rebounds
When an *r-trino* rebounds, it becomes an *l-trino*; and vice versa. Watch a *left* spin hit a wall in front of you. When it rebounds, get in back of it and see it spin *right*.

Push and Pull
There's no such thing as 'attraction'. I can't even imagine the reality of such an operation. Gravity, for example, isn't a *pull*—it's the blocking of a *push*. For ease of understanding, however, I'll use words like 'attract' and 'pull' as a shortcut. As long as we know what we mean, it's so much easier to say things like 'an electron attracts a proton' than to struggle with the wording of the reality. I'll use the word 'pull' only when it won't cause trouble (as in the above section on 'lag').

Trino Hits
Trinos can hit each other only from right angles to their motion. The *reason* for this assumption is simply that it's the only way I can make the whole scheme work. But of course I can't let an assumption go without an attempt at an explanation, and the explanation is already hovering. Instead of asking why trinos can hit each other from right angles, we should ask why they *can't* hit each other from other angles. I'm looking for some kind of relationship between the size and the speed of trinos that keeps them from hitting each other. That is, given their size (say, 10^{-40} cm), there exists one and only one speed (say, 300,000 km per second) at which they aren't even aware of each other (they're in different worlds, so to speak). I can't imagine why this might be, and that's why I'm looking. But let's accept it for a minute and then look at the special characteristic of 90^{o}. When one trino chases another, their relative speed is zero and they can't meet. When they approach each other head-on, their relative speed is $2c$ and they can't *find* each other. Only at 90^{o} is their relative speed c, and only at this relative speed do they 'enter the same world'. Trinos with all other speeds will have long since blasted each other out of existence.

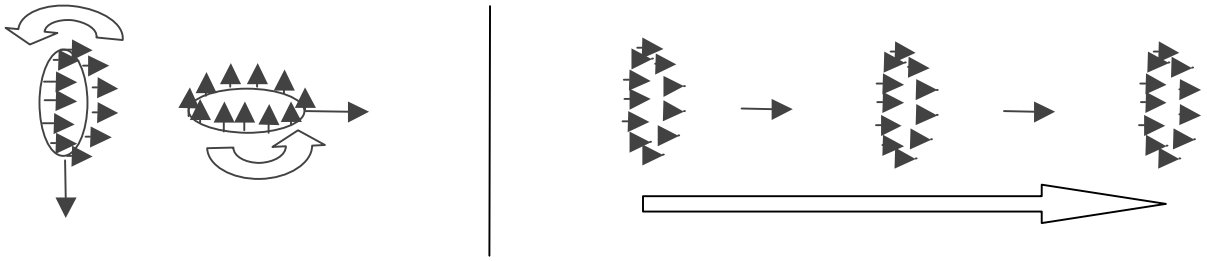
The 11 Questions

0. Gravity, light, electricity, electrons, protons.
These are all covered by the *cosmic shower* described in 'the blinding flash' in the section called 'Physics' of Chapter 5.

1. Why do electrons sometimes behave like waves?
Here's Feynman's famous experiment. He imagines two parallel walls. The first wall has two holes through which bullets or water waves can pass. The second wall catches and records the bullets and waves that pass through the holes. Bullets show one distribution of hits, and waves

show another. Electrons hit the wall with the distribution of waves instead of bullets. Why? Feynman says it can't be explained. That's just the way the universe works.

I explain it like this. An electron emits only *l-trinos*. (*L-trinos* that hit it pass right through and emerge as *l-trinos*, while *r-trinos* rebound as *l-trinos*.) As the electrons approach the first wall, they're preceded by their *l-trinos*. Now the electron is always flipping like a coin, and from this flipping coin, the *l-trinos* will be emerging in spurts. It's like water from a hose that is rhythmically cut off by your thumb; or, more accurately, it's like the spurts that arrive at a given point from a rotating nozzle. The flipping electron is shown below left. When it's facing to the right, it's sending eleven arrows (trinos) to the right. When it's facing straight up, it's sending only one arrow to the right. The spurts are shown below right. The three spurts shown came from three successive flips.



The Flips **The Spurts**

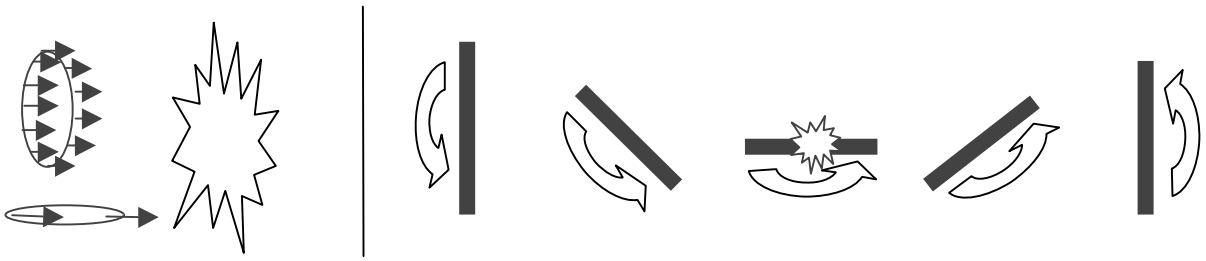
These spurts pass through the holes in Feynman's first wall like waves—with reinforcement and interference. They are waves of *l-trinos,* and when they rebound from the second wall they become waves of *r-trinos*. Then, when an electron comes through either one of the holes, it's met by it's own waves of *l-trinos* that have become *r-trinos.* And these *r-trinos* 'attract' the electron to their point of rebound. They hit the second wall with the distribution of waves because they are being pulled there by waves.

2. Why don't the electrons in an atom crash into the nucleus?

In one place Feynman blames it on *the Pauli exclusion principle* and in another place he blames it on *the uncertainty principle*. "The uncertainty principle says that we can't know both the location and the motion of a particle. If the electron were in the nucleus we would know its position precisely and the uncertainty principle would then require that it would have a very large (but uncertain) momentum with which it would break away." I don't pretend to understand explanations like this. I can only picture *things* happening—not *principles*.

Here's my kind of explaining. Picture the single electron of the hydrogen atom as a coin flipping near the nucleus. It falls toward the nucleus, flipping as it goes, but misses. You see it was being 'pulled' toward the spot where the nucleus was a nanosecond before. It coasts by at top speed but immediately starts getting pulled back. Keep your eyes on the flip and notice that when the coin is face-on to the nucleus it gets a lot more pull than when it's edge-on. This was explained in the preceding point and is shown again below left. Now imagine a proton (the hydrogen nu-

cleus, shown as a star) in front of you with an electron spinning as it orbits (the 'orbit' is back and forth, not round and round, see below right). Take a saucer (as the electron) and regulate the timing of orbit and flip. Face-on (to the nucleus) at the left, edge-on at the center, face-on at the right, and so on back and forth. One flip per orbit. At the end points of the orbit it has maximal pull (11 arrows) and zero speed. At the center it coasts through with maximal speed and minimal pull. And so it goes—flipping round and round as it shoots back and forth. Like the earth constantly falling toward the sun but never getting there, the electron is constantly falling toward the nucleus but never reaching it.



Now imagine the saucer getting a sudden burst of speed. Instead of a half flip on each side of the proton, it will take one and a half or two and a half. It's driven by the balance between its own speed and the pull of the nucleus, but there's no in-between. It has to be face-on at its endpoints and edge-on at the center. That's just the way it falls. Anything else would be like falling up hill.

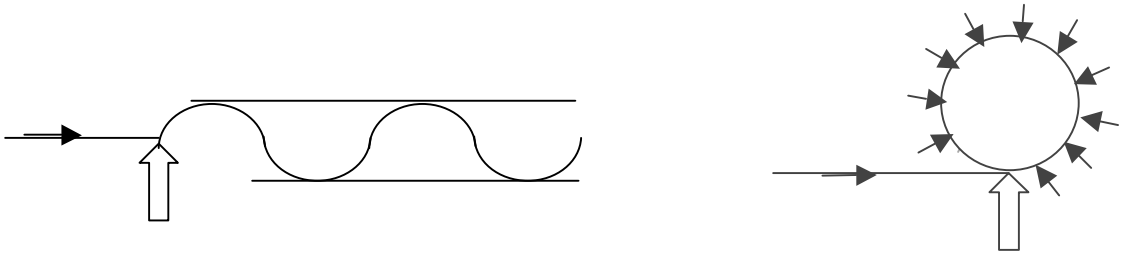
This is the dance of the *hydrogen* electron. With more than one electron in orbit, the electrons are driven by *l-trinos* from each other as well as the *r-trinos* from the nucleus and the dance complicates. But no dance can lead it into the nucleus.

3. What are mass and energy?

I've been assuming that you remember what I said about mass when I reported the original memorable flash that started it all. But I'd better say it again. After I mentioned hitting a neutral trino from the side to produce a photon, I continued with this. What if I hit a *spinning* trino from the side? That wouldn't be the same as hitting a neutral trino. Spinning trinos have direction of spin (an axis) as well as direction of motion. Maybe the hit would serve to *turn* the axis of the spin as well as *push* it. I compared *turning* with *pushing* in my imagination, and what I saw was a trino going into orbit—just like the earth. It kept its original speed but it wasn't getting anywhere. It was going around in circles. Of course it would have to *keep* getting hit in order to stay

in orbit, but isn't that what you would expect? I mean once it got outside its spaceship it would constantly be in the way of other trinos— like a car turning out of its lane.

The *orbit* is the result of the turn. Now let's look at the *push*. For every push it got from this side of its orbit it would soon get an equal push from the other side and the whole orbit would just wiggle around in a fixed space. But isn't this the meaning of *mass?* How tightly something is held in place. It looked to me like a *proton* (clockwise spin in orbit) and an *electron* (counter-clockwise spin in orbit).



The big upward arrow at the left in the above illustration is pushing a non-spinning trino from the side to form a photon. The trino squeezes trinos in parallel lanes and they push back. It's like a car in a many-laned highway. It can 'bounce' back and forth without actually sideswiping.

The big upward arrow at the right is pushing a spinning trino from the side to form an electron or a proton. It turns out of its lane and gets hit broadside—and keeps getting hit forever. This constant broadsiding constitutes mass.

Now let's look at what happens to the trinos that do the hitting around that circle to the right. Imagine that you're a car in a highway lane of identical, equally spaced cars all going the same speed. As long as all the cars stay in their lane, there are no collisions. But suddenly a car turns out of its lane and crosses yours. You hit it broadside and knock it into still another lane. But by hitting, you disappear. You were nothing more than the wallop you carried, and that wallop is now part of the car you hit. Now look at your lane. When you disappeared, you left a hole in your lane as your wallop became part of the tron you hit. Trons feed on trinos like you. A constant diet of your wallop and that of others (the 'wallop' consists of *c,* direction, and size) *becomes* its mass. Look again at what your hit did. It created two things: the hole you left in your lane and the mass you added to the car you hit. You just moved from lane to tron.

As long as a tron gets hit equally from all sides, the circle it forms stays put. Let's say that the rate of hits on any given stretch of this circle is 100 hits per nano-second. Its mass is 100/100, which means that 100 on this stretch is soon matched by another 100 when this stretches reaches the opposite side of the circle. Now let's put it near the surface of the earth, where one of those hundred hits has been knocked out and has left a hole. That hole was left by what would have been number 100 from below but it had gone into the mass of a tron in the earth and had thus become part of the earth's gravity. That hole has changed 100/100 into 100/99. The opposition

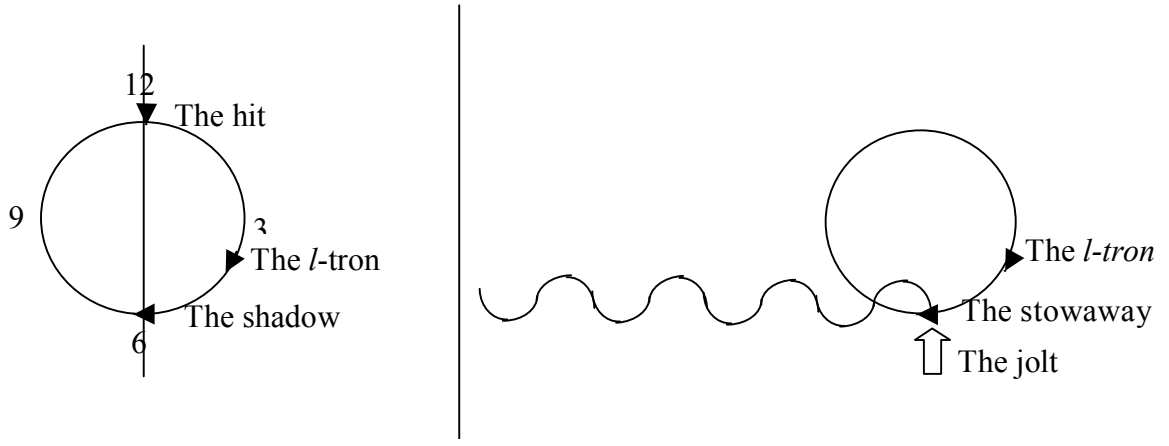
99/99 has become its mass of being, and the extra 1 from above has become its energy of moving. In other words a mass of 99/99 is being moved by a gravity of 1—all because of that gravity hole. How did hit number 100 from above change from mass to energy? It simply became unopposed. Mass is opposed hits; energy is unopposed hits. The trino that hits doesn't even know when it's mass and when it's energy. We see it and name it as a difference—but that's from *our* perspective, not *its*.

The implications of this are endless, as units of mass 'change' into units of energy and vice versa. (Of course the only thing that's 'changing' is our funny use of words.) Notice especially how it explains Einstein's famous equation. Since mass is a measure of how many trinos are being opposed, we can easily conceptualize the equation. *M* is the cross section that gets in the way of trinos, *c* is the trino impact from one side of this cross section (*c*, remember, is trino speed) and c^2 is *c* against *c*. Hence $e=mc^2$ (the amount of energy tied up in the opposed battering of *m*).

4. How can light behave like both particles and waves?

Hold a hula-hoop around your waist and see an *l-tron* in it swoosh around and around clockwise. This is an electron with its *l-tron* swooshing. Now picture con-verging streams of *n-trinos* crossing the hoop straight in toward you from all sides. All these streams are approaching the hoop at 90° and whenever that swooshing tron crosses an incoming stream it gets hit—one hit from each stream. That's what keeps it in orbit and that's what gives it its mass: constant battering by incoming trinos. (I had assumed above that trinos can hit each other only at right angles. But when *n-trinos* hit trons there's a further limitation: *only from the outside*. It's got to do with 'turning out of your lane'.) But every trino that batters the tron must thereby knock itself out and leave a hole in its stream. All of its energy went into the battering. With the hoop numbered like a clock, watch a stream coming in at 12 o'clock. As the *l-tron* passes in front of you, a trino in this stream batters, disappears, and leaves a hole in its stream. The stream, together with its hole, crosses through you to 6 o'clock and beyond. The hole is just like a shadow. A shadow is nothing more than the hole left by a ray of light that was taken out. Now view the whole hoop and see an orbiting tron casting an orbiting shadow across from it.

But wait! While that shadow was moving from one side of the hoop to the other, the *l-tron* that cast it was also continuing on around the hoop. The shadow hits the hoop directly across from where the *l-tron* was when it cast it—not where it is now. By the time the shadow reaches 6 o'clock, the *l-tron* has moved to almost 4. Step out of the hula-hoop and look at it from above. You see an *l-tron* swooshing around the hoop trailed by its shadow 295° behind. Actually, it looks more like the shadow is *preceding* it by 65° (see below left).



The formation of the shadow that pulls in a trino to become an n-tron (a stowaway).

The trino that has become a stowaway tron is dis-lodged by a jolt and becomes a photon carrying the force of the jolt.

We called it a *hole*. Then a *shadow*. Another word is *gravity*. The earth takes out *n-trinos* that were coming our way from below and leaves us standing in a hole. In a shadow. In the earth's gravity. Just as the earth's shadow pulls *us*, so the *l-tron's* orbiting shadow pulls *whatever happens to be there*. A free *n-trino* that happens to be passing by falls into the hole and continues to fall into every succeeding hole along the hoop. (Note to myself: Try to find what they call the corresponding hole in the earth's orbit—the point that collects space junk.) It has been pulled into orbit and it becomes an *n-tron*. It rides the electron like a stowaway.

That stowaway is being held by an extremely weak force. The gravity beam of a single electron tron. The slightest jolt to the electron will dislodge it. And once it's dislodged it will resume its customary straight line of flight. But now it will carry the lateral force of the jolt that dislodged it and will bounce as it goes (with another free *n-trino* falling into the hole it leaves). This 'jolt' is the 'hit from the side' that I saw in my first memorable flash. ('So *that's* how you manage to hit a trino from the side. Just jolt the orbit it's riding in. I no longer have to imagine flicking it with my finger. What a nice tingle that was.') A photon is an *n-trino* that became an *n-tron* by falling into an electron and then became a photon when the electron got jolted. It carries the forward energy of a trino and the transverse energy of the jolt. All of this is shown in the illustration above right.

So that's the *particle* of light. But what about the *waves*? Jolts often come from rhythmic happenings, like electrons being jostled in a pulsating force field. Ima-gine a million electrons being jostled back and forth as a group. At each reversal of the jostle a million photons are dislodged—each one carrying the force of the same jolt. Rhythmic *jolts* create rhythmic *spurts* of identical photons, like rhythmic spurts from a hose. Or, to keep the imagery of the dislodging jolt, like rhythmic flicks of a wet towel that keeps getting doused between flicks. These spurts, or flicks, constitute a longitudinal wave of transverse photons. When we focus on the spurts, we see waves. When we focus on individual photons, we see particles. But now we can focus on both at the same time. Just get a rhythm going of thumb on and off a nozzle and watch the groupings of water drops as they follow each other in evenly spaced batches. Now imagine each drop moving as squiggles instead of lines and measure all the forces they release as they hit a wall. The batches carry waves of forward push; the particles carry bits of up and down push. Aren't these forces just like light?

5. What is the electric force?

Compare the electric force with gravity. Gravity is an imbalance of hits on oppo-site sides.

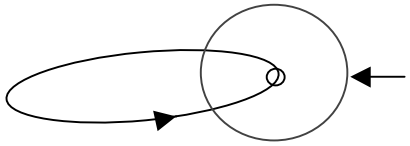
Normally there's an equal number of trinos hitting on this side and that, but when there's more on that side there's a push to this. The electric force, on the other hand, is an imbalance of *kinds* of hits on the *same* side.

Normally there's an equal number of *r*- and *l-trinos* hitting any given stretch of a loop and they either pass through unchanged (*l-trinos* through electrons, and *r-trinos* through protons) or rebound with opposite spin (*l-trinos* rebounding from protons as *r-trinos*, and *r-trinos* rebounding from electrons as *l-trinos*). That's when everything is equal. Only *l-trinos* emerge from electrons and only *r-trinos* emerge from protons. The *l*''s equal the *r*'s and there're no pushes or pulls.

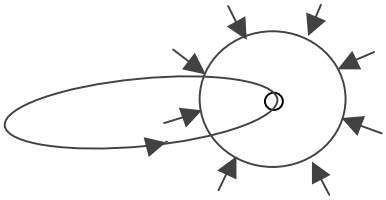
But look what happens when there's an *imbalance* of *r*- and *l-trinos* on any given stretch. Suppose there are normally 50 *r*'s and 50 *l*'s hitting every nanosecond. Now an electron, emitting only *l-trinos*, comes into the vicinity and increases the ratio of *l*''s to *r*'s headed for the proton. Instead of 50/50 it's now 51/49 (one *r*- has been turned into an *l*- by that electron out there). But the opposite side of the proton still has 50/50. Here's the picture: 51 *l*'s confront 50 *l*''s, and 49 *r*'s confront 50 *r*'s. Everything is at balance except that one extra *l*- facing that one extra *r*-. What happens when opposing spins confront each other?

The forward motions cancel each other and the only thing left is the energy of the two opposing spins. Imagine a left spin around your left fist and a right spin around your right. Bring your two fists together till they touch in front of you. Now remove your fists and leave only the spins—like the smile of the Cheshire cat. The two spins were different to your fists but they're the same to your eyes: just one big spin going away from your eyes at the top and coming toward them at the bottom. There's a tremendous amount of energy tied up in those combined spins. What happens to it? It pushes the *tron*. It pushes a proton this way and an elec-tron that. And that's the electric force. (I don't know how it does this—how the energy of a spin is translated into a linear push. That's going to have to wait for my next rare flick of insight.)

Compare the forces of gravity and electricity again. Gravity is made from the minus energy of an *n-trino* that gives up its push and disappears (leaving a shadow or hole). This minus creates an opposing plus. The size of that opposing plus is the wallop of a single trino. The electric force is made from the combined energy of an *l*- and *r-trino* that give up their *spins* and disappear. From those spins that they gave up comes a tremendous amount of push. The electric force is something like 10^{38} as strong as gravity. That's 1 followed by 38 zeroes! If we take *c* as the *forward* push of a trino (gravity), wouldn't this mean that the energy contained in two spins equals that of 10^{38} *c*'s? No, that's only part of the difference. The explanation of this will be much clearer in section 10 on the nuclear force, but briefly it's this. An electron's tron can send and receive only one gravity unit at a time. That's the one from the outside as the tron orbits. Like the earth. But it can send and receive a whole ring of electric units at a time. Picture the tron as wearing a gigantic collar around its neck as it moves in its orbit (that's the circle with the tron at its center). While the collar is getting one gravity hit, it's getting a whole ring of electric hits.



The single unit of gravity



The ring of units of electrical force

6. Why is a proton more massive than an electron?

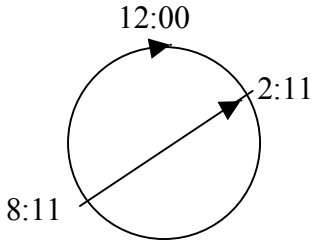
Like the *l-tron*, the *r-tron* also casts a shadow and attracts an *n-trino* into its orbit as an *n-tron*. But in some special set of circumstances at some point in its history, the situation was frozen long enough for the following scenario to run its course. *N-tron*-1 casts shadow-1, which attracts *n-tron*-2. *N-tron*-2 casts shadow-2, which attracts *n-tron*-3. This continues on until the shadow of *n-tron*-3671 lands squarely on the *r-tron* that started it all—and attracts *it*. And this sews up the powerful proton lock. '3672' just happened to be the number that came out even. The proton consists of 3672 *trons* (including the *r-tron*), which is 1836 times the mass of the electron with its *l-tron* and its *n-tron* stowaway. Now notice that all 3672 trons of the proton are locked in direct gravitational beams: *n-tron*-1 has a lock on *n-tron*-2, which has a lock on *n-tron*-3, and so on. The meaning of 'beam' will become clear in point 10 on the nuclear force, and you will see the tremendous difference between a gravitational flicker and a gravitational beam. 3672 gravitational beams the length of a proton orbit's diameter constitute an extremely tight lock. A proton is almost forever.

Both electrons and protons experienced the same two different shadow building processes (1 stowaway vs. 3671), so at one point we had two sizes of both. It just happened that more protons had taken the big alternative and more electrons had taken the small one. It didn't take long for the small electrons to annihilate all the small protons and for the big protons to annihilate all the big electrons. And this gave us the present situation. The mutual attraction between our present electrons and protons is tremendous, but *big* can't readily annihilate *small*—they dance with different rhythms and always miss each other.

7. What is a neutron?

Finding the structure of the neutron can better serve as an example of my stupid-ity than my brilliance. I'll tell on myself this time and assure you that things like this were happening all the time—and still are. When I saw the electron and the proton in that one brilliant flash where I pictured hitting a spinning *trino* on the side and sending it into orbit, I made the obvious guess that a neutron had to be a combination of an electron and a proton. I kept trying to put the two *loops* together in such a way that they would mutually attract instead of annihilate. Year after year. Then it came in one of those rare flashes. "Combine *trons*, you idiot, not *loops*. Just put an *l-* and an *r-tron* in the *same* loop." I had long since put the stowaway *n-* in with an *l-tron*, but somehow I missed the possibility of putting a stowaway *r-* there.

Just as I had put the stowaway *n-tron* in the gravity shadow of the *l-tron*, I pro-ceeded to put an *l-tron* in the electric 'shadow' of the *r-tron*. I visualized the neutron like this. I took a proton with its *r-tron* at 12 o'clock and 3671 *n-trons* equally spaced around a hula-hoop—10.2 trons per degree. Then I watched an *l-tron* get pulled in to *n-tron* number 667, knock it out, and take its place. And this was my neutron: an *l-*, an *r-*, and 3670 *n-trons*, with the *l* about 65.4° ahead of the *r* (about 2:11 on the clock). What was that pull at 2:11 (number 667)? It was the *r-trino* that left the *r-tron* at 8:11. When the *r-tron* reached 12:00 the *r-trino* had reached 2:11.



While the r-tron is circling from 8:11 to 12:00, the r-trino is cutting straight across from 8:11 to 2:11 where it holds an l-tron in the orbit. So when the r-tron is at 12:00, the l-tron is at 2:11.

This was my picture of the neutron for the next several years. I knew, of course, that the *l-tron* was also casting its electric 'shadow', but I dismissed this with a shrug. "So the shadow goes unfilled. What's the harm of its *l-trinos* just going off into space?" But after several years I had to scold myself again. "But then the neutron would have a negative charge, you idiot!" I had really been that stupid.

What we're dealing with here is the mutual attraction of proton and electron. In the hydrogen atom the electron keeps falling into the nucleus and missing, like the dog chasing its tail. In the nucleus, another version of this mutual attraction occurs as proton and neutron lock together (see section 10 on the nuclear force). But just what happens when they're both in the same orbit? The *r-tron*''s 'shadow' is pulling on the *l-tron* at the same time that the *l-tron*''s 'shadow' is pulling on the *r-tron*. What will happen?

I've said all along that trinos can hit trons only at right angles, but that's only the point where *most* of the push registers. With a departure from 90° the push falls off very fast. As *r-* and *l-tron* compete with equal strength to capture the other in their respective shadows, they can only end up with a compromise position— directly across from each other. But this position is so far off from 90° that the mutual pull is extremely weak. It's called the 'weak force'. If the force of gravity is 1, the electric force at 90° is about 10^{38} while the weak force is only about 10^{25}. So, finally, here is my neutron: an *l-* and an *r-tron* directly across from each other in the same orbit with 3670 *n-trons* filling out the orbit.

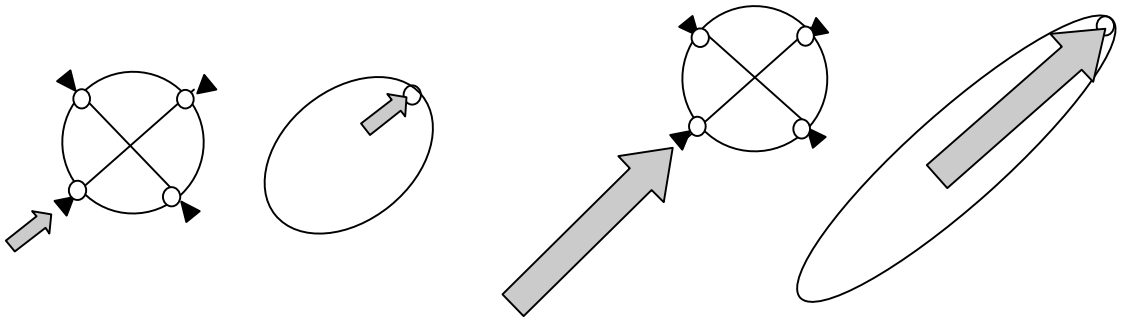
8. Why isn't the earth slowed down in its orbit?

When an electron gets pulled, it's the *l-tron* that gets the pull—not the whole orbit. This creates an interaction between the force that's holding the tron in its orbit and the electric pull on it. The orbital force is like the force on a bucket at the end of a rope that you're swinging around you; and the electric pull is like a powerful magnet in front of you that's turned on and off the instant

the bucket passes by it. The pull of the rope is keeping the bucket moving in a circle. But every time the magnet flashes, it pulls against the pull of the rope and stretches the circle into a pear shape (or, more accurately, an avocado shape) with the narrowed end in the direction of the pull. And the stronger the pull the longer the pear.

Now recall what Feynman said about the earth slowing down: "It would get hit more from in front than from behind." He's thinking of something like the wind on a motorcycle's windshield. But unlike the windshield on the motorcycle, the one on the electron changes shape with the wind. As the electron moves faster and gets more hits per nanosecond, the windshield gets narrower and receives less of them. The balance is perfect. The more due to *fast*, the fewer due to *narrow*. The earth is composed of pears pointing in the direction of its motion.

In the figure below notice the two different kinds of forces. The little black arrows come from all directions, but they can hit the orbiting tron only from the outside (that's the hit they get for leaving their lane and getting hit broadside by approach-ing traffic). The big gray arrows (electrical forces) come from only one direction but they can hit the tron from any right angle. Again. Orbital hits: any direction but only from the outside. Electric hits: only one direction but from inside as well as out. (The illustration shows ellipses instead of pears and should be modified.)



But notice that for the electric force to form a pear, it must hit *only* from the inside. Why does that gray arrow slip by the tron from the outside of the near side of the orbit and hit it only from the inside of the far side?

Let me back up and look at trino hits in general. I'll consider four questions. 1) Why is it that trinos can hit other trinos only at right angles? This is answered above under 'trino hits' (just before the 11 questions). 2**)** Why do *n*-trinos hit only from the outside of the orbit? It's the broadside hit the *r/l*-tron gets for leaving its lane. 3) Why do *r/l*-trinos hit at all right angle positions? The hits are spin-oriented, not broadside. 4) Why *don't r/l*-trinos hit at that one position where *n*-trinos *do* hit? The broadside hit gets in the way. (Of course that's not an answer. It's an answer in progress: the first step towards a guess. I've pinpointed something to think about and can now start guessing the mechanics of the hit. But compare Feynman's method with mine. He *blocks* an answer. I *invite* one.)

Now compare the *n*-trino hits on circles and pears. With the circle, every inward hit is soon matched by an equal and opposite hit as the tron reaches the opposite side of its orbit. The whole orbit jiggles back and forth but stays in roughly the same place. With the pear, the whole orbit is getting more hits on the pear's base—enough to overcome the headwind.

But wait. The pear is not only overcoming the headwind. The imbalance of hits on small end and large is also moving the pear. Not only have we explained why the earth doesn't slow down (the small end); we've also explained why it's moving in the first place (the large end). Just as a stationary circle is frozen into place by equal hits from all sides, so is the motion of a moving pear 'frozen in its motion' by the unequal hits on its shape. This explains Galileo's principle that any motion will continue until it's changed. Whenever we accelerate something, we turn all of its building blocks into the pears formed by that acceleration. An acceleration doesn't *push* an orbit—it *shapes* it. And a pear will hold its shape until another acceleration alters it. We have found the reality of *kinetic energy*. Pears. The axis of the pear shows the direction of the motion and the thinness of its leading edge shows the speed. This is the best kind of tingle. A freebie. You design your model to explain one thing and it also explains another.

9. What is the magnetic field?

Whenever we think we're seeing and measuring trons out there, all we're really seeing and measuring are the trinos they send us; and in a universe with a texture of *c,* the timing of things happening *out there* and impinging *in here* gets tricky. There are three main aspects. 1. *Lag* (things like orbiting electrons falling toward the nucleus but missing—or a dog chasing its tail). 2. *Linear Doppler effect* (things like the change in the wave length of light—or rowing upstream). And 3. *Transverse Doppler effect* (things like magnetism—or running through the rain).

There's no such thing as a magnetic field. The force that we detect, measure, and name is nothing more than a special case of the electric force. Remember we said that the electric force was an imbalance of *r*- and *l-trinos* coming from the same direction. When that imbalance is due to an *unequal* number of protons and electrons out there, we call the force 'electric'. When it arises from the Doppler effect acting on an *equal* number of protons and electrons out there, we call the force 'magnetic'. Now how can an equal number of *r*- and *l-trons* send us an unequal number of *r*- and *l-trinos?* It's because the *r*- and *l-trons* (the protons and electrons) have different speeds. Of course this happens all the time. Electrons and protons in atoms are equal in number but different in speed. And an electric current in a wire has equal numbers with different speeds.

A single example of this force should suffice. Two parallel wires carrying direct current will attract each other when the directions of their currents are the same and repel each other when they're opposite. Now wire 1 has equal numbers of protons and electrons and it's sending out equal numbers of *r*- and *l-trinos*. And so it is with wire 2. But while both wires are *sending out* equal numbers, they aren't *receiving* equal numbers. And it's all because of the difference in relative speeds.

Put yourself in the position of an electron in wire 1 (e_1). When the currents in the two wires are the same, you look over at wire 2 and see that you're standing still relative to all the e_2's but moving past all the p_2's. Now all of these e_2's and p_2's are raining their trinos on you; but while you're *standing still* in the electron rain, you're *walking* through the proton rain. You sweep up more proton rain than electron rain, and this excess of proton raindrops attracts you. (The excess is the difference between *standing still* in the rain and *walking* through it.)

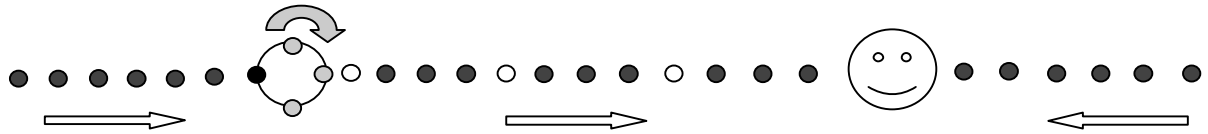
Now reverse the current of wire 2. As you look at wire 2, the proton rain is the same—you're still walking through it and sweeping. But look at those e_2's shooting by in the opposite direction. You find yourself *running* through *their* rain with twice the sweep, and this excess of electron raindrops repels you. (The excess is the difference between *walking* through the rain and *running* through it.)

10. What is the nuclear force?

This point clearly wins the tingle contest and I'm going to use it as an example of how I go about exploring new territory. I'll tell you not just what I found but also how I went about finding it. You'll see that there are far more bungles than in-sights. The idea is that if it took bungles for me to get there, it might take the same bungles to get you there. Maybe that's the way we *all* learn: through bungles instead of explanations. Anyway, this will be more in line with the real purpose of this whole section on physics. It's more about *me* than the *universe*.

Soon after I got the idea of orbiting trons, I saw that gravity was only a flicker. I looked at an electron in front of me making gravity. It was blocking *n-trinos* and thereby creating holes in the cosmic shower. The electron's *l-tron* was getting hit only from 90^o and only from the outside of its orbit—just like the earth. That was the hit that was keeping it in orbit—just like the earth. A trino would hit the tron from the outside, give up its whole self to the 'curving of the tron', disappear, and leave a hole where it had been in the trino stream. It was the hit when the electron's tron was farthest from me that made the hole that hit me. This hole was the gravity that the electron had sent my way. The hole allowed an opposing trino to push.

As I looked at this electron edge-on, I focused on all those trinos going in and all those holes coming out—especially the hole that reached me. As that hole hit me I felt a jolt from its unopposed counterpart at my back. I was feeling the electron's gravity. And I wasn't to feel it again until the electron's tron had made a full orbit and had reached that far point again. It reminded me of a lighthouse. A flicker of light: a flicker of gravity.



Four positions of the orbiting l-tron are shown. (Of course there's a near-infinity of positions that are there but not shown.) Only when the orbiting tron reaches the black

position can it take out a trino in the stream headed for me. The white dots represent the trinos that have been taken out. They are the flicker of the electron's gravity.

I frequently returned to the picture of my flicker coming from the lighthouse. Then one day I saw a moth get caught in the lighthouse beam. In order to stay in the beam it had to actually *orbit* the lighthouse. While *I* was catching a rare *flicker* of light from the lighthouse, the *moth* was bathing in a steady *beam*. I returned to the electron. I was catching a rare flicker of its gravity. What if something, like a moth, got caught in the electron's gravity? What sort of thing could make like a moth and orbit an electron? *Another tron!* All of a sudden I was looking at the inside of the nucleus. I saw one tron bathing in a steady beam of another tron's gravity. Just how much more light would the moth get than I would? And how much more gravity, an orbiting nuclear tron? In other words, how big is the difference between a flicker and a beam? Then came this thought. *Could the nuclear force be nothing more than a gravity beam?*

As I asked myself that question, I felt sure I would be struck dead by the god of physics. The difference between the nuclear force and gravity is one of the biggest numbers in all of physics. And I actually dared to ask whether the two could be different manifestations of the same thing. The number is something like 10^{38}. Can you even imagine the number 1 followed by 38 zeroes? That's how many black dots there would have to be between white dots in the preceding figure!

But *wait!* I was looking at the electron edge-on. And I knew that the electron was flipping. From all other positions of its flip I wouldn't get any flicks at all. After I got one flick I would have to wait until that electron flicked every other point in space before it got around to flicking me again. It would be flicking the entire uni-verse and doing it one point at a time. So the number wouldn't have to be 10^{38}. It would be something like 10^{19} sweeps of 10^{19} flicks each. Still not realistic. Maybe the size of the number wasn't realistic but the idea of flicker and beam certainly was. Whatever the structure turned out to be, it would obviously have to include the difference between being outside an orbit catching a flicker and being inside an orbit catching a beam. I survived the wrath of my god.

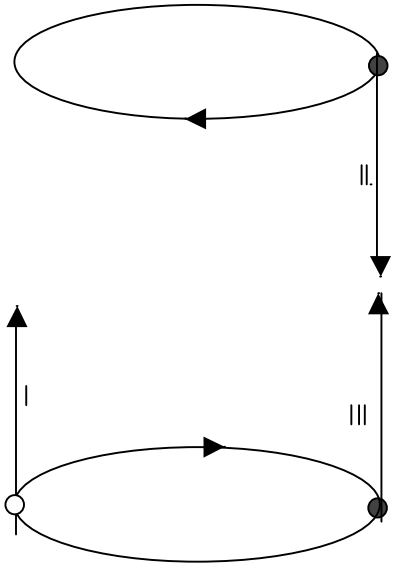
Long after I had worked out my structure of the proton and neutron, I looked again at the nucleus. I started with the deuterium nucleus (hydrogen-2). One proton and one neutron. The proton had an *r-tron* and 3,671 *n-trons*; the neutron had an *r-tron*, an *l-tron*, and 3,670 *n-trons*. How could I position these two hoops so they would *lock onto* each other without *crashing into* each other? Something like the earth and the sun. From hindsight it would appear that once I knew their structure, putting them together to form a deuterium nucleus should have been a slam-dunk. Try it and see. Transfer the trons from the picture models of proton and neutron shown below onto two quarters so you can move them around. Now see how long it takes you to observe the slam-dunk as they click into place. Then you can smile at my stupidity. You see *it took me years!*

Remember, now, the *r-trons* (black dots) are sending out *r-trinos* through their 'collars' (the circles at right angles to their orbits) and the *l-tron* (white dot) is sending out *l-trinos*. And all three

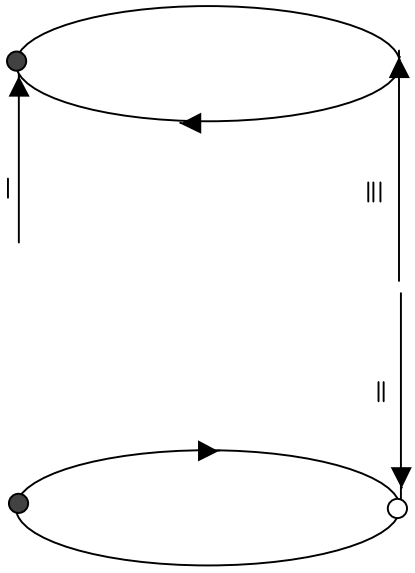
trons are receiving trinos through their collars. As you watch those dots moving around your two quarters, look for a whole ring of *r*- and *l-trinos* converging in through the collars and a whole ring of *r*- or *l-trinos* shooting out.

If you haven't figured it out yet, you can start like this. Put one quarter on the table and hold the other one an inch and a half above it (half the circumference of a quarter). The bottom quarter is the neutron and the upper one is the proton. The *r*- and *l-trons* of the neutron are shooting *r*- and *l-trinos,* respectively, straight up (as well as in all other directions outward from the collar), and the *r-tron* of the proton is shooting *r-trinos* straight down (and all other collar directions). Play with the quarters for a while.

If you need more help, I'll go straight to the figures shown below. On the left, the proton quarter is shown above the neutron quarter with black (*r-tron)* directly above black. Now start both quarters in a clockwise rotation and notice that the two blacks and the white keep their relative positions as they orbit.



The start of the trino run run



The end or the trino run

Now shift your attention from the orbiting trons to the trinos they're sending each other. Neutron and proton are taken to be exactly half a circumference apart so a tron is travelling half an orbit while its trino is covering the distance from one quarter to the other. An *l-trino* travelling straight up from the neutron's white (number 1, left) will thus reach the proton just in time to meet the proton's black (1, right). And you know what happens when *l-trino* meets *r-tron. Tug!*

At the same time you will see an *r-trino* from the proton's black dot (11, left) cover the distance straight down just in time to meet the neutron's white (11, right). *Another tug.* It's the mutual attraction that we expect between an electron and a proton. But because of the exact positioning and timing, this attraction is happening between a proton and a neutron. The two figures show the start and the finish of the same trino run.

In our old conception, we imagine the mutual attraction of plus and minus bring-ing electron and proton together with a bang of destruction. But with the lag, we can see how the plus and minus parts of protons and neutrons keep trying and missing—forever. Like the dog and its tail. If the two quarters were any closer together or any farther apart, the trinos wouldn't hit the trons. And if the relative position of their trons weren't exactly in place (black directly above black), the trinos wouldn't hit the trons. How did they ever find such an exact position? The same way a falling rock finds the exact bottom of a hole—or rainfall in the mountains finds the exact best way to the sea. They *fell* into it.

But what about the upward moving *r-trino* from the neutron's *r-tron* (111, left)? When it reaches the proton, there's nothing there (111, right). It shoots straight off into space to attract an orbiting electron. (This answers one of the biggest mysteries of nuclear physics: 'Why don't the protons in a nucleus repel each other?')

Now what would happen if the two quarters were both neutrons? Just put a white dot across from the black in the top quarter. Instead of seeing the quarters held together by *two* electric beams, you see *four*. You will see below how important this becomes.

So the biggest part of the nuclear force is the two electric beams between proton and neutron. But what about gravity? The 3672 trons in both proton and neutron are interlocked by 3672 gravitational beams. *Beams*, not *flickers*. I started this section with the vast difference between flickers and beams. But could it be *that* vast? The nuclear force is about 137 times as strong as the electric force. Could 3672 gravitational beams account for this difference? The number 137 is one of the unexplained constants in physics. Here's my first guess. Could there be 137 times as many *n-trinos* in the universe as *r/l-trinos?*

So far, I've talked only about the deuterium nucleus: one neutron and one proton (*np).* Once I had solved that, the next three nuclei were instantaneous. Tritium (hydrogen-3) was an *npn* sandwich (or *pnn*). Helium-3 was a *pnp* sandwich. And helium-4 (the alpha particle) was either *pnnp* or *pnpn*. But at that point I went stupid again. Years of stupidity preceded that insight

and years of stupidity followed it. That seems to be the best I can do. Sort of like the flicks of gravity. I get a flick and then wait several years for the next flick. I envy the moth.

Here's what was so stupid. I just assumed that once I got the alpha particle figured out, everything higher had to be a structure of alpha particles. Isn't that what radioactivity tells us? The units that pop out from higher nuclei are either electrons or alpha particles. I didn't even consider stacking higher sandwiches. I just kept trying to assemble alpha particles in such a way that they would cling together with the same fervor as proton and neutron. Two years later I had to admit it. "It just ain't gonna happen. There's just no place to cling."

Then one day I got into an argument with myself.

"Look. The sandwich structure is perfect. Why not just keep on stacking?"

"Are you crazy? We're talking about a *nucleus*. It's got to be a tight little ball—not a skyscraper that can reach more than 200 stories. Can you imagine electrons orbiting a skyscraper? *Lengthwise?* Anyway, we know that all these structures have got to flip in response to their internal activity. The electron, proton, and neutron obviously flip. And our sandwiches can flip too. But a skyscraper?"

But two years later I went behind my back and gave it a try. Just for fun. And was it ever fun! "So a nucleus can't be like a skyscraper. That doesn't mean I can't play with it." I started stacking new layers on the alpha particle. It was a natural. As long as I didn't put two protons together, it continued to be mutual attraction with lag all the way. And I was free to stack my sandwiches in different ways. When I got to nitrogen-14, for example, I could stack it in either of these ways: *npnpnpnpnpnpnp* or *pnpnpnnpnpnpnp*. And the double *n* of the latter could go anywhere. Then I thought about the flip. I looked at the nitrogen nucleus and inspected its quivers and shakes. "Hey, it doesn't *flip*—it *flails*." And as I watched the N-14 stack flail (see the illustration four pages further on), I saw the ends of the flailing snake approach each other. *P* against *n*. You guessed it. The snake bit its tail! It was the story of the benzene ring all over again. Higher nuclei are rings. Or hoops. Or doughnuts. And at what point can the stack bend sharply enough to bite its tail? Nitrogen-14. This explains the nitrogen mystery (see below under *Numbers and Percentages*).

We've moved quickly from *coin* to *sandwich* to *stack* to *hoop*. Coins and sand-wiches *flip*. Stacks *flail*. And hoops *writhe.* The nucleus of uranium-238 is a long thin hula-hoop that twists, coils, and convolutes. You can easily model any nucleus by screwing together the two ends of a clear plastic hose and drawing in parallel circles spaced a half circumference apart: red for protons and blue for neutrons. Then dot in the *l*- and *r-trons* on each circle: white for *l-trons* and black for *r*'s. Pick up the hoop and twist it into a figure 8. Keep twisting till you get a double spiral. Then bend the whole thing around to make a ring of double spirals. Anything you can do with the hose, the real nucleus might do to itself—as it twists, coils, and convolutes.

Put uranium-238 on a plastic hose and start it up—that is, start up the orbitings of the *l*- and *r*-*trons* of the 238 orbits. Now look at a chart of the radioactive series that runs from uranium-238 down to lead-206. If you wait long enough you'll see an alpha particle, *pnnp*, pop out of a stretch like -*pnpnnpnnp*-, leaving -*pnnnp*-, as uranium-238 changes into thorium-234. Next you'll see an electron pop out from that middle *n* leaving -*pnpnp*-, as thorium-234 changes into protactinium-234. Finally, after 8 alpha pops and 6 electron pops you'll see it get down to lead-206, and there it will stay forever. Wouldn't it be fun to play around with the model to find out which structures for U-238 could go through these pops and end up as Pb-206? Everything that happens is driven by the overall balance of forces in this writhing hoop.

The overall balance of forces! That's what it's all about now. You can see what needs doing. Now that we've got a model, it's time for the math. *Before* we had a model all we could measure was ghosts. But *with* a model we can measure real *things*. Actually we've already got the measurements. The figures given in a chart of the nuclides are real enough. They were just waiting for something real to measure. So here's the game I'm suggesting for anyone who's interested. Take my nuclear model and a chart of the nuclides and play away. The game consists in juggling the model and the measurements until you reach the optimal overall balance of forces. It will be largely a matter of trial and error.

Here are some of the existing observations and measurements that we can use.
1. Packing fractions. How tightly are two or more things being held together?
2. Ratio of neutrons to protons.
3. *Numbers* of protons and neutrons: the preponderance of evens over odds and the so-called magic numbers 2, 8, 20, 50, 82, and 126.
4. Percentage of occurrence of isotopes and nuclides in general.
5. Half lifes. How long will a structure last?
6. Energy of emission. How strong is the pop?

1. Packing Fractions. Suppose A has a mass of 40 and B has a mass of 60. Then a mutual attraction brings them together resulting in A+B with a mass of 99. The old explanation is that a unit of mass has been *changed* into a unit of energy, and this energy is what holds them together. If the combined mass had been 98 in-stead of 99, the packing would have been twice as tight. Of course *our* explana-tion is that A and B both shield each other from the inside and leave unopposed forces that push them together from the outside (their mutual gravity). Whichever explanation we use, the same figures apply. And physicists have got figures for almost all of the possibilities.

2-4. Numbers and percentages. Tin has 10 different stable isotopes. Its 50 protons can be stable with any of the following number of neutrons: 62, 64, 65, 66, 67, 68, 69, 70, 72, and 74. Iodine has only one: 53 protons with 74 neutrons. Why? They're roughly the same size. It appears to be because 50 is even and 53 is odd (another answer in progress). All evens can take more different numbers of neutrons than odds. The total number of stable isotopes for even numbered elements is 208. The total for odd numbered ones is 62. The ratio of 208:62 is the av-

erage. The ratio of 10:1 is the extreme. As we play the game, we should be looking for an explanation.

And notice this. Out of 1,000 atoms of neon, 909 will be Ne-20, 88 will be Ne-21, and only 3 will be Ne-22 (all such figures are taken from Isaac Asimov's **Under-standing Physics**). And we know the percentages of isotopes for all elements. What determines these percentages? We know that it's related to *odds* and *evens* and to the ratio of neutrons to protons. Ne-20 has 10 *n*'s and 10 *p*'s: both even and therefore more stable. Ne-22 also has even numbers of *n*'s and *p*'s (12 and 10), but the *n*/*p* ratio of 10:10 is more stable than the ratio 12:10. This even ratio applies to all lower elements, but after calcium (20 protons), it takes more and more *n*'s to maintain stability. Remember the extra strength of the *-nn-* link mentioned above? At lower levels this *-nn-* link tends to overpower the weak force that holds the neutron together, and one of those *n's* has to pop an electron. This is why carbon-14 is unstable (see the nucleus of carbon-14 below). But at higher levels this extra force is needed to hold the nucleus together.

The overall balance of forces in the nucleus. That's what the game is all about. Measure the *-np-* link, the *-nn-* link, and the weak force of the neutron. Then try to see how odds and evens affect the overall balance. And the ratio of *n's* to *p's* as the numbers increase. Then use these figures to calculate the electron and alpha particle pops in radioactivity. That will be some game!

And here's a real gem. Another freebie. The one big exception to odds and evens is N-14, which has 7 *p*'s and 7 *n*'s—both *odd!* And yet out of 1000 atoms, 996 are N-14 and only 4 are N-15, which is odd/even (7 *p*'s and 8 *n*'s). *Why?* This is the nitrogen mystery mentioned above and it screams out for an explanation. Here it is. It's because N-14 can bite its tail (with an *-np-* link) and N-15 can't (the strength of the *-nn-* link would tear apart one of the *n's).* The extra stability provided by the n/p packing fraction of the 'bite' makes all the difference. This was the only element where *stack* structure competed with *hoop*, and the hoop won by a landslide. From there on up the *hoop* was supreme.

5. Half lifes. This is a measure of stability. The hydrogen-2 nucleus will last forever, while any amount of hydrogen-3 that you start with will be half gone in 12.26 years, uranium-238 will be half gone in 4,500,000,000 years, radium-226 in 1620 years, and polonium-212 in .0000003 seconds.

6. Energy of emission. When an alpha particle pops out from a nucleus, it can pop at different speeds. This speed, like half lifes, is a measure of stability. The alpha pop that changes uranium-238 to thorium-234 is in no hurry. It takes four and a half billion years and then just dribbles out. The one that changes polonium-212 to lead-208 takes .0000003 seconds and goes out with a bang.

Points 5 and 6 can also be applied to non-radioactive nuclides by using *artificial* radioactivity. For example, sodium-24 doesn't exist naturally but it can be produced by nuclear bombardment. We bombard ourselves up a sample and watch what happens. Electrons are popping out all over

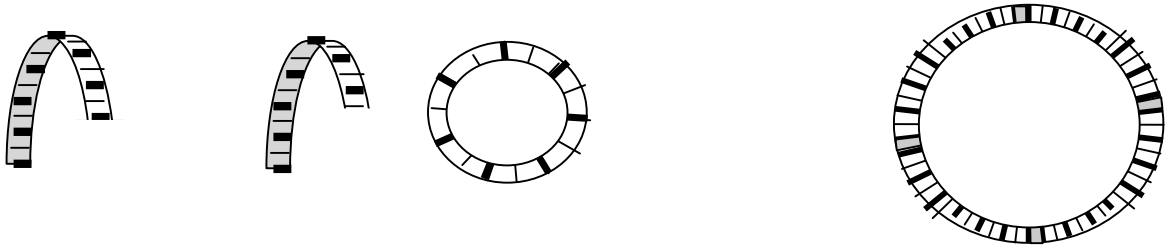
and after 15 hours half of the sample is sodium-24 and the other half is magnesium-24. And to keep you reminded of 'overall balance', notice this. From all the stable nuclei we have seen, sodium-24 would appear to be quite stable. Why can't it last? It's because magnesium-24 is even more stable. No matter how deep a hole a rock has fallen into, if it finds a still deeper hole at the bottom, it will fall deeper. The only thing that separates Mg-24 from Na-24 is one little *l-tron* in one of sodium's neutrons. Should it stay there, where it's already snug, or should it jump out to the orbit, where it's snugger? Let's watch as it teeters.

The neutron where that *l-tron* resides is held by the sum total of all the forces of the nucleus. Look at the sources of the various forces. The dancing electrons out in the atomic orbits are sending it an ever-changing mixture of forces as they dance. The writhing hoop is sending it an ever-changing mixture of forces as it writhes. And our little *l-tron* is receiving this kaleidoscope from a different angle every instant of its orbital swoosh. The dancing, the writhing, and the swooshing are all independent, and the different combinations of these independent forces that converge on that *l-tron* at any given instant are both infinite and random (for all practical purposes). But it was already teetering and sooner or later there would come, from among that infinity of random forces, one that would knock it out of its neutron and into an atomic orbit. *Pop!* On an average it takes about 15 hours, but it could have happened in a nanosecond and it could have taken years. It just depended on the *odds* of getting the right step of the dance, the right bend of the writhe, and the right point in the swoosh coming together at the same time.

Let me get you started on the game. The first thing we need to do is to model the proton/neutron structures in a way that doesn't drown us in details. When we were stacking sandwiches, it was easy enough to just label the layers *n* and *p* as shown below.

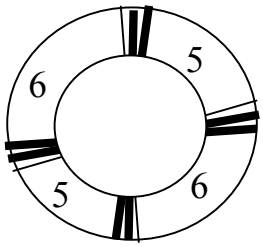
H-2	Np	Li-6	Npnpnp	C-12	Npnpnpnpnpnp
H-3	npn	Li-7	npnpnpn	C-13	npnpnpnpnpnpn
He-3	pnp	Be-9	npnpnpnpn	C-14	npnpnpnpnnpnpn
He-4	pnnp	Bo-10	npnpnpnpnp	N-14	npnpnpnpnpnpnp
	npnp	Bo-11	npnpnpnpnpn	N-15	npnpnpnpnpnpnpn

But this is already getting unwieldy. We want something that will highlight what counts and downlight what doesn't. You may have missed the double *n* in carbon-14, for example—and that's the very thing that could explain why carbon-14 is unstable and can thus be used to date historical objects. But let's first get past the point where the ring model takes over and see what's needed. Look below at nitrogen-15 and two possibilities for nitrogen-14. You can see that even though the N-15 stack is higher than the proposed N-14 stack, and thus more able to bend around to its tail, the *n/n* tail-bite just won't hold. (Neutrons are shown with heavy lines, protons with light ones.)

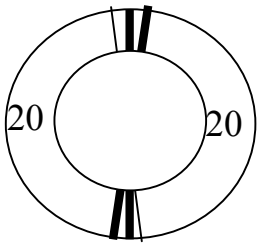


Nitrogen-15 Nitrogen-14 Iron-56

From N-14 on, the ring model becomes a much more useful way to see what's going on. But then the sheer size soon starts to overwhelm us again. Remember we're headed all the way to U-238. Look above at iron-56—the most stable nucleus in the universe. It's got 4 more *n*'s than *p*'s. Whereas a double *n* was a negative for carbon-14 (that is, it made it less stable), extra *n*'s are absolutely essential for every nuclide past calcium-40. The 4 double *n*'s of iron-56 are crucial, and yet you can't see the extra *n*'s without counting. We want them to jump out of the page at us. I've put them in balancing positions around the iron-56 ring and I've highlighted the double *n*'s to call attention to their position. But we've still got those long boring stretches of meaningless *pn*'s. I want to show the *space* taken by these meaningless stretches without specifying the *contents.* Iron-56 and lead-206 are shown below in this format. For iron-56 the unit that repeats without telling us anything important is *pn,* and only the number of these units is given in each section. For lead-206 the repeated unit is *pnpnn* (chosen because it shows the average p/n ratio), and only the number of these units is given. Then the interesting part of both nuclides comes into clear view.



Iron-56 is divided into four sections by *pnn* units as shown by lines. The numbers in each section show the number of repeating *pn* units. Notice that 22 x 2 plus 4 x 3 equals 56.



Lead-206 is divided into two sections by *pnn* units as shown by lines. The numbers in each section show the number of repeating *pnpnn* units. Notice that 40 x 5 plus 2 x 3 equals 206.

These two guesses were guided only by the attempt to balance out the effect of extra *n*'s (that is, *n*'s that are in excess of *p*'s), and it's probably the best first guess. But we can now start to bring in other kinds of evidence. Almost all nuclides above lead-206 are radioactive, and for every radioactive change we know these three things. What it was, what it lost, and what it became. We know, for example that there are two different sources of lead-206. Sometimes it results from thallium-206 popping an electron and sometimes from polonium-210 popping an alpha particle. In order for thallium to pop an electron it would have to have a triple *n, like -pnnnp-,* so that it can pop an electron from the middle *n* and become *-pnpnp-*. But the model that we have guessed above for lead-206 doesn't have a stretch like *-pnpnp*, so we'll have to change it.

This is a good example of the game. We made our best guess and had to change it to allow for a known fact. We then check out our new guess and make changes as necessary. Altogether there are 20 steps from lead-206 back to uranium-238 that need checking. We could conceivably get through 19 of these steps back to thorium-234 and find that there was no way to get a uranium-238 that would allow for the thorium-234 that took us months to guess up. We would have to go back and start all over again. See how much fun the game can provide?

At least it would be fun for certain people. I can't devise efficient computer models and I don't have all the known measurements at my fingertips. Anyway, having created the game, I'm ready for tingles in other directions. But I'm sure there are lots of people who have all three requirements and are raring to go.

11. And what else?

I've given my answers above to 15 questions about physics. And the whole universe is explained with nothing more than a trino. Five of these answers were summarized under point 0, and ten followed by the number. I think these 15 points cover almost everything.

"Everything? What about relativity, the uncertainty principle, quantum mechanics, the big bang, black holes, quarks, and all those particles? You've left out all the big ideas of the past 100 years."

All of those things are part of *their* universe (the universe as it appears to the human brain and is measured by math)—not *mine* (the universe as it is). Notice how Stephen Hawking portrays the difference.

"We could still imagine that there is a set of laws that determines events com-pletely for some supernatural being, who could observe the present state of the universe without disturbing it. However, such models of the universe are not of much interest to us ordinary mortals. It seems better to employ the principle of economy known as Occam's razor and cut out all the features of the theory that cannot be observed." (A Brief History of Time: page 59)

You can see how far apart we are. The very thing that Hawking dismisses as 'not of much interest to us ordinary mortals' is the thing that has dominated my life ever since I was 5. In fact my interest was so great that the word 'interest' didn't do it justice. I had to find a new word for it. 'Tingle.' Like his 'supernatural being', I *can* observe the present state of the universe without disturbing it. How do I do this? I observe it in my mind (g*uess, imagine, picture, think)*. Einstein wanted to do it this way, but he couldn't think up a model that worked—a model that he could put in his mind, measure it, and watch it operate as it went on to explain everything. He not only gave up for himself; he gave up for the human brain and reluctantly changed to 'math over mind'.

In Chapter 3, I quoted a poem written by my friend Paul Lee over 50 years ago. Let me bring it back now and apply it to their universe and mine.

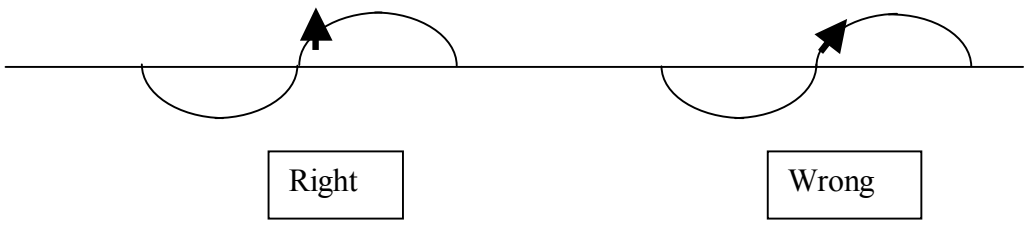
When the unthinkable has been thought, (*my theory of the universe)*
When the undoable has been done,
When the unbelievable is believed by all,
And sand is touched only by sun; (*without being distorted by man)*
When the only right is wrong, (*their universe)*
And the only wrong is right, (*my universe*)
Someone, somewhere will still ask 'Why'
As I ask 'Why' tonight, *(and throughout this book*)
And that unknown created by man (*relativity, quantum mechanics, the big bang*)
Shall perish with him.

Let's see what my theory has to say about 'those unknowns created by physicists'. Things like relativity, the uncertainty principle, quantum mechanics, the big bang, black holes, quarks, and subatomic particles.

Relativity

The basis of my theory is that *everything* is made up of trinos moving at speed *c*. Actually, it's meaningless and misleading to say 'trinos moving at speed *c*'. There's no such thing as trinos *not* moving at speed *c*. *C*, direction, and size are simply aspects of what trinos *are.* And the universe consists of nothing else. Nothing *but* trinos (with or without spin, and with or without side pushes). *C* is the *texture* of the universe. What we call 'standing still' is just *c* going around in circles—and that's what *we're* made of. Lots of *c*'s going around in circles. Just as we feel that the earth stands still while the sun moves, so we feel that *we* stand still while *light* moves. But once we get outside ourselves, the problems of 'relativity' largely vanish. *C* isn't 'relative to the source' or 'relative to the observer'. It's relative only to the trino's line of flight. But this is nothing more than a word game. Here's a better word game. The trino isn't *moving*—it's *being*.

I said that trinos have *c*, direction, and size. We just looked at *c*, now let's look at direction. Here's a common example. Suppose a light is reflecting back and forth between the floor and ceiling of a space ship. The line of flight of the photons is straight up and down. This line of flight is 'drifting' (moving with the ship) and the photon is actually tracing out a zigzag in space and thus moving faster than *c*—to *us,* not to *it*. *It* doesn't know it's drifting. Its nature is '*c* as she goes', and that's all it can do. The difference between line of flight and line of actual motion is clearer with a *spinning* trino since it's got an axis. The axis is straight up and down as the trino moves along this line at speed *c*. *But it isn't moving through space in the direction it's pointing.* It's like an airplane propeller in a sideward. It goes its own speed along its own axis. It doesn't even know its outside world is moving. The figure below represents a spinning trino moving straight up and down in a space ship. The arrow indicates its axis. Its movement through space is shown by the curve, but its orientation is as shown at the left, not the right.



That's the reality of what the universe is. Just a bunch of trinos doing their thing. Now what's the reality of us observing them? All we can *observe* is the trinos that impinge on our sensors; so if we want to know what's really going on out there, we've got to 'subtract' what happened during the impinging. I've given examples of lag (the structure of the atom and the nucleus) and transverse Doppler effect (magnetism). And I've mentioned the well-known example of linear Doppler effect (light). Now let me add another case of linear Doppler—*Doppler mass*.

I choose this because I've heard relativists use the relativity of mass as their ultimate defense. "But we've got absolute *proof* of relativity. We've actually *measured* the tremendous increase in mass of particles approaching the earth at great speed from outer space. Surely you can't argue with measurements." But I *can* argue. What they're measuring is the cosmic shower *as it hits them*—not *the cosmic shower as it is.* They're measuring *what comes in here*—not *what is out there*. The difference is well understood with light. The reality is one color, but what impinges on their sensors—the thing they measure—is a completely different color. Well with the fast particles from outer space they're measuring the *Doppler effect on mass*, not the *actual* mass. As it is with different colors, so it is with different masses. What is Doppler mass?

Let's measure, in our heads, the mass of an electron—first at rest and then as it approaches us. Mass is 'created' when opposing trinos 'destroy' each other. Every opposition creates one unit of mass and leaves two holes going in opposite directions. If we receive one hole every nanosecond, that tells us the electron's mass. We can say that its mass is one opposition per nanosecond.

Now look what happens when this electron comes towards us at high speed. After one hole is created and comes our way, the next hole has less distance to travel and arrives earlier than we would have expected. Let's say we're now receiving holes at the rate of two per nanosecond. But that's exactly what we would be getting from *two* stationary electrons. It's the same phenomenon as the pitch of the whistle from an approaching train or the color of the light from an approaching star. The physicist measures the holes in the *shower*—holes that *arrive* at two per nanosecond. I measure the holes in *reality*—holes that are *produced* at one per nanosecond. And how do I do this? I measure the *model* in my head. And I don't find any increase in the mass of the electron.

I've got one last thing to say about relativity. Einstein *did* try to make models to represent his math. But since he wasn't looking at real happenings, he had to make these models out of *words*—not *things*. You can't watch words as they do their thing. You can't measure them. He went from math to words without ever passing reality. He said things like 'curved space' and

'contracted time'. To me, these are nothing more than word tricks. If 'space' is 'nothing', then 'curvature' is meaningless; if it's 'something', then 'what'. If 'time' is something that can be 'con-tracted', then show us 'what' and 'how'. If you can't do this then you're modeling a ghost. Language tricks are so easy. All you have to do is select a ghost and modify it with an adjective. Everybody does it. I certainly do. Whenever our thinking isn't clear we just wrap it up in ghosts. And it sounds so profound. Like "I think, therefore I am." Einstein ran up against something he couldn't explain. His equations didn't work. He found the fudge factor that would make them work (the universal correction) and looked for a ghost to explain it (contracted time, and the like). It was so easy to find ghosts like 'space' and 'time' and modify them with adjectives like 'curved' and 'contracted'. And that's what it took to help stretch our limited brain to accept the limitless god of math.

One of the sentences in the previous paragraph said it all, but it went by too fast. Before I bring it back, let me remind you of veil number 3: Words // Experiences. This means that words (the veil) are hiding, distorting, or fabricating experiences (the reality). Now here's the sentence. *He went from math to words without ever passing reality.* That was the leap that boggled our minds and we cried '*genius'*. But when I looked behind the veil, I found nothing there. His words were ghosts. Instead of 'genius', I cried *'folly'*.

Here's a challenge. If you enjoy mental gymnastics, try to visualize all the other things in the cosmic shower that arise from movement at high speeds. Keep in mind the nature of trinos; that is, *c* and the distinction between *pointing* and *drifting*. And be careful with the timing of the arrival of the trinos to your sensors; that is, lag and the Doppler effect. Start out with things like this. What happens, in our eyes, to an object's length as it comes and goes at high speed? What happens to the electric force? I've been playing this game for years, and it's fascinating. But it's getting harder and harder for an old brain. I wish I could have played this game fifty years ago. Of course a computer model would help.

The Uncertainty Principle

When we measure the air pressure in a tire, a little air has to be released into the air gauge and the pressure becomes less. In other words we change the air pressure by measuring it, and we can never know the exact pressure at any time. Similarly, we can never know the exact velocity and position of a particle, since measuring the velocity changes the position and measuring the position changes the velocity. The only thing we *can* measure is the *probability* of the particle being somewhere and the *probability* of it moving in a certain way. This idea was realized nearly 80 years ago and given a name: 'The Uncertainty Principle.' But for some reason that I can't understand, this principle came to change both physics and philosophy. Since most great thinkers accept this, I guess I'll have to admit that it's me that's missing something—not them. But since my purpose is to show you how I think, I'll have to expose myself here.

Of course there are things we can't measure. *Of course* there are things we can't know. But that hasn't got anything to do with the *universe*. That only has to do with *us*. It looks to me like physicists are saying that if we can't know something for sure, then the uncertainty lies in the

universe—not us. Isn't that what Stephen Hawking said in this quote? "Heisenberg's uncertainty principle is a fundamental, inescapable property of the world." Isn't he doing what my little playmates were doing when I first discovered the second veil: Faith // It ain't necessarily so? Ake saw the world as a Japanese; Johnny as a Californian; Leo as a Catholic. And now *Hawking is seeing the universe as a Human Being*. What's the difference between Hawking saying *"s*uch models of the universe are not of much interest to us ordinary mortals*"* and Ake saying "such a model of the world isn't of much interest to us ordinary Japanese"? Keep this in mind as you read some more quotes.

Isaac Asimov: [After showing that the uncertainty of *time and energy* can be substituted for the uncertainty of *position and velocity*, Asimov says this.] "During the interval of time in which energy content is uncertain, a proton might, for instance, emit a small particle. It doesn't really have the energy to do this, but for the short instant of time during which its energy cannot be exactly determined, it can violate the law of conservation of energy with impunity—because, so to speak, no one can get there fast enough to enforce it. By the end of the time period, the particle that the proton sent out must be back where it started, and the proton must again be obeying energy conservation. The particle, which is emitted and re-absorbed too quickly to be detected, is a *virtual particle*. Reasoning shows it can exist, but no system of measurement can detect it."

Richard Feynman: There is a rule in quantum mechanics that says that one cannot know both where something is and how fast it is moving. What keeps the electron from simply falling in [to the nucleus]? This principle: If they were in the nucleus, we would know their position precisely, and the uncertainty principle would then require that they have a very *large* (but uncertain) momentum, i.e., a very large *kinetic energy*. With this energy they would break away from the nu-cleus.

[Then later he says this.] Nature, as we understand it today, behaves in such a way that it is *fundamentally impossible* to make an exact prediction of *exactly what will happen* in a given experiment. This is a horrible thing; in fact, philosophers have said before that one of the fundamental requirements of science is that whenever you set up the same conditions, the same thing must happen. This is simply *not true*; it is *not* a fundamental condition of science. The fact is that the same thing does not happen, that we can find only an average, statistically, as to what happens.

John Wheeler takes the idea to the extreme with his principle of "observership". He says things like this. All physical laws are dependent upon the presence of an observer to formulate them. And this. A universe without an observer is not a universe at all.

Now Einstein, Hawking, Asimov, Feynman, and Wheeler are profound thinkers. They can comprehend things like virtual particles. I can't. But then I don't have to. You see they don't exist in my simple-minded universe. That's the universe that existed and managed to run perfectly well long before the human mind came along to twist it. This is the universe that Paul Lee saw, "where sand is touched only by sun". I suggest that the reader look again at the above quotes and

notice to what extent they're talking about *man*—not the *universe*. As Paul Lee said, "And that unknown created by man shall perish with him." Notice especially the underlined parts in the above quotes and think about Ake, Johnny, and Leo.

Here's what I think happened. Einstein said that the human mind has limitations and in some cases has to be replaced by math. This meant one thing to him—but something quite different to the following generation. These new physicists were *raised* on the idea. They went from 'the universe as it is' to 'the universe as *we* (humans) measure it to be'. And then came the folly. 'As we measure it to be' came to be taken for granted to the point that it went without saying. Look again at the Hawking quote. "Heisenberg's uncertainty principle is a fundamental, inescapable property of [measuring] the world." 'Measuring' went without saying and was left unsaid. Was it an *oversight*? (We forgot we were talking about 'measuring'.) Was it a *leap?* (If we can't measure it, it isn't there.) Or was it something far too deep for me to comprehend? Whatever it was, measurements *became* the reality. I wonder if they would say the same thing about the pressure in a tire. "The tire doesn't *have* a definite pressure. It only has the *probability* of a pressure."

Quantum Mechanics

Where relativity is the physicists' way of handling (that is, *measuring*) things of high *speed,* quantum mechanics is their way of handling (that is, *measuring*) things of small size. They get an equation from things they *can* see and use it for things they *can't,* and when they get to zero and infinity, their equations go wild. Things like black holes, big bangs, and wondering what holds an electron together. Then they get hit by the uncertainty principle and are forced to measure only probabilities. I think my model of trinos and trons explains things of small size. Look especially at the difference between flicker and beam.

The Big Bang

The physicists saw that the universe was expanding, and they made a good guess. It's an explosion in process. They found the equation that shows the rate of expansion and they reversed it to see where and when the explosion started. The equation shows that about 15 billion years ago the entire mass of the universe was in zero or near-zero space. Things like this no longer needed to make sense. It was a clear case of 'math over mind'.

Now how does my theory account for the expanding universe? I look for some-thing in my model that would push atoms apart. We know that while atoms are electrically neutral they aren't always *perceived* or *felt* as neutral. For example, when protons and electrons are equal in number but different in speeds (as they are in atoms and electric wires), their *l*- and *r*-trinos aren't *received* in equal numbers because of the Doppler effect. We call this *magnetism*. For another example, notice the force pushing against your feet. The outer electrons of the atoms in the floor and those in your shoes get much closer to each other than to the protons further in, and *l*- and *r-trinos* aren't received in equal numbers. This is a *physical push*. Could either of these perceived forces account for a prevailing but extremely weak repulsion between atoms throughout the universe? *Different speeds?* I think not. The differences would balance out. *Different dis-*

tances? They too would balance out, but the effect of the nearer trons would *count* for more because of the inverse square ($1/r^2$). The effect would be very noticeable when atoms are pushed together (like your feet on the floor), but this effect would drop off very fast. Let's take a look.

Look at two atoms of helium next to each other in front of you and measure the attractions and repulsions between all electrons and protons. First let's put them 2*r* units apart, where *r* is the distance from the helium nucleus to the orbiting electrons. The two atoms look like this: *e pp e e pp e*. Here are the *relative* figures I get when I add up all attractive forces and all repulsive forces. Attractive: .6044. Repulsive: .6527. Now let's put them 100*r* units apart. Attractive: .00076915677. Repulsive: .00076915688. Could a universe-wide accumulation of such a minute difference cause an expanding universe? If not, I'll just have to keep guessing.

Black Holes

The gravity equation says the greater the mass the greater the gravity. Can you see what my idea says about this? You may want to think about it before looking ahead. Remember, my 'mass' takes out trinos and leaves holes. The more the mass, the more trinos are taken out, and the more holes are produced. Now as mass gets greater and greater, what's the difference between their gravity and mine? Their limit is infinity (there is no limit). *My* limit is the density of the cosmic shower. Once you reach enough mass to take out *all* trinos that come at you, you've reached maximal gravity. *Twice* that critical mass would produce the *same* gravity. The critical mass and all greater masses would block out all trinos that hit it. No trinos would get through. One great hole would be emanating in all directions. *But this doesn't mean that any trinos it produces itself can't get out.* The light from a feeble flashlight could escape. In my theory, gravity acts on light from the side only.

Quarks

When electrons are shot at protons, they bounce off at angles that would suggest the presence of three hard particles inside the proton. This, among other kinds of evidence, led to the theory of quarks. Could this scattering be explained by the orbiting trons of my model? The angle of rebounding from a proton would simply depend on where the *r-tron* happened to be in its orbit when it got hit.

Subatomic Particles

New particles are being found all the time—most of them lasting only fractions of nanoseconds. Could all of these particles be explained as nothing more than different combinations of trons in orbit? A neutron has one *r-tron*, one *l-tron*, and 3670 *n-trons*. Picture a neutron disintegrating step by step and take a high-speed picture of each short-lived step. You might get hundreds of different snapshots along the way. Each different snapshot would show a different particle.

Preface

http://www.copyright.gov/

Form of Notice. — If a notice appears on the copies, it shall consist of the following three elements:

(1) the symbol © (the letter C in a circle), or the word “Copyright”, or the abbreviation “Copr.”; and

(2) the year of first publication of the work; in the case of compilations or derivative works incorporating previously published material, the year date of first publication of the compilation or derivative work is sufficient. The year date may be omitted where a pictorial, graphic, or sculptural work, with accompanying text matter, if any, is reproduced in or on greeting cards, postcards, stationery, jewelry, dolls, toys, or any useful articles; and

(3) the name of the owner of copyright in the work, or an abbreviation by which the name can be recognized, or a generally known alternative designation of the owner.

(c) Position of Notice. — The notice shall be affixed to the copies in such manner and location as to give reasonable notice of the claim of copyright. The Register of Copyrights shall prescribe by regulation, as examples, specific methods of affixation and positions of the notice on various types of works that will satisfy this requirement, but these specifications shall not be considered exhaustive.