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*Presidential Address*

## A time for insight and reflection

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It is a very great honor to address this long-established and prestigious Society as your President. The honor I sense is not that which comes purely from position but is a feeling engendered by the respect you all appear to have for this office. It is unique. There are others more deserving, but I am grateful and proud of this confidence.

I never fail to be impressed by your ability to bestow these laurels upon a Canadian. This demonstrates a remarkable quality in Americans that may be described in one word as magnanimity.

This is one of the outstanding impressions Canadians receive on meeting Americans, whether we meet on foreign soil during a war, seeking solitude and fish in a remote Canadian lake, hunting and marvelling at the beauty of wildfowl in the prairies, or just being your guest. As a country and as individuals, you have a remarkable instinct to share. Mind you, unlike the Eskimos, you draw a very strict line in certain areas—and for very good reason!

We are all aware of the unprecedented expansion in medical knowledge during the last 50 to 75 years—in our own specialty in the last 30 years. With a background of medical history, I would like you to join me in viewing and assessing some of the implications of this changing scene in medicine.<sup>1-14</sup>

Let me take you back in history to one sunny morning in 1591, a little less than 400 years ago. Students and teachers of the University of Pisa in Italy are assembled at the foot of the wonderful, white marble, leaning tower of Pisa. A young professor with a look of serious dedication climbs a spiral staircase until he reaches the gallery surmounting the seven tiers of arches. The people below watch him intently as he carefully balances two metal balls on the edge of the gallery, one weighing ten times more than the other. They are released at the same instant and are seen to fall evenly through the air until they are heard and seen to strike the ground at the same moment.

The sound of those weights as they hit the ground reverberates to this day. That episode initiated a revolution in thinking.

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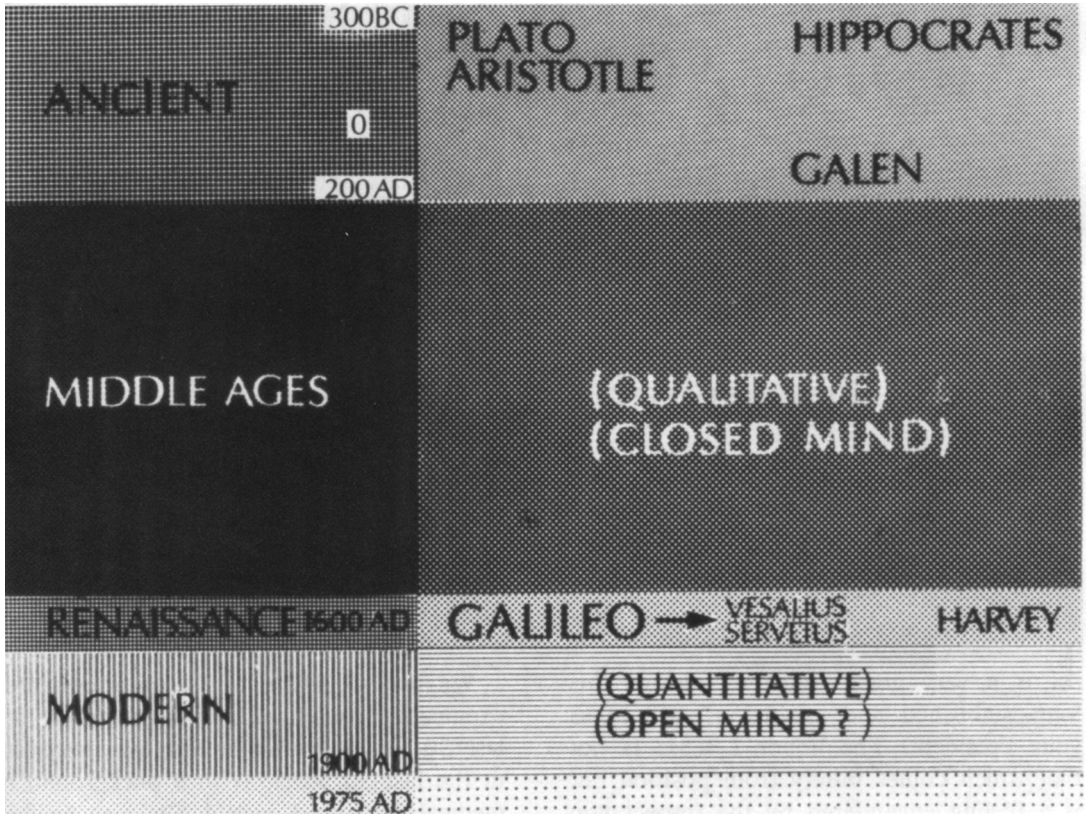


Fig. 1.

Who was this man, and why does such a simple happening call for such high-sounding remarks? His name as you have guessed was Galileo, and he had just taken a courageous first step to prove as false some of the hallowed teachings of Aristotle that had dominated European thought for almost 2,000 years.

With apologies to the real historians in the audience, I shall present a remarkably simplified diagram (Fig. 1) to depict the last 2,300 years in science and medicine!

From Aristotle about 300 B.C. until the Renaissance in the sixteenth and seventeenth centuries, a philosopher needed only to know Aristotle by heart. To understand him was secondary; to contradict him was blasphemy. The *natura* of the ancients (earth, air, fire, and water) had been accepted without question by highly intelligent people during this entire period. Aristotle's great writings are full of incredibly

astute and accurate observations interwoven with completely erroneous statements that could be tested with the simplest experiment. The fact that no one attempted to test these ancient, untenable theories during this period indicated an incredible conformity and submission of the human mind to authority: Empiricism, magic, and occult sciences flourished.

Galileo's simple experiment destroyed the axiom of Aristotle regarding the laws of motion. Aristotle had stated that the speed of a falling body was directly related to its weight. He believed that a ten pound body falls ten times as fast as a one pound body. Galileo dramatically proved him wrong. He applied this new experimental approach to many areas, exploding myths and pushing back the frontier of knowledge. As a result of his life's work, the right of the scientist to question authority and to pursue his research through observation and

experimentation was established. Galileo introduced to the world the two most significant aspects of modern science—its method of enquiry and its criteria for truth. He separated science from philosophy.

Galileo made his own observations with the newly developed telescope and endorsed the theories of his predecessor, the physician Copernicus, that the earth and the planets revolve about the sun. This was in direct contradiction to the teachings of the Church and the universities. Biblical authority had pronounced that the earth was the center of the universe.

As a result, Galileo was summoned to Rome by the Pope, tried by the Inquisition, forced to repudiate his beliefs, condemned to permanent house arrest, denied medical care, and forbidden to publish. He died blind but unbowed and was buried in unconsecrated ground.

Remember, that was only 350 years ago. The men who condemned him were intelligent humans, but they were humans.

Now, what of the medical scientists? Hippocrates lived around 400 B.C., a contemporary of Aristotle and Plato. He was the father of medicine. About 500 years later lived the great Galen. Recognizing organic and functional disease, Galen insisted upon a careful history and accurate examination of the patient. His anatomy was gleaned from the dissection of animals.

Unfortunately, he combined this extraordinary astuteness with inaccuracies and dogmatism, for he explained disease on the basis of the three spirits (or *pneuma*) and the four humors—blood, phlegm, yellow bile, and black bile.

Galen became the ultimate authority in medicine. After Galen came the Middle or Dark Ages, and it is reasonable to say that progress in medicine ceased for over 1,000 years until Galileo and the Renaissance liberated medical minds. During the Middle Ages, philosophers and professors of medicine could lose their jobs and students could be expelled for contradicting Galen.

However, in the pre-Renaissance period 100 years before Galileo, the bud of medi-

cal knowledge was taking form and ready to burst into flower. Universities were being founded—unfortunately under the wing of the Church. In 1443 two chairs in medicine were established in France. Medical students and teachers of medicine were expected to be celibate. Haven't we come a long way? In 1598, 150 years later, medical teachers were actually allowed to marry!

It was difficult for the biological sciences to develop in the Renaissance. The religious theory of the special creation of man made it dangerous to enquire into his origin or function. The basic progress was in anatomy with Leonardo da Vinci and finally the great Vesalius, who "put it all together" in a masterful set of atlases published in 1543, about the time of Galileo's birth.

Those who went beyond anatomy suffered the consequences. Servetus published his discovery of the lesser (pulmonary) circulation in 1553; for this and other heresies he was burned at the stake by John Calvin. Such free thinking was a threat to authority. Harvey contradicted Galen's theory that blood passes through pores in the septum of the heart by his discovery of the general circulation in 1628. This aroused bitter criticism, and he lost much of his practice.

Both these men were contemporaries of Galileo. There is good evidence that it was Galileo's brave challenge of religious authority and his establishment of the right of the scientists to pursue research that allowed acceptance of these radically new concepts and set the stage for the beginnings of modern medicine.

Are we giving too much credit to Galileo? He was like Christ in the evolution of science. Although the two have a historical parallel, it must be admitted that in the social sense there was a slight difference! Galileo must have been a swinger. He had three children by the same mistress. In this, he resembled his fellow genius, Robbie Burns, who had two children by the same mistress. Poor Robbie Burns, however, had a Presbyterian conscience to contend with; unlike Galileo, he eventually married the girl.

This Renaissance knowledge did not all originate with Galileo, but he had the scientific personality required to create a revolution in thinking. He was honest, aggressive, pugnacious, and yet flexible. He did not publish in Latin, as was customary, but communicated to the people in Italian. One cannot help seeing an analogy in the use of the press in our time. (Today we have many revolutionary thinkers, and they come in all sizes!)

Alexis Carrell,<sup>15</sup> in his book *Man the Unknown*, claimed that Galileo and his Renaissance associates became engrossed in studying the "quantitative" aspects of life, for such things as dimensions and weights were tangible and measurable. The qualitative abstractions, empiricisms, the mind and the soul—these things that represented the now discredited Middle Ages, were rejected. Perhaps the new scientists overreacted in their desire to dissociate themselves from the Dark Ages. The net result was that this aspect of our thinking appears to have been neglected, and we are just recovering. Carrell calls the past 400 years "the tyranny of the 'quantitative.'" One of the members of this Association, Sterling Edwards,<sup>16</sup> in collaboration with his son, has just published a superb biography of this great man.

Why have I spent so much time recounting this era in history? Besides its interest and excitement, it may convey a message. I would like to ask you two questions:

Do you think it is possible that we have not fully recovered from the rejection by the Renaissance of the qualitative and subjective with its de-emphasis of the mind?

Do you think it is possible that the large collection of superbly intelligent people composing this Association could be capable of the same kind of closed-mindedness and reluctance to probe into the unknown that was demonstrated by our fellow men for 1,000 years prior to the Renaissance?

### **The qualitative—the mind**

To discuss the first question, I shall look briefly at our own specialty. The develop-

ment of pulmonary surgery followed by open-heart surgery has been the most spectacular, thrilling, and productive accomplishment in the history of medicine. If I were asked to name two special qualities possessed by those doughty pioneers who developed our specialty, I would have to say moral courage and a significant ego!

In heart surgery during the past 25 years, it has been possible to replace valves, dramatically revascularize the heart, correct fantastically complicated congenital heart defects, and even transplant hearts with comparative safety.

This could happen with such speed only in North America, where surgeons are no brighter or imaginative than others, but where team work is possible due to the low profile of the individual team member. This probably stems partly from the pioneering heritage of North Americans, who have survived by team effort; partly from the type of individual who is attracted to immigrate to the New World; and partly from the influence of some of our medical pioneers, who by good fortune became leaders in North American surgery—Halstead and Blalock and, in Canada, Ed Gallie and many others. These men and most of their contemporaries de-emphasized the cult of personality and converted the teacher to a perpetual student. This eliminated the hierarchy or *geheimrat* that often successfully strangles creative work in the Old World.

With this climate of collaboration, the development of heart surgery has flourished. It has been like total war, with top priority being given to quickly producing a safe method of correcting the major cardiac lesions under direct vision. This is the American way, and this is the correct way to attack a complex problem based on a selection of obvious priorities.

We should recognize that many of the major problems are on their way to solution and we are experiencing a pleasant relative plateau. My plea is this: Now that the armored divisions have advanced close to their objective, it is important that we

pause and reassemble the supporting units. Now is the time to seek *insight* into what we have done and to *reflect* upon it.

Our preoccupation has been great during this 25 year period. To assess this new open-heart surgery, we first studied hospital mortality rates. A few years later, we began reporting late deaths, then late complications, and recently employability and cost-benefit analyses. All are measurable and quantitative. The quality of life or degree of happiness following major repair of the heart has received little attention.

My friend and associate Jim Key<sup>17</sup> was ahead of his time in 1971 when he reported 146 symptomless abdominal aneurysms without a hospital death. He assessed the quality of life in his follow-up study in this way.

There have been 10 who celebrated their golden, and 10 their silver anniversaries. The combined group have lived to welcome the birth of 59 grandchildren and 13 great grandchildren. One man of 76 claimed that the most significant event after surgery was an attack of acute epididymitis.\*

What about our present-day problems of the mind as they relate to cardiac surgery? What areas should we study? I would like to mention three.

**I. Psychosocial assessment.** We should listen to Charles Kimball,<sup>18</sup> a psychiatrist, who undertook a most interesting study. He examined patients prior to open-heart surgery and, without any reference to the nature or stage of their disease, he classified them psychologically into four groups: adjusted, symbiotic, anxious, and depressed. The symbiotic have manipulated the relationships in their family, social, and economic environment to make life balanced, bearable and, in truth, sometimes rather pleasant through secondary gains. The depressed patient may be difficult to diagnose without specialized help. He can appear outwardly normal.

Kimball's study of the results of surgery

showed that the adjusted group did well. The symbiotic group had poor late results. The anxious patient had a high incidence of hospital morbidity. The depressed group had a high late mortality rate. The conclusions from the work of Kimball and others is that the state of mind plays a key part in the patient's recovery and in the excellence of the results, irrespective of the nature or stage of the disease or the conventional risk factors. It is unbelievable but apparently true. Our own experience confirms Kimball's conclusions.

Routine preoperative psychosocial assessment can be carried out rapidly and effectively by a social worker trained in psychiatry. Some patients can be prepared for surgery by a social worker, some require a psychiatrist, and others are not recommended for surgery.

Instead of seeing patients, some of us see diseases. Should we consider a classification based on the individual and his psychological state rather than on the disease?

**II. Rehabilitation.** Rehabilitation is another facet of patient management that deserves attention. Patients who underwent valve surgery at our hospital are being followed regularly in a special clinic, and data are being harvested by a computer. We were shaken out of our complacency a year ago following a special study by O'Leary<sup>19</sup> of the quality of life in a group of these patients who underwent aortic valve replacement. Seventy-eight per cent were employed preoperatively and only 52 per cent following successful surgery. Of the unemployed patients, 88 per cent were in New York Heart Classes I or II. Of course, in aortic valve surgery, age and retirement partially explain this fact. There are several similar published reports.

Blachly<sup>20</sup> has formulated the "law of the year." If the patient has been unemployed preoperatively for over one year, the chances for re-employment are poor, regardless of results. The published re-employment figures vary from 19 to 70 per cent, which suggests that re-employment is related to the excellence of rehabilitation.

\*From Key, J. A., and Sokol, D. W.: Can. J. Surg. 16: 297, 1973, published by Harpells Press Co-operative, Ottawa, Ontario, Canada.

We have called for help from Dr. Terry Kavanagh,<sup>21</sup> a pioneer since 1967 in the fields of rehabilitation. He and others have had excellent results from a controlled progressive exercise program after myocardial infarction. He has evidence that the condition of patients undergoing coronary bypass can be similarly improved. It is difficult indeed for the postoperative patient to choose a safe yet adequate level of activity without help and testing.

In most patients, regular tests show improvement in the blood and in cardiorespiratory fitness. Positive exercise tests sometimes return to normal. It is not known whether this means increased coronary circulation, more efficient utilization of oxygen, or both.

After several years experience, Dr. Kavanagh mounted a carefully controlled prospective study. The experimental group met once a week for exercise. The control group also met once a week under the direction of a physician hypnotist with no exercise. This was considered a harmless method of holding the controls together.

Dr. Kavanagh's team was amazed to find the physical results of hypnotherapy were as good as those obtained by moderate exercise. This included electrocardiographic changes suggesting marked reduction in myocardial ischemia. They had to develop a new control!

In these studies, the postinfarct psychological state of each patient determined his response to rehabilitation exercise. Special testing showed that one third of these patients were depressed—a disturbingly high incidence. In only 10 per cent of these could depression be detected by routine clinical examination.

Most of us have been conditioned to correlate self-worth with steady employment. An unemployed adult must surely be a detriment to himself and to all those about him.

We should strive for a better quality of life by adequate rehabilitation as well as education of those responsible for hiring personnel.

Dr. Kavanagh has carried his series to

somewhat dramatic lengths: Four men with proved cardiac infarcts finished the Boston Marathon of 26 miles. Five finished the Honolulu Marathon, including the director.

**III. Thanatology.** Dr. Kübler-Ross,<sup>22</sup> in her book *On Death and Dying*, discussed a new science called thanatology. She showed that dying patients may be lonely, unhappy, and unable to communicate with their families and even with their doctors and nurses. She suggested that doctors should have a clearer understanding of the workings of the mind of a dying patient. Is this blind spot the result of our natural aversion to becoming involved in studying matters of the mind or to our natural aversion to facing death? I read this to a friend of mine, who thought for a moment and then said: "The orientation of the healing profession has been to preserve life. We see death as failure."

Carrel's remark about "tyranny of the quantitative" in the past 400 years was probably partially correct in 1935. However, the rapid growth and increased value of psychology and psychiatry in the past 50 years has demonstrated the importance of the mind in the modern treatment of disease.

Perhaps specialties such as cardiovascular and thoracic surgery do not make full use of these relatively new disciplines. However, studies dealing with the mind and qualitative values are beginning to appear in our specialty. Of 200 abstracts received for our program this year, three dealt with the patient and his mind. This is a beginning.

It may be said that a good doctor-surgeon will manage the mental as well as the physical health of his patients. The future may require carefully integrating the resources we have with psychiatry, psychology, social work, and the chaplain service.

### Open-mindedness

The second question calls for an assessment of our open-mindedness. Do we display any evidence of the medieval conformity in thinking?

I am not sure just how to assess this in

the "modern" period. During the nineteenth century doctors were reluctant to accept Darwin's theory, Lister's principles, and the practice of human body dissection. In the twentieth century we seem more ready to consider fresh ideas. Technical advances have been accepted almost too readily. Medical scientists feel free to challenge established authority.

A remarkable open-mindedness was demonstrated by the granting of the Nobel Prize in medicine and physiology to three men whose main thesis has been that human beings can learn about the function of their minds, not their bodies, *their minds*, from the study of animals. I refer to Tinbergen<sup>23</sup> with his study of birds, Lorenz<sup>24</sup> with his animals and birds, and Von Frisch<sup>25</sup> with his bees. They are pioneers in the new science of *Ethology*—the comparative study of behavior. Their methods of studying the animal in his natural habitat have opened a treasure house of knowledge of human behavior. The medical scientist has insisted that the experimental animal be brought to him in the laboratory.

This whole new concept has been produced, accepted, and rewarded by this supreme prize in the past two decades. It is a great leap forward. However, it must be confessed that only one of these men, Lorenz, has a medical degree. He never practiced medicine.

Dr. Rhine<sup>26</sup> of Duke University has for more than thirty years found it difficult to gain acceptance for his very well controlled studies in parapsychology. This may be an other instance in which a future field in medicine has been pioneered by a scientist without a medical degree. Perhaps when new knowledge encroaches upon our religious beliefs or represents a totally new concept, we still show some fear and a resistance to accepting or even testing it in our laboratories. I can understand our not accepting his findings. I fail to understand why, until recently, we have avoided duplicating his experiments. The inhibiting factor of the Renaissance was jail or the stake. I suppose the modern factor is ridicule and the media.

But I can hear you saying, "How can man in this day of electrical communication be anything but completely informed and open-minded?" Marshall McLuhan,<sup>27</sup> one of the few Canadians who is known beyond our borders, states in his book *Understanding Media*: "Since we have extended our nervous system in a global embrace by the new media, the principle of *numbness* comes into play. We have to numb our central nervous system when it is extended and exposed or we will die." I suppose he refers to our daily television exposure to disaster and gruesome death. "Thus the age of anxiety and of the electric media is also the age of the unconscious and of apathy."

Now what factors may determine this open-mindedness? I believe the answer is education and research. This is a large subject, but I would like to make some random observations.

**Education.** Some educators feel that acquiring a modern, advanced education is a calculated hazard since it produces narrow-mindedness and a limited perspective.

The trend to unload the medical course and allow time for free thinking is good. Students should work or spend holidays extensively in a nonacademic environment to avoid mind-stifling intellectual conceit. The new Chinese educational program with periodic assignment of the student to manual labor is commendable in this respect.

In teaching, we should emphasize the limits of our knowledge as well as the origin of our knowledge so as not to exaggerate the status of modern science. We should not be too pious by insisting on scientific indications for all treatment. We should remember that about one half of the drugs in common use were discovered in the pre-science era and originally used empirically. I think of aspirin, curare, quinine, digitalis, and their derivatives.

Unfortunately, modern teaching in medicine has almost eliminated empiricism. My father, who was a prairie surgeon, treated many unexplained diseases on an empirical basis that later proved correct and helpful.<sup>28</sup>

Dad was not always right. In the 1920's he recognized a "special kind of pneumonia"

that often occurred in elderly men following prostate surgery. This was before peripheral collapse of the lung was recognized. His patients were mostly prairie farmers who were in the habit of sleeping in their long underwear all year. With great faith in his powers of observation, he concluded that this special pneumonia was due to the switch from "long johns" to a brief hospital gown. He was so convincing that the board at this Manitoba hospital allowed his elderly male patients to continue their homey sleeping habits in the hospital.

I do not think medical science has progressed far enough to eliminate the value of harmless empiricism. This is a form of open-mindedness.

### Research

In my view, Alfred Blalock was the first man appointed to an important chair in surgery in America whose research ability was given priority over surgical, teaching, and administrative skills. Since that time, involvement in research has been a common prerequisite for the academic surgeon. In our research experience, we have had to learn the limits of knowledge and develop broad contacts with other disciplines. This provides open-mindedness and a healthy perspective.

Speaking of research, we all accept the concept of hypothermia in cardiac surgery. It is ancient history. Even so, the state of medical knowledge prior to the initial experimental studies illustrates our limitations in modern medicine.

After initiating experiments, our team was disturbed to discover that the available literature on the subject indicated that cooling animals or humans actually increased their oxygen consumption. Our first experiments disappointingly confirmed this fact. Our theory stimulated very little interest among our associates.

Thanks more to stubbornness than insight, we continued to experiment, and a year later the solution to lowering oxygen consumption during hypothermia was clear and, as usual, extremely simple. It was a matter of

eliminating not only shivering but also the associated increased muscle tone. This done, the oxygen consumption was enabled to fall in direct relation to the fall in temperature.<sup>29</sup>

The new idea is often a tender flame. Tenacity is required to keep it alive. The idea usually falls on the prepared, uncluttered mind, for there appears to be a danger in knowing too much about a subject and allowing oneself to fall under the magic spell of authority.<sup>30</sup>

Of course, curiosity is important. It has been described as one of the greatest and most life-enhancing of human qualities. Applied to your work or your hobby, it will enrich your life.

### Discussion and summary

I am fairly new to this business of presenting semiphilosophical papers without any hard data to hide behind. It is time to discuss and summarize, but how does one do this when he is not sure he has said anything?

1. Regarding our history lesson, it could be said that when one ascends the heights in order to obtain a view of the past, he automatically enhances his ability to see the future with greater perspective.

Perhaps the history story, describing as it does the illogical vagaries of the human mind, will give young surgeons courage to think independently.

2. Pierre Teilhard de Chardin,<sup>31</sup> in his book *The Phenomenon of Man*, visualized a physical evolution as well as an evolution of the mind, each with its own form of energy, converging as man peers into the future. Perhaps the Renaissance did upset this balance by de-emphasizing the mind, but there is evidence that this is being corrected today.

The unbelievable increase in our powers of communication, the birth of psychology and psychiatry, and the increased social awareness are all pointing to a moral and intellectual *evolution* that is catching up to our physical and technical *revolution*.

3. I have mentioned specific areas in cardiac surgery in which we are gaining a



whole new perspective regarding the importance of the mind in surgical treatment. These areas include the preoperative psychological assessment, modern rehabilitation, and the psychology of the dying patient.

4. We appear to be acquiring a fantastic degree of open-mindedness, free thinking, and freedom from authority. Yet, on examining our behavior more closely, I cannot help being disturbed to discover strange persisting islands of conformity in thinking.

Is it possible that human nature has changed very little and that we modern medical men have the same inhibitions that our predecessors had?

Are we afraid, for example, to study metaphysics in the scientific laboratory just as medieval scientists for 1,000 years in the Middle Ages avoided the study of physiology? If this fear is still present, it is disappearing.

5. Many diseases, particularly vascular diseases, are caused by maladaptation to our environment. Actually, some authorities pose the question of whether we are rapidly creating a social environment that may even threaten our survival.

As one views the new science of ethology, it would appear that there are thousands of ready-made experiments around us—animals whose instincts have not been affected by association with men.

Although we will continue to learn more about our specific behavior from physiologists, psychologists, and psychiatrists, I suspect in the future ethology will illuminate our general human behavior and the best means of adapting to our environment.

These are thrilling times, particularly in the field of cardiothoracic surgery. However, at this critical moment in medical history, when knowledge, technology, and our environment are changing at breakneck speed, this Association should accept a responsible role. We should pause, evaluate our history, and examine our sister disciplines. It is a time for insight and reflection.

I wish to thank Mrs. Dorothy Cowper, Toronto General Hospital Librarian, for her interest and help.

## REFERENCES

- 1 Castiglioni, A.: *The Renaissance of Medicine in Italy*, Baltimore, 1934, The Johns Hopkins Press.
- 2 Cooper, L.: *Aristotle, Galileo, and the Tower of Pisa*, Ithaca, 1935, Cornell University Press.
- 3 Galilei, G.: *Discoveries and Opinions of Galileo*, translated by S. Drake, Garden City, 1951, Doubleday & Company, Inc.
- 4 Drake, S.: *Galileo Studies: Personality, Tradition and Revolution*, Ann Arbor, 1970, University of Michigan Press.
- 5 Durant, W.: *The Renaissance*, New York, 1953, Simon & Schuster, Inc., Publishers.
- 6 Evans, M. G.: *The Physical Philosophy of Aristotle*, Albuquerque, 1964, University of New Mexico Press.
- 7 Gibson, W. C.: *Young Endeavor*, Springfield, Ill., 1958, Charles C Thomas, Publisher.
- 8 Huxley, T. H.: On Certain Errors Respecting the Structure of the Heart Attributed to Aristotle, *Nature* **21**: 1, 1879.
- 9 Moon, R. O.: *The Relation of Medicine to Philosophy*, New York, 1909, Longmans, Green & Company.
- 10 Sarton, G.: *Six Wings: Men of Science in the Renaissance*, London, 1957, The Bodley Head.
- 11 Taton, R., editor: *A General History of the Sciences*, vol. 1, *Ancient and Medieval Science*, London, 1963, Thames and Hudson, Ltd.
- 12 Taton, R., editor: *A General History of the Sciences*, vol. 2, *The Beginnings of Modern Science*, London, 1964, Thames and Hudson, Ltd.
- 13 Thorndike, L.: *Science and Thought in the Fifteenth Century*, New York, 1929, Hafner Publishing Company, Inc.
- 14 Gillespie, C. C., editor: *Dictionary of Scientific Biography*, vol. 1, New York, 1970, Charles Scribner's Sons, pp. 250-280.
- 15 Carrel, A., editor: *Man the Unknown*, London, 1935, Hamish Hamilton, Ltd.
- 16 Edwards, W. S., and Edwards, P. D.: *Alexis Carrel: Visionary Surgeon*, Springfield, Ill., 1974, Charles C Thomas, Publisher.
- 17 Key, J. A., and Sokol, D. M.: The Symptomless Abdominal Aneurysm: A 15-Year Review, *Can. J. Surg.* **16**: 297, 1973.
- 18 Kimball, C. P., Quinlan, D., Osborne, F., and Woodward, B.: *The Experience of Cardiac Surgery. V. Psychological Patterns and Predictions of Outcome*, *Psychother. Psychosom.* **22**: 310, 1973.
- 19 O'Leary, A. N.: An Assessment of Activity, Knowledge of Condition, and Anxiety of Patients Following Prosthetic Replacement of the Aortic Valve, Thesis, School of Nursing, University of Toronto, 1974.

- 20 Blachly, P. H., and Blachly, B. J.: Vocational and Emotional Status of 263 Patients After Heart Surgery, *Circulation* **38**: 524, 1968.
- 21 Kavanagh, T., and Shephard, R. J.: Importance of Physical Activity in Post-coronary Rehabilitation, *Am. J. Phys. Med.* **52**: 304, 1973.
- 22 Kübler-Ross, E.: *On Death and Dying*, London, 1969, Macmillan Publishing Co., Inc.
- 23 Tinbergen, N.: *Functional Ethology and the Human Sciences*, (The Croonian Lecture, 1972), *Proc. R. Soc. Lond. [Biol.]* **182**: 385, 1972.
- 24 Lorenz, K.: *On Aggression*, London, 1966, Methuen & Co. Ltd.
- 25 Von Frisch, K.: *The Dancing Bees*, London, 1954, Methuen & Co. Ltd.
- 26 Rhine, J. B., and Pratt, J. G.: *Parapsychology: Frontier Science of the Mind*, Springfield, Ill., 1972, Charles C Thomas, Publisher.
- 27 McLuhan, M.: *Understanding Media: The Extensions of Man*, New York, 1964, McGraw-Hill Book Company, Inc.
- 28 Bigelow, W. A.: *Forceps, Fin and Feather*, Altona, Manitoba, 1969, D. W. Friesen & Sons Ltd.
- 29 Bigelow, W. G., Lindsay, W. K., Harrison, R. C., Gordon, R. A., and Greenwood, W. F.: Oxygen Transport and Utilization in Dogs at Low Body Temperatures, *Am. J. Physiol.* **160**: 125, 1950.
- 30 Blalock, A.: The Nature of Discovery, *Ann. Surg.* **144**: 289, 1956.
- 31 Teilhard de Chardin, P.: *The Phenomenon of Man*, London, 1959, William Collins Sons & Co., Ltd.