Communicating without Language and Grammar

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Chronicling the Development of a New Science

By

Victor H. Yngve

With contributions by

Patricia C. Sutcliffe, Bernard Sypniewski and Lara Burazer

Edited by

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WORD FROM THE EDITOR

BY LARA BURAZER

For Vic

As I was setting out to navigate the landscape of the academic community, right at the start of my scientific journey as a linguistics scholar, I had the pleasure of meeting one of the greatest names in the then scientific linguistics circles. Victor H. Yngve (Vic for short), honored my home University (of Ljubljana) with his attendance at a linguistics and translation studies conference in 1999. At the time, these two fields represented a crossroads for his research interests, for both our research interests in fact. With his distinctive humble attitude, he invited a few colleagues at the Faculty of Arts to embark on the journey of investigating how people communicate, and to do that within the framework of the hard-science or 'real science', as he would refer to it. He had named this newly emerging field of study Hard-Science Linguistics or Human Linguistics (abbreviated to HSL and HL, respectively).

Human linguistics? one might ask. His perception of science and the world was grounded in physics. His affiliation within the University of Chicago, however, was with the Department of Linguistics and Psychology. With his approach to the investigation of human communication, these three fields – physics, linguistics and psychology - seamlessly converged into the perfect angle, opening up a unique perspective on the subject of research. In trying to come to the bottom of human language use and discovering how people produce language with the ultimate aim to communicate with each other, HL would apply the laws of physics and other hard sciences to analyzing instances of real-world human communication. The goal was to find the way for linguistics to make a step outside the realm of the soft sciences and tread into the realm of the hard sciences, on a par with physics, chemistry, or biology.

His journey of trying to find the common denominator for two such diametrically opposed fields of study – language, firmly set in semantics and humanities, and natural science – strongly marked its beginning as the new approach to linguistic studies by the publication of his 1996 book *From*

Grammar to Science – New Foundations for General Linguistics. In it he proposes that the term hard science linguistics be used for the linguistics whose research and results are based on tangible evidence from the *real world*, in order to distinguish it from 'most current brands of linguistics which are properly characterized as *soft sciences*'.

Since the primary focus of observation has been shifted from language (a philosophically based entity) to people (parts of the physical world), the term *human linguistics* had also been introduced to further emphasize the fact that the object of scientific observation has become *the human being, people* and the physical reality underlying human communication. The evidence obtained through careful observation and experiment will then serve the scientists to test the predictions of theory against the real world.

In its relatively short existence, hard science linguistics has been introduced in a number of international linguistic events (SLE in Europe, LACUS in the United States of America and Canada) and has been recognized as a plausible linguistic theory, attracting and engaging a number of well-established scholars. This seemingly controversial but incredibly appealing idea of merging linguistics into hard science, also foregrounded an alliance with me and a few other colleagues at the Faculty of Arts, one characterized by mutual respect and keen engagement into the realm of the unknown. This was a bold move for me, as someone who was just starting out professionally. But as fortune favors the brave, it eventually evolved into a fruitful professional cooperation as well as a true friendship.

During our academic exchange, when we were working on scientific projects together, I would often stray into what Vic strictly referred to as 'semiotic tradition' rooted in the principles of a few linguistics scholar's 'intuitive guesses'. The physicist in him would not allow any such drift from the hard-science path and would immediately reroute my thought process into the HL landscape. It was tough sometimes; he was a stern teacher. I had to learn how to draw a hard and fast line between hard and soft sciences, between science and intuition, basically unlearning the fundamentals of linguistics that I had thus far acquired.

Some priceless lessons awaited me in this professional and personal, friendly alliance. One of the most important ones was '*to ask the right questions*', as he would always highlight it as an indispensable starting point in any scientific endeavor. Looking back, I now realize that despite his grudge against intuition, my mentor, my role model and a friend was teaching me the fundamentals of true hard-scientific scholarly work. Another valuable lesson was that of having the courage to embark on the journey of exploring the unknown, the unexpected, and the impossible.

Vic's scientific exploration came to a halt in 2012. But his ideas continue to expand. To us, though, his circle of friends and colleagues, Vic will always be the epitome of the hard-working scientist, dedicated to discovering the underlying truths of the real world and how people communicate. As a scholar, he was also one to recognize the value of mentorship and guidance and how important it is to have people in your life you look up to. But also how important it is to be the person that your younger counterparts can rely on. He would generously and unselfishly acknowledge our contributions to the furthering of HL, however miniscule we thought they were. He would recognize the achievements of those that came before us.

He generously shared with us, his trusted colleagues and successors, the honors that were served to him personally by the University of Chicago – the Enrico Fermi commemorative stamp issued on the occasion of the University of Chicago's Centennial Celebration. He versed his dedication so beautifully and eloquently, that I invite you to browse through the following two pages and read it to get a sense of the persona that Vic was with us, the circle of HL scholars.

In loving memory of a dear friend and colleague,

Lara Burazer

November 1, 2001

Dear Bernard, Carl, Doug, Lara, Laura, and Mojca.

Two days ago, on Saturday Oct. 29, I was invited to a centennial celebration at the University of Chicago of Enrico Fermi's birthday. Many dignitaries were there and many of his former students and colleagues at Chicago spoke at an all-day session of remembrances. The US Postal Service unveiled a new commemorative stamp honoring Fermi to be issued today. Enclosed is the stamp with a "first day of issue" cancellation. It's a collector's item and I wanted each of you as key early pioneers sharing Fermi's scientific legacy to have one.

What is Fermi's scientific legacy and how does it relate to what we are doing?

During World War II I served in the Pacific as a technician carrying out medical laboratory tests such as blood counts. I was happy to have been assigned there as I was able to do something positive in a world that seemed to have gone mad with hate and destruction. I was horrified when the atomic bombs went off over Japan and knew immediately from my physics training what they were.

Then after the war I went to Chicago to take up graduate studies in physics. There, as it turned out, I found on the faculty many of the scientists that had been instrumental in ushering in the nuclear age. For many people the horror of the bomb was blamed on the scientists and we are witnessing even today a backlash against science. But science is neutral. It can be used for good or for evil. The cave men who found out about stones could use them as tools for hunting and preparing food or for killing each other. Fire can be used to cook food and to keep us warm in cold weather or it can be used to destroy others. It's much the same with nuclear energy. It has always been that way.

And it's easy to see that it will be the same with what we find out scientifically about how people communicate. Communicating is the glue that holds societies and cultures together but it can also be the instrument of oppression, fear, hate, and the worst that we abhor.

Although science is neutral, my personal choice after finishing my PhD at Chicago in physics was to leave science proper and to try to use science for some positive good. That's basically why I went to MIT to try to find out how to translate languages by computer. In a world gone mad it seemed to me that finding out how to improve international communication would be a force for good. But when the translation studies revealed that there was something wrong with the scientific foundations of linguistics, I was challenged to try to do something there along the lines of pure science. I am essentially optimistic that on balance people will use the new scientific knowledge we gain of how people communicate to help build a better world that can live at peace.

So what is Fermi's legacy for me? It's not the atom bomb. It's the man as scientist and as inspired teacher. The stamp shows him as I remember him, a quiet and unassuming teacher. He was by far the best teacher I had at Chicago. He could explain otherwise obscure things with the greatest clarity and he could penetrate quickly to the essence of any problem and often solve it ten times faster than anyone else could. He could explain things with such clarity because his insatiable curiosity had driven him to understand them in their essence.

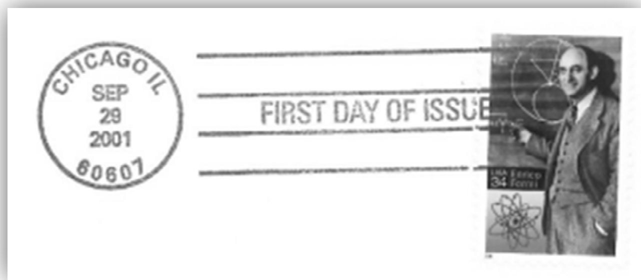
Fermi laid great emphasis on giving students problems to solve. After each lecture he would assign one or two problems, and solving the problems was a large part of the course. Remembering that part of Fermi's legacy, I think it would be wise, as a collaborative effort, for us to develop a set of problems for each chapter in the 1996 book.

I wish I had one tenth of Fermi's genius and I wish that I could wave a magic wand and confer it on you. The future of what we do lies in doing good science, and that future is in your hands.

May I wish you happy and successful scientific explorations.

Yours,

Vic Vic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FOREWORD

BY BERNARD SYPNIEWSKI

Anyone who has read any of Professor Yngve's writings cannot but be struck by his concern for science. He began, at MIT, attempting to create computer programs for machine translation but rapidly changed his focus, and that of his group, the Mechanical Translation Group, from a specialized machine translation program to a more generalized approach called COMIT. COMIT used some modified rules based on the early work of Noam Chomsky's transformational grammar. The group's major effort, called COMIT, became a general-purpose language designed for mechanical translation but that could be used also for other purposes.

By 1959, Professor Yngve's work on mechanical translation induced him to formulate his famous "depth hypothesis", published in 1960.The hypothesis essentially says that language is not infinite as some linguists postulated but could compactly use rules to create complex sentences using small amounts of memory. The depth hypothesis made Professor Yngve famous. It was a hypothesis based on then-current linguistic theory.

He became dissatisfied with these theories by the mid-1980s. His concerns for the "science of linguistics" can be summed up simply: linguistics was not very scientific. Traditionally, linguistics has roots in ancient Greece, first formulated by Aristotle. Aristotle's codification was based on his development of logic and the notion that thought processes could be systematized. That meant that language could be too if it were in some sense logic-like.

Curiously, this assumption hadn't been challenged in any serious way for 2500 years. Other disciplines, like Professor Yngve's favorite example, astronomy, has moved from an assumption-based field of discussion to a science based on a study of the real world of which the universe is a part. When he came to asking himself why there was a difference between such disciplines, Professor Yngve noted that while astronomy and other actual sciences studied real, existing things which could be observed, measured, and otherwise analyzed, linguistics studied theoretical objects like *morphemes*, *phonemes*, *grammar*, and *language* which were not physically real.

He asked himself what a form of linguistics which studied only real things would look like. First, a scientific linguistics would have to be based on the four fundamental assumptions accepted by other sciences: (1) that there is a real world out there to be studied, (2) that it is coherent so we have a chance of finding out something about it, (3) that we can reach valid conclusions by reasoning from true premises, and (4) that observed effects flow from immediate real-world causes. There were only two working criteria: (1) that the predictions of theory agree with the results of observation and experiment and (2) that the results of observation and experiment be reproducible. If any assumption were not accepted or either criterion not part of the machinery of a new linguistics, there was no science to be had. None of these assumptions and criteria were basic to traditional linguistics.

This was radical stuff; it shook the very basis of traditional linguistics. Needless to say, it was rejected by most linguists. How could Professor Yngve say that traditional linguistics didn't study objects in the real world? Actually, it was quite simple. One of the objects that Professor Yngve thought that a scientific linguistics could fruitfully study were sound waves. Traditional linguists see *words* as consisting of *phonemes* among other things. Professor Yngve's scientific linguistics, which came to be known as Hard Science Linguistics or, simply, HSL, rejected the notion that there was a real-world object called a *word* and explored sound waves instead. Take any sound editing program, no matter how simple. You can input sounds. The program does not care whether the input is a *word*, a *sentence*, a bird call, or some gibberish. It will accept them all as long as the proper input connections are made. Let a traditional linguist input a *word*, any *word*. The program will produce a graphic representation of the sound. Now let the traditional linguist looking at the graphic representation say where the *phonemes* are. There are no *phonemes* evident in the sound graph. Can a program be written in such a way to identify traditionally described *phonemes*, assuming that traditional linguists can identify them all? Certainly, but such a program assumes several things. It assumes that there are *phonemes*; it doesn't produce evidence for them. It assumes that they were correctly identified according to a generally accepted system; good luck with that. The programmer will have to take the representation of the *phonemes* and the sound input into the program and match the written *phonemes* to the input. In other words, the sound input will have to be converted into some written system which can then be used to compare with the written *phonemes*. There mustn't be any bits and pieces left over either.

HSL researchers have developed a simple and apparently infallible test to determine whether something is a real-world object which could be studied or not. Ask simply: where is it (the object)? Where is *language*? Where is *grammar*? Where is a person? Where is a sound wave? The last two questions can be answered unequivocally. Both can be directly perceived by human senses or otherwise detected by aides to those senses, such as the aforesaid sound program or by the ear or both. What about *language*? People certainly speak to each other, but they do so via sound waves which are intercepted and processed by others. Once again, the sound waves are real. *Language* is a concept and, when you get right down to it, an ill-defined one at that. *Language* is often claimed to be a communication system but are whistles, gestures, and the like part of *language*? When we look at a definition of *language*, we find that it consists of yet more concepts; *language,* according to the tradition, must have a *grammar*, but *language* is not simply a code. Linguists can disagree about linguistic concepts and often do. Here is yet another problem that Professor Yngve confronted and addressed. There is no way to prove or disprove which concepts are valid. In fact, validity doesn't enter into HSL. Proof is the hallmark of science. These concepts can be argued about but never definitively proved.

As you read this book, keep in mind that science, one of which HSL aspires to be, requires not just a hypothesis but one capable of being proved by both experimentation and reproducibility. HSL provides a structure in which researchers can work. HSL does not tell us how people communicate or how the various elements of the real-world influence human communication, if indeed they do. HSL provides a framework for research, not a set of conclusions. HSL researchers use the framework to structure their studies. What does a hypothesis have to do in order to be subject to experimentation? First, decide what needs to be examined; second, state that decision in everyday language. What does a researcher wish to study? Is that subject so common that it can be observed “in the wild” or must there be some sort of laboratory that will be used? How many people are involved in the study and how do they communicate with each other? Are objects other than people involved? Take, for instance, the situation in which one person, Able, arrives at the door of the apartment or house of another, Baker. Able presses the doorbell. So far, there are two people involved, a setting of an apartment or a house, and two objects, a doorbell button and a door. Not much here but what comes next? We know that Able expects (HSL recognizes and can use expectations) that the doorbell buzzer will cause some sort of sound (sound wave – could be a buzz, a bell, chimes, etc.; could also be loud or soft – properties of the sound wave) signaling to Baker that there is someone on the other side of the door – a simple form of communication. What if the bell is broken or disabled in some way or if the sound is not loud enough to penetrate that part of the dwelling inhabited by Baker or if Baker is otherwise distracted (a phone call, taking a shower, etc.) or is not even at home?

What began as a very simple scenario can be seen to require some thought in its description (linkage). If the researcher were to observe only those instances in which Baker were home, some things which we've just discussed become irrelevant and need not be considered. If the researcher were to observe a variety of situations, some or all of those things we've discussed, and probably more, would need to be included. If there are a sufficient number of observations – the number will vary depending on the hypothesis to be tested - the researcher can develop a description complete with rules: if this were to occur, then that will occur. The description and the rules can be tested by making a new set of observations and determining whether the rules predict the way that the newly observed instances occur. If so, the hypothesis is supported. If other researchers test the hypothesis and get similar results, we can say that scientific criteria have been satisfied.

It is important to see that if the new observations are not predictive the hypothesis does not satisfy the scientific criteria at the heart of HSL. Either the hypothesis must be reformulated or rejected altogether. A reformulation may include a simplification of the hypothesis or the addition of new elements. If the hypothesis is reformulated, a new series of observations must be made and used to test the hypothesis once again. The scientific method is not easy. It is tedious and repetitious. Properly done, the scientific method which Professor Yngve so forcefully encouraged others to adopt when studying matters of linguistic concern allows us to say that some, no doubt small, aspect of the way that people communicate with other people in the real world does so in a certain way.

Showing how the world works in well proven ways is the point of science. This accounts for the title of Professor Yngve's seminal 1986 book: *From Grammar to Science.* Some traditional linguists may have taken the title to indicate that the book's contents were nothing more than another complaint by a disaffected linguist about this or that technique or theory. The book, as well as his subsequent efforts, were the result of a long, diligent attempt to create a scientific basis for a "science" that had never been scientific for all its long history.

One peculiarity about HSL is that, while HSL techniques and their use require considerable effort on the part of a researcher, HSL does not require the researcher to have been deeply immersed in linguistic theory and jargon. Indeed, a significant difficulty when designing a project using HSL techniques is to recognize and discard linguistic notions that are non-scientific. For someone steeped in traditional linguistic theory, the elements of that tradition are ingrained and unconscious. Anyone who knows how to observe the world can use HSL techniques fruitfully. In fact, Professor Yngve's early experience with COMIT came full circle. COMIT was originally designed for linguists to use in a way that did not depend on the linguist's knowing how computers and programs worked. COMIT was developed in the mid to late 50s. Not many people knew how to program a computer. COMIT enabled the linguist use computers for linguistic purposes without learning the arcana of computer science. What Professor Yngve found is that people other than linguists began to use COMIT for their purposes as well. In other words, a well-designed computer language created for a specific purpose became a computer language with a general purpose. HSL techniques can be used for purposes other than linguistics as well. Anthropology and sociology come easily to mind because HSL allows – actually requires – the researcher to describe what *people* do.

Since HSL permits linguistics to be a science, it is HSL's way too. Rather than describing here what HSL is in detail, read what Professor Yngve has to say about his new scientific method in the rest of this book.

THE NEW SCIENCE: COMMUNICATING WITHOUT LANGUAGE AND GRAMMAR

CHRONICLING THE DEVELOPMENT OF A NEW SCIENCE

BY VICTOR H. YNGVE

with contributions by:
Patricia C. Sutcliffe, Bernard Sypniewski
and Lara Burazer

PREFACE

Language is dead, killed at the beginning of the twentieth century by Ferdinand de Saussure, who understood that language is not real; it is only created by a point of view. He introduced abstractions instead, but to no avail; abstractions are also not real and only created by a point of view. Language has seemed very real to us but there is no proof. It cannot be studied by science.

Where does this leave linguistics, the would-be scientific study of language, and where does it leave our understanding of how people communicate? It left a whole discipline caught up in the lie that took language to be real and not realizing it or how to get out of it. They acted as if they really did believe there was such a thing as language, although some knew better. With talk of convenient fictions they continued to pretend or hope that with progress, false beliefs would eventually become true. They were deluded. Fictions, convenient or not, cannot be studied by science either.

Galileo would brook no false beliefs. He convinced many people of the Copernican view that the sun does not orbit the earth producing day and night as it seems to us: it is really the earth turning on its axis.

Our only defense against unreal abstractions and false beliefs is science, the science of Galileo and modern standard science.

This book, forty years in the making, offers a new science for consideration by all students of nature that proposes a solution to the age-old mystery of how people communicate and unlocks previously hidden secrets of many of the things that make us human.

Galileo is perhaps best known for building the first astronomical telescope and for the startling discoveries he made with it. More important, however was his role in championing science as the best way of learning about the world. This was truly a magnificent gift to humanity. A gift we celebrate in this book by introducing a new science where there has been no proper science and using it to try to push back the edges of ignorance.

This new science builds on the standard assumptions and criteria of all science that we find in Galileo's work. It leads to proposing a new scientifically justified theory for understanding human communicating and human institutions such as marriage.

The mystery of how people communicate is one of the most puzzling we have wondered about since ancient times, and one of the most important still largely unsolved. Fundamental questions have been neglected, inadvertently shoved aside in favor of long established intellectual agendas by those who would never suspect that physical methods would be appropriate and effective for problems faced in the social sciences and the humanities.

We need a proper science here to stand alongside physics and chemistry. Such a science is Hard-Science Linguistics, the scientific study of how people communicate. It is a new linguistics governed by Galileo's science–a proper science without language and without grammar. How can we have a linguistics without language and without grammar? And how can such a linguistics be based on Galileo's science? We will use a method of analysis familiar in the sciences and start with simple things first. We will start with the communicative effect of a touch by the hand and then go on to solve a number of more complex and puzzling mysteries about how people communicate.

INTRODUCTION

Galileo studied the world known to the ancients, the world of the sun and the moon and of the stars and planets. With his telescope he could see them more clearly than could the ancients with their unaided eyes. People had tried to understand these things in terms of theories that would explain what they were seeing. The ancient Ptolemaic theory put the earth at the center with the sun and everything else revolving around the earth. The newer Copernican theory put the sun in the center with the earth and the planets revolving around the sun and the moon revolving around the earth. With his telescope Galileo found convincing evidence by studying Venus and the moons of Jupiter that the newer theory with the sun at the center was correct.

Galileo studied the real world. Language, long seen as at the heart of communicating, had been assumed to be real, in fact, not so long ago, it was thought to be a real living organism with a life of its own separate from the people who speak, and thus it was thought it could be studied by science. But we now know, thanks to Saussure's insight, that language is only created by a point of view. It is not a real object and thus it cannot be studied by science. We must instead study the real-world people who communicate. They can be observed and the observations can then be compared with the predictions of theory to build a new science where before we had none.

As you will see in this book, Hard-Science Linguistics, the scientific study of how people communicate, opens up a whole new world. Surprisingly it holds answers to questions about society, our occupations, concepts, potentially about much of what matters to us that we talk to each other about or think about. Communicating is the key.

But gay marriage? Yes indeed. That's there, too. All social institutions operate by people communicating. Marriage is all about communicating. Galileo's science can help us understand how.

It had been thought that physical and social phenomena required quite different orders of theory: that the social and behavioral sciences were soft and incompatible with the hard physical and biological sciences and that their theories would therefore have to be quite different. But as we show here, we only need one science: standard science as we know it from Galileo's science and modern science.

This book shows that social, behavioral, and cultural phenomena as well as physical phenomena can be understood in a hard science in ways we learn from Galileo's science, and that the results lead to new insights into the social, behavioral, and cultural, phenomena.

In order to understand scientifically how people communicate, we need to study people. We must move our studies of how people communicate completely out of philosophy and into the real world of standard science where the other sciences are located. This book shows how.

Many linguists nevertheless, following habit or tradition or older writings, continued to pursue an abstract grammatical linguistics far outside of standard science and featuring the predictable disarray of disputed claims and wild guesses. Decades of research that looked instead for guidance to Galileo's gift of science yielded the hoped-for results we present here: a coherent and scientifically justified theory of how people communicate, a testable hard-science that banishes language and grammar and moves our studies out of philosophy and into standard science.

A prize-winning historian of linguistics provides the needed historical perspective and insight for understanding how the older flawed views came about and for understanding what now has to be done to replace them.

The foundations of this new science are explained here and the first steps taken in building a new discipline on them that is now available for all.

CHAPTER ONE

GALILEO'S DISCOVERIES

Galileo's astounding book *Sidereus Nuncius* (The Starry Messenger, or Astronomical Message) caused a sensation in 1610 when it first came out and it became an instant best-seller.

It recounts briefly in Galileo's own words the story of his constructing the first astronomical telescope and of his first observations with it. It is thrilling even after four centuries to read in the excellent and easily available translation by Stillman Drake (*Discoveries and opinions of Galileo*, 1957, Anchor) Galileo's own account of his exciting first discovery of mountains on the moon and to see Galileo's drawings of them and the other things he observed through the telescope that had never been seen before and to read what he made of it all.

And as if mountains on the moon were not enough, Galileo goes on in this amazing but true story to recount his discovery that the milky way is just a vast multitude of stars and that there are moons revolving around Jupiter just as our moon revolves around the earth. He also explains how he distinguished the satellites of Jupiter from background stars and how he determined that they were orbiting around Jupiter with those in orbits close to Jupiter going around faster than those further away. He later determined their orbits and periods.

Then came his startling discoveries that Venus goes through phases just like the moon and that Saturn appeared through his telescope as having two close large moons traveling along with it, and then to his surprise some four years later they had disappeared! We now know that they were Saturn's rings that disappeared from view when they turned edge on to the earth. And he tells us what momentous things he concluded from these observations that were destined to completely overturn age-old views of the universe to the approval and delight of astronomers but to the considerable consternation, dismay, and displeasure of certain powerful personages who wanted to preserve traditional views.

In this day of moon landers, Mars rovers, orbiting telescopes, close exploration of Saturn, Jupiter, and their satellites, and explorations of the far reaches of the solar system and beyond, it is hard to believe that these discoveries would have met with any opposition or aroused any controversy about what exists in nature, especially since these things were clearly visible for all to see through the telescope and Galileo provided telescopes for the opinion leaders of the day who wanted to see for themselves, but some refused even to look through Galileo's telescope.

These discoveries did arouse considerable controversy and even opposition. Although astronomers were quick to hail his discoveries, his conclusion that there were mountains on the moon was opposed by the peripatetics, those philosophers who followed what they took to be the teachings of Aristotle that the moon was a perfectly smooth unblemished sphere.

Galileo had noted that the existence of moons revolving around Jupiter as our moon revolves around the earth was just what one would expect under the theory of Copernicus, put forth seventy years earlier, that the sun was at the center with the earth and other planets revolving around it and with the moon revolving around the earth. It was an example of observations agreeing with the predictions of the newer Copernican theory and not the older
Ptolemaic theory.

Galileo had also noted that the fact that Venus shows phases like our moon indicated that Venus was revolving around the sun, not around the earth as had traditionally been thought. In its revolutions around the sun, we on earth could see that different sides of it were illuminated by the sun and it showed phases like the moon that depended on which side was turned toward the sun and which side toward the earth. In fact Copernicus had predicted this, but was unable to see it in those days before the telescope.

Galileo pointed out that both of these observed phenomena, the moons of Jupiter and the phases of Venus, argued powerfully for a Copernican world system with the earth revolving around the sun like the other planets. He was opposed in this by the theologians and clergy and their followers, who believed that what they understood from the Bible must be literally true, a Ptolemaic world system with a stationary earth and the sun and planets revolving around it.

It was a clash of two quite different ways of deciding what to believe about the world: the newer scientific way that proceeded by careful reasoning from observations of the real world, and the older way of proceeding from faith in the literal truth of ancient writings from Aristotle or the Bible.

Galileo warned of the problems attending the clash of these two ways of knowing in a note he added in the preliminary leaves of his own copy of his *Dialogue Concerning the Two Chief World Systems—Ptolemaic and Copernican* (Drake 1967:v):

"Take heed, theologians, that in your desire to make matters of faith out of propositions relating to the fixity of sun and earth you run the risk of eventually having to condemn as heretics those who would declare the earth to stand still and the sun to change position—eventually, I say, at such a time as it might be physically or logically proved that the earth moves and the sun stands still."

We can learn from these controversies of four centuries ago lessons that are still relevant today and we should take to heart the importance of being willing to doubt entrenched authority and discard long established opinions, no matter how firmly held, when they contradict the careful and confirmed findings of observational and experimental science.

That Galileo was right is now understood by virtually everyone. The rotation of the earth is demonstrated by many phenomena and in many experiments on earth. To give just two, the Coriolis force, which affects the circulation of the winds oppositely in the northern and southern hemispheres so hurricane winds circulate counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere; and the Foucault pendulum that when set swinging freely out of the wind in a high tower gradually changes its direction of swing with respect to the earth as the earth turns under it. To these we can of course now add the views from space we get of the earth as it turns.

Galileo's Starry Messenger is an excellent introduction to science because it so compactly and beautifully illustrates Galileo's methods in the conduct of a scientific investigation, methods that were being developed at that time and earlier and are still followed essentially unchanged to this day in the investigation of nature. It powerfully evokes for us the excitement and adventure that one meets with in scientific exploration and the discovery of new and wonderful things, an excitement one still feels today in dispelling ancient mysteries and finding out new things about how people communicate.

The view one gets of science from Galileo's Starry Messenger is not unique to Galileo. We could have chosen other scientists in other fields and indeed encourage the reader to read about those others who played a formative role in the development of science in many fields besides astronomy. But we can deservedly call the gift of science Galileo's gift:

Of all the seventeenth century founders of modern science, it was Galileo who was the most influential in its wide acceptance. With his extraordinary literary talent he wrote for the general educated public of his time and was his own popularizer. He turned his considerable wit and cogent arguments against unsupportable ancient lore and entrenched authority and was instrumental in the wide acceptance of the Copernican cosmology, where everything revolves around the sun, to replace the ancient and deeply entrenched tradition of Ptolemaic cosmology, backed by a powerful Church and influential philosophers, where everything revolved around a fixed and unmoving earth.

It was Galileo who built the first astronomical telescope and used it to greatly advance our understanding of the universe. And it was Galileo who had the temperament to carry on extensive intellectual and polemical arguments with all comers in an effort to convince everyone of the correctness of what he had learned from his observations, a temperament he perhaps received from his father, who reformed musical theory in the direction of the equal-tempered scale to better accord with how his singers actually sang rather than following the ancient Pythagorean theory of pure mathematical intervals in the musical scale.

It was Galileo who took it upon himself to try to convince everyone that scientific research was the proper way to find out about nature rather than to blindly follow Aristotle or Holy Scripture–in the study of nature, follow the teachings of nature, not of books. And it was Galileo above all others who gave us many clear and incisive explanations of the causes of things.

It was Galileo who gave us an account of his first explorations with the telescope that, including some of his drawings and diagrams, is only 32 pages long in the English translation and a model of clarity and completeness of explanation and a marvelous teaching and learning tool. Everyone interested in science should read it and study it carefully. It's beautiful.

Galileo was condemned to house arrest for life in 1633 for claiming that the earth moves when the Church said it did not move.

It was Galileo who gave us in his last and most important book, *Two New Sciences* (1638), the first great work of modern physics which was the model for physics texts even up to the twentieth century. This book was completed when he was an old man, blind, and still under house arrest. He died in 1642.

Galileo was rehabilitated by the Catholic Church in 1992 after 359 years.

For a better understanding of Galileo and his importance:

Start with the other selections in Stillman Drake's (Anchor 1957) excellent paperback translation *Discoveries and Opinions of Galileo* we have already dipped into, and Galileo's two major books: his most famous

Dialogue Concerning the Two Chief World Systems—Ptolemaic and Copernican, and his most important *Dialogue Concerning Two New Sciences*. There are also good translations of most of Galileo's other works.

It's always important to read historical materials in the original or in a good translation rather than secondary materials; in the case of Galileo an enjoyable experience because of the superb literary quality of his writings.

Physicists and astronomers were immediately swayed by Galileo's discoveries and arguments, but the theologians, who had a different explanation for the motions of the stars and planets took a bit longer. Galileo's views are now almost universally accepted. People who still think the earth stands still and the sun moves around it producing day and night are in a vanishing minority.

Discussion

Q. I understand that the earth turns and that gives us sunrise and sunset and day and night. How can I understand that? The earth seems so solid and I don't feel any motion and there doesn't seem to be any danger of falling off.

VHY- Galileo did not find the answer to that. It had to wait for Newton and his law of gravity. There are still mysteries surrounding gravity that physicists, astronomers, and cosmologist study.

CHAPTER TWO

THE MYSTERY OF HOW PEOPLE COMMUNICATE

The mystery of how people communicate is one of the most baffling of mysteries that have puzzled our best minds for millennia.

Communicating is involved in essentially everything we do. Its impact on human affairs is immense. Although it is the essence of what makes us human, its inner workings have remained largely hidden from us.

There have been many attempts. The landscape is littered with discarded theories once held in high regard. They had each been put forward with hope (and sometimes hype) only in the end to be tossed on the refuse heap with the others. And the theories still remaining in contention are doubted, disputed, and disappointing. They offer us little hope.

Incredible as it may seem, this unsatisfactory state of affairs regarding the still unsolved question of how people communicate wends back through time to the beginning of recorded history and myth.

Will we be able to solve this ancient mystery?

In this book we will try. We will follow the science of Galileo and modern science and venture to propose a new theory of how people communicate. In following science we hope to ensure that our theories are correct and are thus not destined to end up on the trash heap of failed theories.

Why have they failed? I think all for the same reason. It has to do with a crucial question: How can we decide what to believe? How can we decide whether or not to accept a particular proposed theory? It's a question that had a partial answer dating back at least to about 300 to 150 B.C and the ancient Greek Stoics, whose philosophy was destined to have considerable influence on Western thought for millennia. The Stoics distinguished three parts of philosophy, the physical domain, the logical domain, and the ethical domain. We will be concerned here only with the physical and logical domains.

The physical domain included their views of nature, the physical universe, stars and the planets, living things and the gods, and the human psyche, or soul, which they believed had eight parts: the five senses, the faculty of speech, the intellectual faculty or the mind itself, and a faculty concerned with reproduction, generation, and healing.

The logical domain, on the other hand, was concerned with an ideal of perfection and with a theory of knowledge, how a perfectly rational wise man or sage could come to know and speak the truth. This part of philosophy was often divided into rhetoric and what they called dialectic. Rhetoric dealt with speaking well on matters set forth in plain narrative. Dialectic dealt with correctly discussing subjects by question and answer, or subjects true, false, or neither true nor false. Both in rhetoric and dialectic the Stoics maintained a thoroughgoing distinction between the subject matter expressed and the expression. The emphasis was on perfection, on speaking and writing Good Greek.

The Stoics were very much concerned with questions of how to decide what to believe as true. In the forerunner of modern science in the physical domain, one could decide what to believe about the world ultimately by means of observation by the senses, and they were agreed on that as also were other philosophers at the time. And that still holds today in the physical and biological sciences. Galileo's works are excellent examples. Modern science decides whether or not to accept a proposed theory in the same way, that is, comparison of its predictions with the results of observation and experiment with the real world. This boils down ultimately to observation by the senses. It is only in the physical domain that one can have theories that are properly scientifically justified because only in the physical domain can one test one's theories against the real world.

In the logical domain, on the other hand, it all came down to opinion, and opinions may differ and cannot be justified scientifically. One would think that the ancients would have taken the question of how people communicate as part of treating the faculty of speech, thus in the physical domain, and so today we might have achieved agreement here as well in a proper testable physical-domain science that might have developed out of it. But no, these things were in the logical domain along with dialectic and the norms of correct speaking and writing.

So today we are faced with the question of what kind of a theory can we have of how people communicate. In this book I will tell you the solution to the mystery in the beginning. Your task will be to understand it so as to be able to apply it.

The answer is that in asking about how people communicate we must ask about people, not about language or communication or any other abstractions. We must move from the logical domain, where most work on communicating has traditionally been located, to the physical domain and