

# HISTORY OF BIOFEEDBACK AND NEUROFEEDBACK

## The Hershel Toomim Story

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*The author summarizes the life of Hershel Toomim, a gifted inventor, proponent of biofeedback and self-regulation, husband, father, and humanitarian. Throughout the past several decades, Hershel Toomim has taken a lead in developing neurotechnology, particularly in biofeedback, neurofeedback, and hemoencephalography. Hershel Toomim continues to develop new approaches in neurotechnology as well as new treatment strategies, all with the exuberance of a man much younger in age. The article includes photographs from various epochs in Toomim's life and tributes from friends and family.*

### Hershel's Life (in a Nutshell)

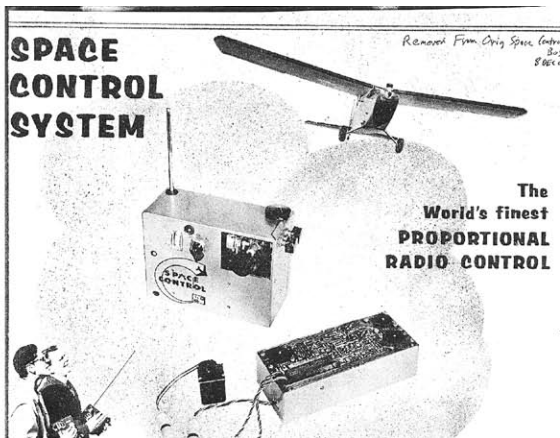
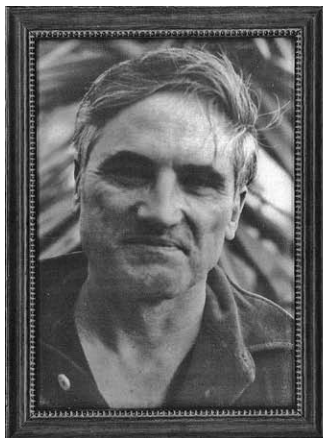
Hershel Toomim, the middle child of five, was born in Waco, Texas, on "June Teenth" (19th), as he calls it, in 1916. Growing up was difficult for Hershel, with his strict father. Feeling like a square peg in a round hole with his family, Hershel, a natural for engineering, turned his interests to objects and science and excelled with brilliance.

As a youngster, he loved to fly radio-controlled airplanes, but radio-controlled technology had much to be desired in that there were only on-off-type controls at that time. So as a young engineer in 1958, Hershel designed the original proportional (fine control) radio-controlled (RC) controller using servo systems in hobby radio-controlled airplanes.

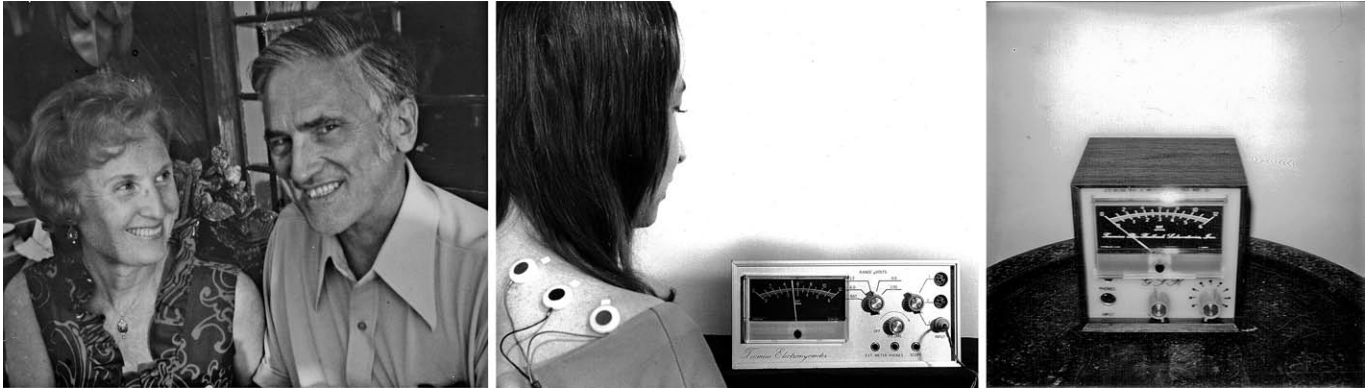
He designed a four-channel system using a vacuum-tube transmitter and transistor receiver under his company name, Solidtronics, and later sold it to Zel Richie, who marketed it as the Space Control System. In 1960, they took their RC controller to the National Championships in Dallas, Texas, and in 1965, Zel flew an airplane with Hershel's controller at the World Championship in Sweden. Zel plans to resurrect the Space Control System and fly an airplane using it in a heritage exhibit at the nationals in 2008. Hershel will also be the first to be inducted into the RC Hall of Fame, in 2008. The RC Hall of Fame Web site now features a narrative about Hershel's contributions in that area, at <http://www.rchalloffame.org/Manufacturer/SpaceControl/history/index.html>. Later in life, Hershel became a licensed airplane pilot and, later yet, a skilled sailor.

Hershel and his first wife Patty had four children before the relationship ended in divorce. A few years later, Hershel remarried to Marjorie (who also had four children), a marriage that endured for 37 years until she died in January 2005 of heart failure.

Hershel was devastated by Marjorie's passing. He wrote a gripping and tearful tribute to Marjorie, which was included in an article by Siegfried Othmer (2005). Hershel credits Marjorie's continuing influence for the new strength and joy for life he has discovered since her death. Hershel presently



**Left:** Hershel Toomim in his younger years. **Middle:** An ad for Hershel Toomim's original Space Control System, roughly 1959. **Right:** Hershel's friends Zel, Ralph, and Cliff showing off their Phantom using Hershel's radio controller in Sweden.



**Left:** Hershel and Marjorie early in their relationship, early 1970s. **Middle:** Hershel's early electromyography system, about 1969. **Right:** Hershel's first galvanic skin response system (about 1970).

works with Stephanie Dupont (his psychologist) and Bob Marsh (his technician).

### The Brain Brightening Begins

In the 1960s, Dr. Antoine Remond, a famous researcher in electroencephalography (EEG) and medical doctor with Air France, began experimenting with voluntary control of brain waves. Shortly afterward, Remond discovered the EEG signature in those with attention deficit disorder (ADD), or minimal brain dysfunction as it was known back in the 1960s. He is credited as the founder of this discovery. He soon published his findings in a booklet titled *The Alpha Average* and explained his discoveries into the inner working of the brain and mind. In 1969, Hershel Toomim read this seminal book on brain waves and neurofeedback and was consumed with intrigue about this amazing new world. Remond's book was a pivotal fork in the road for Hershel and led him to his rewarding journey into self-regulation.

In the early 1970s, when biofeedback instruments were first being devised and used as relative measures, Hershel developed the first standardized and calibrated systems spanning the measures of electromyography (EMG), temperature, galvanic skin response (GSR; now known as electrodermal response), and EEG. These were provided as stand-alone biofeedback systems under the name of the Toomim Research Institute.

Shortly thereafter, Marjorie and Hershel published a breakthrough study of GSR for clinical use (Toomim & Toomim, 1975). Marjorie went on to use EMG monitoring to develop an understanding of muscle set points in stretch receptors. This was used to determine muscle high resting levels that caused pain from excessive and useless muscle tension. She used this learning to develop a slow-stretch technique that successfully freed tense and painful muscles.

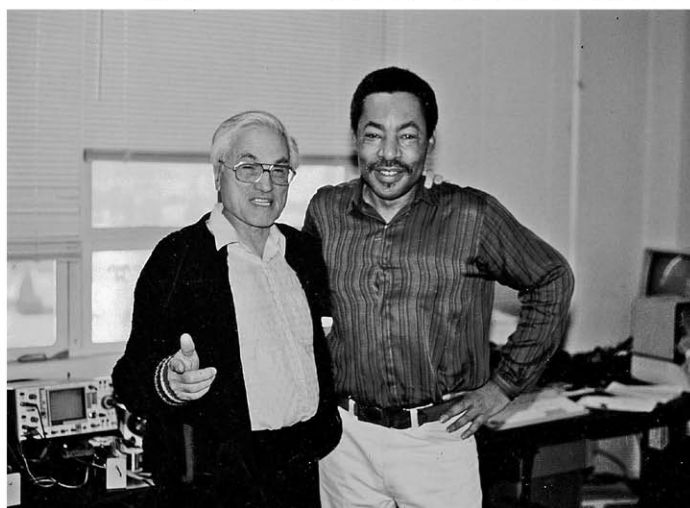
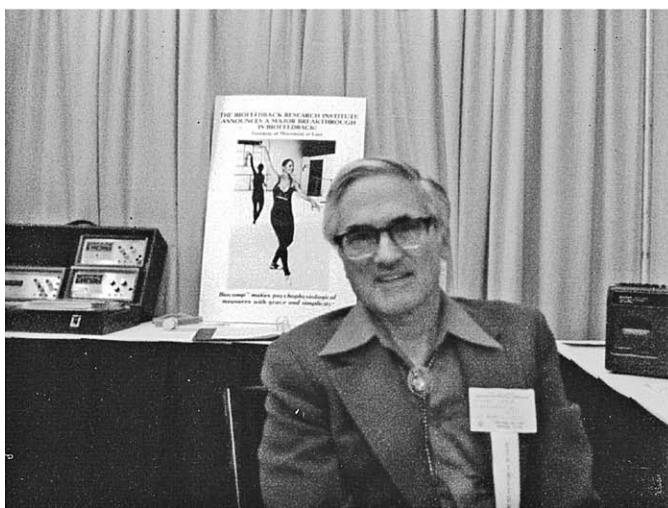
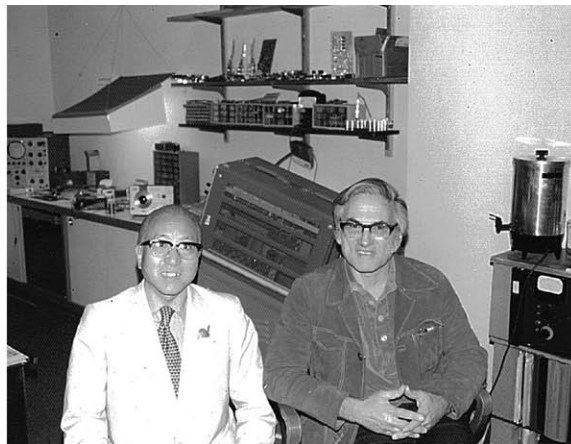
In 1972, Hershel recognized the value of computers and began teaching himself about their use. He used the now

obsolete Motorola 64000 microcontrollers and developed the world's first programmable biofeedback system. This unique design provided the clinician with the ability to simply select any one of 18 various modalities in each of four channels, simply by typing the three-letter name into the appropriate space on a master page. These instruments included the following:

- DFP: Diastolic Finger Pressure
- PPV: Peripheral Pulse Volume
- EEG: Electroencephalograph      PRS: Pressure
- FFT: Fast Fourier Transform      RSP: Respiration
- HEG: Hemoencephalography      SCR: Skin Conductance
- HRT: Heart Rate      SFP: Systolic Finger Pressure
- PEN: Penile Erection      SPR: Skin Potential Response
- TMP: Temperature
- 1/3: Ratio of chan. 1 data to chan. 3 data
- 2/4: Ratio of chan. 2 data to chan. 4 data
- 1+3: Sum of chan. 1 data and chan. 3 data
- 2+4: Sum of chan. 2 data and chan. 4 data

In 1973, and now well versed in the practice of several types of biofeedback, Marjorie created the Biofeedback Institute of Los Angeles (BILA). At the Institute, Marjorie devoted herself to her psychology practice, specializing in treating pain, stress, and psychological disorders. In her simple caring way, her clients felt immediately understood and soon became far more successful human beings in all aspects of their lives. For 30 years, Marjorie's and Hershel's training programs served biofeedback clinicians, an exceptional pioneering effort.

In the summer of 1979, Chuck Davis just happened to be walking by Hershel's office in Los Angeles and spotted Hershel leaning over an old Apple II computer, programming a Biocomp system. Chuck asked him what he was doing. Chuck told Hershel about his interests in alpha brainwave training. (Chuck was currently employed testing missile



**Top Left:** Biocomp 2001 infrared wireless system, 1975. **Top Right:** Hershel and Ken Tachiki, 1976. **Bottom Left:** Hershel promoting his Biocomp 2001 in October 1979 at the Biofeedback Society of America. **Bottom Right:** Hershel and Chuck Davis in the mid-1980s.

systems, and it wasn't his inspiration.) Hershel then told Chuck about his quest to develop wireless biofeedback and neurofeedback capability for the Biocomp system that he had been producing for a few years now. Chuck commented that he could build it, so Hershel hired Chuck on the spot. Chuck thoroughly loved working with his soon-to-be mentor for many years, and to Chuck, it always felt as though he and Hershel were just good old buddies having tons of fun debating life and inventing things together. Chuck credits Hershel with getting him out of the mental streets and teaching him enlightenment.

In 1984, following experimentation with a variety of wireless radio bands, Hershel Toomim and Chuck Davis developed the world's first wireless (infrared) biofeedback system based on the Apple II.

In 1992, a stressed out Victoria Ibric, seeking a way to calm her nerves, was introduced to Hershel and Marjorie at the BILA. She quickly enrolled in their training program and worked at the BILA for 3 years as the neurofeedback therapist and codirector of the neurofeedback program. In

1992, Hershel and Victoria Ibric had many debates on brain function, which stimulated further insights into the mind. They particularly debated whether cerebral blood flow could be controlled by one's own volition.

### Hemoencephalography Comes to Town

In the early 1970s, a brilliant researcher named Marcus Raichle found a correlation between regional cerebral blood flow (rCBF) and the beta/theta EEG ratio (which is known to play a critical role in attention and ADD). Hershel immediately made the connection between beta/theta ratio neurofeedback training and its impact on increasing rCBF. Hershel located a single-photon emission computerized tomograph (SPECT) system through a contact at the Union Hospital in Baltimore, Maryland. The Union staff agreed to conduct SPECT blood distribution scans on Hershel's pre/post beta/theta neurofeedback participants to compare rCBF results. The prospective experiment enticed two women PhD candidates, who decided to head up the SPECT study as part of their dissertations.





**Left:** Rick Toomim, Marjorie Toomim, Hershel Toomim, Tamera Toomim, Donald Toomim holding Michael, Donald's ex-wife Susan. **Middle:** Hershel and Marjorie with grandson Jonathan, about 1990. **Right:** Hershel toasting Marjorie in 2000.

Unfortunately, a new physician, newly in charge of the SPECT equipment, would not allow the use of the SPECT for anything other than strict medical necessities, and he blocked the study. The PhD students were not going to sit back and let their study get crushed, so one of them contacted her friend Barbara Milsudski (a representative of the County of Baltimore and presently a senator for Maryland). She wrote a letter to the National Institutes of Health (NIH) to get approval for this important research. The NIH put Hershel's study into the queue for a functional magnetic resonance imaging analysis, which was frustrating for Hershel as the queue had a 1-year wait. Shortly afterward, in 1992, Hershel received an email from the other PhD student who had a friend in the physics department at New York University. Her friend asked if she knew anything about spectrophotometry. She did not, so she called Hershel and asked him what he knew on this topic. She sent Hershel a paper by Britton Chance, which explained the ability to monitor oxygen uptake on red blood cells through the skull and within the brain.

Hershel built a red and near-infrared red emitter and sensor system. He connected it to an oscilloscope and was thrilled to discover that he could move the line up and down on the oscilloscope at will as he varied what he realized was cerebral blood oxygenation. He tried his prototype on a few other people, who also found that they could modulate their brain's blood oxygenation. Hershel proceeded to build the world's first brain blood oxygenation biofeedback device. By 1994, Hershel had made an interface to run the device from his Biocomp. He named the biofeedback concept *hemoencephalography* (HEG) and his apparatus containing the light emitter and sensor the *Thinking Cap*. According to Hershel, his HEG does not have the artifactual upsets of traditional EEG neurofeedback, particularly where eye roll artifact is severe. According to Hershel, traditional EEG artifact, and eye movement in particular, interferes with training of the important control area of the brain, the executive portion on the forehead.

## Across the Sea

Ben Ling is an entrepreneurial lawyer from Bangkok, Thailand. In 1996, he paid a visit to Hershel and Marjorie to inquire about their revolutionary new HEG biofeedback system. During his visit, Ben purchased a Biocomp with the HEG add on. He took it to a hospital in Thailand under the direction of Dr. Penkhae Limsila. This was a 150-bed Yuwaprasart Waithayopatum child psychiatric hospital devoted to the treatment of autism and funded by the royal family of Thailand. Autism is of particular concern to the royal family because, for possible genetic and environmental reasons, there are an unusually high number of autistics among their heirs. The royal family also founded a school for the study of autism within Kaesetsart University, headed by Professor Daranee Utairanakit.

Penkhae began training autistic individuals with Hershel's HEG and soon reported that HEG was the best treatment modality ever used in autism treatment. Presently, 10 years later, the autism hospital project continues to use HEG in the treatment of autism. Their high-functioning graduates advance readily in the special school.

Based on their 30 years of friendship, Hershel drew on Antoine Remond to assist his further research on the potential of the HEG. Following Dr. Remond's death in 1998, Hershel wrote a touching eulogy in the French biography of Remond's life, summarizing Remond's contributions to science and humanity. Reading that document brought a tremble to his voice and a tear to his eye as he read it to me.

## Tributes to Hershel Toomim From Friends and Family

*Rick Toomim Talks About His Father (Edited by Dave Siever)*

My father Herschel had a favorite professor in college, Professor Wright, whom he holds even today in the highest regard. It was Professor Wright who was responsible for my father's staying in school, finishing, graduating, and doing



**Left:** Dr. Kwong presents Hershel Toomim with the Career Achievement Award at the 2005 International Society for Neurofeedback and Research (INSR) annual conference. **Middle:** Hershel Toomim and Victoria Ibric at ISNR, 2005. **Right:** Hershel lecturing on hemoencephalography, 2005.

some very important work in the early field of how magnetic tape actually worked. But another exceptional story is that Professor Wright taught my father how to fly an airplane. So my father became a pilot, and he loved to fly. Pilots love to tell tales around the hangars, and the other pilots would tell the story that if you ever stalled your engine, you could put the nose of the airplane down, build up air pressure, and restart the engine. Well, my father, always seeking truth, decided to go up and try it. So he took off and flew maybe 10 miles away from the airport to the farmlands of Texas and turned off the ignition switch. Sure enough, the engine died. So my father decided to make a real test of it. And because the propeller was still spinning, he put the nose of the plane up, let the air speed fall, and waited until the propeller slowed down and finally stopped. "Now," he thought, "I can make a real test of it."

So he put the nose of the airplane down and built up some speed, and the propeller moved a little bit. "Well that's not enough." So he put the nose down further, and the plane began building up more speed. The propeller commenced to move a little bit. So he put the nose all the way down and was pointed straight toward the ground, falling out of the sky and building up a tremendous amount of speed. The propeller began to move, until the engine came up against its compression and stopped dead cold. My father was forced to land in some farmer's field in the middle of Texas. He had to turn the tail of the plane around, and he was then faced with trying to restart the airplane engine. (This was before there were electric starters in airplane engines.) So he had to put the switches on, get out in front of the plane, and hand pull the propeller over a couple times, go back into the cockpit, switch off the ignition, adjust the mixture a little bit, switch it on, and pull the propeller a couple more times. Finally, over the course of an hour or two, he was able to restart the engine. He then took off from the field and flew back to the airport, where he landed. His pilot friends came out and said, "Hershel Toomim, where have you been? We thought you

were lost and were about to organize a search to come and find you! What happened?"

"My engine stalled," replied Hershel.

That was typical of my father to try a lot of things he shouldn't.

In the late 1950s and early 1960s, my father designed the world's first 4-channel proportional control radio control system. It consisted of a transmitter the size of a notebook computer and a receiver the size of a couple of packs of cigarettes. It was called the Space Control, built by Space Control Corporation and later Electrosolid Corporation in California.

### *Zel Ritchie's Story*

I had been flying RC airplanes since 1954 with several different types of RC equipment, but until I met Hershel in 1960, no one had developed a fully proportional control system for flying model airplanes. The system Hershel developed provided full proportional control of four functions, which was all that was required to provide full control of the airplane, aileron, elevator, rudder, and throttle!

When Hershel introduced me to his Space Control System, it was the ultimate! I could actually fly an RC model airplane exactly like I had learned to fly in a Piper Cub! I couldn't wait to install the system in an airplane and try it out. It completely met all my expectations! I wanted to build an airplane to show it off the max, so I built a look-a-like F-86 Saber Jet, and it flew like a dream.

Hershel and I went to Dallas in the summer of 1960 to fly in the national contest. We had high hopes and great expectations, but unfortunately, we ran into a temperature problem. We had been flying the Space Control System in California with no problem, but the 140°+ temperature on the runway in Dallas caused the controls to drift out of range and ultimately ended up in a spectacular crash, which ended our hopes. Hershel immediately solved the problem when we got back home.



**Left:** Psychologist Stephanie Dupont and technician Bob Marsh. **Middle:** Hershel and Stephanie. **Right:** Hershel at work.

Shortly after that, Hershel had to devote his time to other business demands, so I took over the manufacturing and distribution of the Space Control System. I eventually had to give up the production of the Space Control System, but I continued to fly the Space Control System until I quit RC flying in 1965. During that time, I competed in many national contests, placing third in Chicago in 1962, second in Los Angeles in 1963, second in Dallas in 1964, and first in the Pylon racing event in Dallas in 1964. I competed in the international contest in Malmo, Sweden, in 1965 and won first place in the team event.

Hershel's Space Control System was a major contribution to the RC world. At the time, it was a major breakthrough, but it was unfortunate that we could not continue to produce it competitively.

### *Victoria Ibric's Story*

Since I came to United States, after 10 years in the academic world and after the Romanian revolution, I found myself more stressed than ever. This extreme stress brought me into a psychologist's office, where I learned about biofeedback using computerized programs. When I observed how powerful biofeedback seemed in letting me learn how to control stress, I asked my therapist where I could learn about using it with other people, and he guided me to the BILA. There I met a couple of incredibly passionate teachers, Hershel and Marjorie Toomim. At that time, Hershel was reaching the respectable age of 76. He reminded me so much of my dad, whose passion for study, work, and teaching did not die until the last days of his beating heart. At BILA, I found this new family, which I embraced with love and immense gratitude. Learning the theory behind the benefits of biofeedback was enlightening. The power of the human mind was beautifully revealed by these wonderful teachers. The learning process was so greatly eased by the teachings of Hershel's complete left brain and by the caring of Marjorie's right brain. Finishing the course, I was asked by both to learn the neurofeedback modality and replace

the neurofeedback therapist who was moving to Alaska, so I became the neurofeedback therapist and the codirector of the neurofeedback program at BILA. During my 3 years of working at the Institute, I had many incredible brainstorming sessions with Hershel. His curiosity on how the brain works and his reluctance to believe that neurofeedback was an extremely effective cure-all treatment modality guided him to his new invention, the HEG. We had debated for hours and hours about the possibility of controlling cerebral blood flow. But Hershel, as persistent as we all know he is, continued to investigate the possibility of being able to evaluate and modify regional blood flow, rCBE, by volition. He developed a new type of biofeedback device that uses infrared and measures spectrophotometrically the changes in cerebral blood perfusion, the variation between the O<sub>2</sub> hemoglobin and CO<sub>2</sub> hemoglobin. In 1995 in Scottsdale, at the third meeting of the (Society for the Study of Neuronal Regulation (the forerunner of the present day organization, International Society for Neurofeedback and Research [SSNR]), I presented his off-the-wall idea. We raised many eyebrows, yet even my own skepticism has been satisfied by the passing of time. Hershel continued to study how we could use the innate abilities of focused attention to modify brain blood perfusion and thus enhance brain function. During my apprenticeship at the BILA, I also met Chuck Davis, who used to work with Hershel before I came to the Institute. Life unfolded, and great discoveries, good times, and greater losses followed. Losing Marjorie almost 2 years ago was like losing my own mother all over again.

### *Jay Gunkelman's Story*

In 2002, and at the golden age of 86, Hershel went to Jay's office in Beverly Hills to attend one of Jay's open-forum get-togethers on the brain. Jay closed up the forum early, and the parkade subsequently became closed to outside access. Hershel decided to walk downstairs instead of taking the elevator and ended up in a locked outdoor area that was elevated 15 feet above street level. Rather than spend the



whole night there, Hershel squeezed through a second-story hedge and then traversed hand over hand for 50 feet along a steel security fence mounted on a concrete wall until the fence height dropped to 6 feet above a concrete area of the parking garage. He then dropped and did a shoulder roll onto the ground. He went home and then phoned Jay up, scolding him for leaving early.

### *Hal Meyer's Story*

I met Hershel in the early 1970s while attending my first Biofeedback Society of America meeting. I was impressed by his engineering knowledge and creativity. This was the year Thought Technology was founded, and I traveled alone to introduce our GSR1-GSR unit. Hershel was generous in his enthusiasm for the product. This was the start of a friendship and business relationship that has spanned more than 30 years.

For several years, both of us were involved in a back assessment project, so I got to spend quality time with Hershel outside of the convention hall. Hershel has always maintained a no-nonsense, honest—and especially warm—attitude in both personal and business situations. Hershel has continued to innovate and excel even following the great loss of his long-time partner. We are all blessed to have him in our lives.

### *Jeff Carmen's Story*

Sometimes it feels as if I have known Hershel forever, but it actually has not been that long. I first met him at the ISNR conference in Myrtle Beach in 1999. Since then, we have been in frequent contact as we have investigated the concept of using light waves for neurofeedback, a concept that Hershel defined as HEG. The concept belongs to Hershel. He invented it and was rolling along long before some of his ideas began to penetrate into the work I was doing. I had been trying to use infrared techniques with migraines without much success. It wasn't until I learned about his theories on activating the frontal lobes that I switched my emphasis and realized that he was on to something. The rest is history.

Hershel's invention of HEG is only one in a long list of things that he has been involved in. It's hard to realize just how long he has been around as a professional engineer. The significance of his age is that he has been involved in inventions, some of which today seem unbelievably primitive, but in their day were cutting edge. In a somewhat earlier time, he would have invented the light bulb and the telephone.

Hershel's mind is truly a wonder. We often get into discussions that evolve into my questioning my most basic

assumptions. I get back at him by making him question his. I have to admit, though, that he has me rethinking things much more often than the other way around. What amazes me is that he thinks in numbers and forgets absolutely nothing. We will often get deep into a discussion, and he will start quoting authors and results and specific data from many years prior as well as current research. Sometimes he recalculates my data in his head, in real time, and then bounces back with questions that take me hours to process.

### **Brief Quotes About Hershel Toomim**

"I think Hershel is a genius. He has made several major contributions in the electronics world. I consider it a privilege to have had the opportunity to share in one of his many accomplishments!" (Zel Ritchie)

"After 25 years in the industry, Hershel is still the most knowledgeable man I've ever met, and I've met some bright people over the years." (Chuck Davis)

"I bought my first biofeedback machine from Hershel when he was around my age. I don't know very many people who are both as independent and critical a thinker as Hershel. He has inspired me with his zest for life. He constantly keeps us young whippersnappers on our toes." (Jay Gunkelman)

"Hershel, old friend, I would like to propose a toast to you, attributed to Francis Bacon: "The best preservative to keep the mind in health . . . is the faithful admonition of a friend." (Hal Myers)

"Life is a path that we are meant to walk on, that gives us knowledge, pleasure, pain, and memories of all. Hershel losing Marj was more than you could bear, but you did. Marj's love and the strength and gentleness have transferred from her into you, and that has been repeatedly expressed by you. The transcendence of Marj's soul into you is very real. You and Marj are loved and will live forever!" (Victoria Ibric)

"Hershel and I have become fast friends. Even our lives have evolved on a somewhat parallel course, sometimes painfully, as we both lost our wives to serious illnesses. Even our politics are similar, something he is passionate about. Don't get him started unless you have an extra 2 or 3 hours. It has been both a pleasure and an honor to become a friend and colleague. I look forward to extending that relationship for many more years." (Jeff Carmen)

"With the passing of Marjorie, Hershel was devastated. And despite the pain, Hershel's clouds had a silver lining. Marj's unconditional acceptance and positive regard toward Hershel was a catalyst in his emotional awakening following her death. As his heart opened, he had a profound experience of love—a testimonial to the hidden insights that had permeated from Marj into his soul through their many

years together, founding a substrate of trust, self-worth, and, finally, a core sense of himself. I was privileged to help guide Hershel through his quest in becoming aware of the feelings in his body. Since that time, Hershel has become increasingly more relaxed; he's softened and he's opened his psyche to positive emotional experiences, including a new joy for life." (Stephanie Harris)

"Hershel is presently 92 and continues to work actively promoting HEG, developing new concepts into neurotechnology, exercising his creativity, and being lively. Long live Hershel!" (David Siever)

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