

Article Type: Obituary

LRH: MARINE MAMMAL SCIENCE, VOL. \*\*, NO. \*, \*\*\*\*

RRH: MEMORIES

[photo goes here]

Louis M. Herman

1930-2016

*"Do not go where the path may lead; go instead where there is no path and leave a trail."*

Ralph Waldo Emerson

Emerson's words epitomize much of the journey, career, and remarkable life of Dr. Louis M. Herman, a researcher and emeritus professor at University of Hawaii at Manoa. Lou followed his own path and was a true trailblazer in the field of marine mammal science. To many, his name is synonymous with pioneering studies of both dolphin cognition and humpback whale behavior. He was a charter member of the Society for Marine Mammalogy and developed the world-renowned Kewalo Basin Marine Mammal Laboratory (KBMML). At KBMML, Lou worked with dolphins Keakiko, Nana, Puka, Akeakamai, Phoenix, Elele, and Hiapo, and scores of students and colleagues, to conduct groundbreaking studies of dolphin sensory perception, cognition, and language abilities. He initiated one of the longest continuous and most productive scientific investigations of humpback whales in the world. Lou's success can, at least in part, be attributed to his tenacity and resilience perhaps best illustrated by his ability

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/mms.12387](https://doi.org/10.1111/mms.12387)

This article is protected by copyright. All rights reserved

to overcome the criminal theft of the dolphins Puka and Kea in 1977. Like the phoenix bird, for which he named one of his new dolphins, Lou emerged from this tragedy with even greater energy and determination, leaving a legacy of nearly 60 yr of innovation and discovery, with a publication record extending from the late 1950s to the present day.

Over his distinguished career, Lou authored or coauthored 181 scientific publications, including 161 on marine mammals, and was an invited and keynote speaker at countless conferences. His many discoveries on dolphins and whales were featured in more than 230 media articles, television and radio programs, and documentary films. Along with a voracious appetite for research, Lou was a dedicated mentor. As a professor at University of Hawaii, he supervised 40 graduate students (see Appendix S1), many of whom are now prominent figures in the field of marine mammal science. Lou created innovative internship programs that provided hands-on opportunities for undergraduate students from around the world to get their start with marine mammals. KBMML's doors were also opened to hundreds of Earthwatch Institute volunteers and Dolphin Institute participants to assist in research efforts, as well as to thousands of Hawaii's school children to learn first-hand about some of the latest discoveries on dolphins and whales.

Lou also cared deeply about the conservation of marine mammals, serving for many years as chair of the conservation committee on the Hawaiian Islands Humpback Whale National Marine Sanctuary Advisory Council. In many of his television, film and radio interviews he discussed how his laboratory's discoveries could serve as a launch pad for inspiring individuals to care about and protect dolphins, whales and their marine habitats. In

1993, Lou, together with former student and long-time colleague Adam Pack, founded The Dolphin Institute (TDI), a nonprofit organization dedicated to dolphins and whales through education, research, and conservation.

In March 2015, Lou's family, former students and colleagues gathered in Honolulu to celebrate his academic career and achievements at a surprise Festschrift. At that event, Lou's inspiring journey was retraced. Below, we provide a synopsis of Lou's many contributions to marine mammal science, as well as a short chronicle of the adventures that led him there. A more complete biography of Lou's early career may be found in Herman (2012a).

#### *Biography*

Louis Marvin Herman was born in Queens, New York, to Jewish immigrants, the youngest of four children. At an early age, Lou developed a life-long passion for swimming and the ocean. Family outings in the 1930s were spent at the beach. Lou was a competitive college swimmer at City College of New York, where he earned his Bachelor's and Master's degrees in Psychology. Lou also spent his college summers lifeguarding at New York City's largest and busiest beach, Far Rockaway. Years later, after moving to Hawaii, Lou swam in the Masters Nationals and Aloha State Games, and frequently competed in Hawaii's famous 2.4 mile open-ocean Waikiki Roughwater Swim beginning in 1972 and as recently as 2014.

In 1953, Lou enlisted in the Air Force where he served as an intelligence officer during and after the Korean War, interviewing repatriated Air Force pilots who had been subject to Chinese interrogation techniques. In 1957, after spending 9 mo at Emory University in Atlanta studying concept learning in

rhesus monkeys, Lou entered the graduate program at Penn State University. In 1961, Lou earned his Ph.D. in Experimental Psychology, focusing on human information processing. Penn State was also where Lou met and married fellow graduate student Hannah Schattner. After graduation, Lou and Hannah headed to Columbus, Ohio, where Lou took up his first job at the North American Aviation Company. One of his projects involved working on the problem of how to improve a sonar operator's ability to correctly classify echo returns as "submarine" or "whale," foreshadowing his future research studying whales and dolphin echolocation.

The type of creativity and ingenuity that many of Lou's students and colleagues witnessed over the years in his studies of dolphins and whales was evident early in his career. In 1962, Lou's dissertation, which investigated how people process information when confronted with competing demands from two simultaneous auditory tasks, won the first "Creative Talent Award" from the American Institutes for Research (Harlow *et al.* 1962). Given the significance of the award, Lou was inspired to pursue a path in academia. In 1963, he became an Assistant Professor at Queens College in New York City where he studied information processing and human performance (*e.g.*, Herman 1965, 1969; Herman and Bahrick 1966; Herman and Kantowitz 1969, 1970; Herman and McCauley 1969). In 1966, Lou and Hannah traveled across the country to Hawaii where Lou took up a position as an Associate Professor in the Psychology Department at the University of Hawaii at Manoa.

In addition to teaching classes in experimental psychology, Lou set up a new undergraduate lab course to teach students the principles of conditioning using white rats. However, he quickly

turned his attention towards the study of learning and cognition in dolphins after some encouragement from a student and realizing that little had been reported about the subject. After spending the summer of 1967 conducting a dolphin research project with his students at Hawaii's Sea Life Park (Herman et al. 1969), Lou located an abandoned shark display facility adjacent to Ala Moana Beach Park. In early 1969 he welcomed his first dolphins to the property and in 1971 he formally named the facility the Kewalo Basin Marine Mammal Laboratory. His vision was to create a laboratory fully devoted to the scientific study of dolphin sensory perception, cognition, and communication abilities. During KBMML's tenure from 1971 to 2004, and under Lou's direction and careful guidance, that vision was realized.

At KBMML, Lou set out on a mission to characterize what he called the "cognitive characteristics" of the bottlenose dolphin, including its abilities, specializations and limitations (Herman 1980a). Together with his students and colleagues, Lou began exploring visual and auditory sensory perceptual characteristics, auditory working memory capacity, and concept formation abilities in the dolphin. With an innovative apparatus of his own design he and his first marine mammal graduate student Frank Beach Jr. demonstrated that a dolphin could learn and apply a "win-stay, lose-shift" rule across numerous novel problems after a single trial with arbitrary sounds, and at levels of performance comparable to those obtained with nonhuman primates (Beach and Herman 1972, Herman and Arbeit 1973). Lou also forged new ground in dolphin sensory perception, showing the dolphin's ability to detect small degrees of frequency modulation, as well as its sensitivity to other types of sounds (Herman and Arbeit 1971a,

b, 1972; Thompson and Herman 1975), and its sensitivity to temporal differences in sounds (Yunker and Herman 1974). He made new discoveries about dolphin short-term memory abilities for single novel sounds as well as lists of sounds, and the mental processes involved in retaining these memories (Herman and Gordon 1974; Herman 1975; Thompson and Herman 1977, 1981; Herman 1980a; Herman and Thompson 1982). In the 1970s, Lou and his students also mapped the dolphins' visual acuity underwater and in-air, revealing its sensitivity in different areas of the visible spectrum, and characterizing its limitations in discriminating different colors (Herman *et al.* 1975, Madsen and Herman 1980).

Lou pioneered the scientific study of Hawaii's humpback whales in the 1970s. In 1976, when most people were not even aware of the presence of humpback whales in Hawaiian waters, Lou conducted the first all-island aerial surveys of the population. At that time, there were an estimated 500-800 individuals of this endangered whale species migrating to Hawaii each year compared to the more than 10,000 individuals that now make this journey. From small Cessna airplanes he and his students documented the whales' presence, abundance, and distribution as well as the areas of high calf density. These flights were complemented by a boat-based effort to photograph the whales at close range and to begin to identify individuals from the unique markings on their tail flukes. In 1977, Lou published his first seminal article on humpback whales describing their numbers, distribution, and behavior in Hawaiian waters (Herman and Antinaja 1977; also see Herman *et al.* 1980). It was here that he coined the term "escort" to identify the adult whale often seen accompanying a mother-calf pair. These escorts are now known to

be males competing for access to the females but at the time it was considered possible that they were female "aunties" helping to guard the calf. Always moving in new directions, Lou also briefly entered the world of historical ecology to investigate whether humpback whales had a historical presence in Hawaiian waters (Herman 1979).

During the winter breeding season of 1977, Lou, Ron Antinoja and graduate student Paul Forestell set up KBMML's first whale research field camp on the island of Lanai. Inflatable boats were launched daily to document humpback whale identities, social organization and behavior. In 1978, young marine mammal scientists Randy Wells and Giuseppe Notarbartolodi Sciara joined the humpback whale project, now launched from the islands of Molokai and Maui. In addition to helping with more aerial surveys and underwater behavioral studies, Randy, Giuseppe, and Paul assisted Lou in the development of what has now become one of the largest long-term archival catalogs of individually identified humpback whales.

In 1980, Lou ventured north to Sitka, Alaska with Hannah, their 1-yr-old daughter Elia, and students Paul Forestell, Scott Baker, and Bill Stifel, to inaugurate KBMML's studies of North Pacific humpback whales in their feeding grounds. KBMML's early research in Alaska continued through 1986, providing fundamental information on the migratory movements of individually identified humpbacks between winter and summer grounds across the North Pacific, mapping the long-term associations within cooperative feeding groups, and investigating the impact of vessel traffic in Glacier Bay National Park and Preserve on humpback whale behavior (Baker *et al.* 1982, 1983, 1985, 1986; Baker and Herman 1984a, 1985, 1989; Perry *et al.* 1985). In 2007,

Adam Pack resumed KBMML's studies of humpbacks in Alaska and continues this work today photographing many of the same individuals first identified by Lou and his team in 1980.

Whether he was investigating whales or dolphins, Lou's scientific approach was always rigorous and creative. In the late 1970s and early 1980s, he again broke new ground with a study investigating the dolphin's ability to comprehend sentences within two artificial language systems. One system was acoustically based, with different sounds representing different objects, agents, actions, modifiers, and relationships. The other system was visually based, with these same items represented by different gestures provided by a human. The languages also had sets of grammatical rules that governed the order in which different symbol types could appear to create different meanings. Phoenix, who was taught the acoustic language, and Akeakamai, who was taught the visual language, excelled in their abilities to comprehend novel sentences, importantly showing that they could understand that the same words placed in different orders created entirely different meanings. As Lou often liked to explain it: "A Venetian blind is not the same as a blind Venetian." Thus, Lou showed for the first time that a dolphin could take into account both the semantic and syntactic components within sentences, the two fundamental features of human language (Herman *et al.* 1984, 1993a, b; see also Herman 1986, 1987; Shyan and Herman 1987; Herman 1988, 1989; Herman and Morrel-Samuels 1990; Morrel-Samuels and Herman 1993; Herman 2002a, 2009a; Herman and Uyeyama 1999). Further work showing that Akeakamai could report on the presence or absence of named objects from her habitat, reinforced the idea that the dolphins understood the referential



function of their language symbols (Herman and Forestell 1985, Herman *et al.* 1993b). Lou's whole approach to working with a dolphin was to tutor and educate it the way you would a child to reveal the full flower of its intellect, and always to be alert and responsive to what the dolphin's behavior indicated about what it understood. He passed this wisdom on to his human students, who he taught to be flexible and willing to modify their approach to any research project based on the dolphins' responses, which so often were unanticipated and remarkable.

The early 1980s also marked the publication of Lou's first edited book "Cetacean Behavior: Mechanisms and Functions" (Herman 1980b). In addition to his own chapters on dolphin cognitive characteristics, communication systems in cetaceans (with William Tavolga) and the social and ecological correlates of cetacean vision and visual appearance (with Carolyn Madsen), *Cetacean Behavior* contains chapters by notable researchers Bill Dawson, R. H. Defran, Ken Norris, Art Popper, Karen Pryor, and Randy Wells. It is considered by many to be a classic text in marine mammal science. As noted in a recent letter to Lou by Andy Read: "[Cetacean Behavior] turned out to be formative for me...it also introduced a new and exciting world of social behavior and cognition, underpinned by the concept that whales and dolphins were *individuals* with rich social lives."

Throughout the 1980s, 1990s, and 2000s, Lou, his students, and colleagues continued to pursue the answers to key questions about dolphin sensory perception, cognition, and communication. New light was shed on dolphin memory, abstraction abilities, concept formation, sound perception, echolocation, social cognition, self-awareness, and creativity. In many cases, the dolphin's cognitive skills rivaled those of apes leading Lou to

suggest, "The major link that cognitively connects the otherwise evolutionary divergent delphinids and primates may be social pressure..." (Herman 1980a, p. 421).

Some notable discoveries with the dolphins were:

- ! An ability to imitate *both* arbitrary novel sounds and motor behaviors, a rarity in the non-human animal kingdom (Richards *et al.* 1984, Xitco 1988, Herman 2002b), and one of the first studies of vocal mimicry in nonhuman mammals.
- ! An ability to apply a concept of "sameness" that was shown earlier with auditory stimuli (Herman and Gordon 1974) to a wide variety of visual stimuli, thus demonstrating an invariance of cognitive performance across visual and auditory modalities (Herman *et al.* 1989 1994; Herman 1990; Mercado *et al.* 2000).
- ! An ability to spontaneously understand television displays as representing the real world; a skill that some ape species find difficult without human assistance (Herman *et al.* 1990).
- ! An ability to categorize different melodic sequences and spontaneously recognize the same sequence shifted across octaves; a skill difficult for some songbirds (Ralston and Herman 1995; also see Richards *et al.* 1984 for spontaneous octave shifts in vocal mimicry).
- ! An ability to spontaneously recognize complex shapes across the senses of echolocation and vision (Pack and Herman 1995; Herman *et al.* 1998; Pack *et al.* 2002b, 2004), thus demonstrating that through echolocation, dolphins can appreciate the spatial structure of objects.
- ! An ability to make fine angular discriminations by echolocation (Branstetter *et al.* 2003, 2007).

- ! An ability to demonstrate an awareness of its own actions (Mercado *et al.* 1998, 1999), thus revealing new dimensions of dolphin self-awareness beyond mirror-self recognition (Reiss and Marino 2001).
- ! An ability to understand human directed referential pointing at distally placed objects; a skill which comes easily to the dolphin (Herman *et al.* 1999; Pack and Herman 2004, 2006, 2007a; also see Xitco *et al.* 2001 for spontaneous dolphin productive pointing), but which appears difficult for some ape species (e.g., Povinelli *et al.* 1997, Call and Tomasello 1994).
- ! An ability to understand symbolic references to its own body parts *via* human gestures, expanding further our understanding of dolphin self-awareness (Herman *et al.* 2001).
- ! An ability to be vigilant either visually or acoustically, by reporting amidst distractor stimuli each occurrence of either key images appearing on a television monitor or key sounds projected underwater (Hoffmann-Kuhnt 2003).
- ! An ability to perform self-created behaviors in tandem with another dolphin (Braslau-Schneck 1994, Herman 2006), a skill that demonstrates both creativity and intra-species coordination.

In parallel with the dolphin work, KBMML continued field research efforts to address key issues in humpback whale behavior, ecology, and communication, focusing primarily on the waters off Hawaii Island and Maui. In addition to KBMML's in-house work, several of these studies were collaborations spearheaded by other research groups. Both efforts yielded new insights into fundamental features of humpback whale ecology

such as migratory movements within breeding grounds and between breeding and feeding grounds (Baker and Herman 1981; Gabriele *et al.* 1996; Craig and Herman 1997; Cerchio *et al.* 1998; Salden *et al.* 1999; Calambokidis *et al.* 2000, 2001; Craig *et al.* 2003); reproductive histories, crude birth rates, and calving rates of females (Baker *et al.* 1987, Perry *et al.* 1990, Craig and Herman 2000, Herman *et al.* 2011); population size increases and distributional changes in the breeding grounds (Baker and Herman 1987; Calambokidis *et al.* 1997; Mobley *et al.* 1999); and calf mortality and adult survival rates (Gabriele *et al.* 2001, Mizroch *et al.* 2004).

Other studies focused on describing and understanding the behaviors, social interactions, and communication systems involved in the humpback whale mating system. Notable among these were studies:

- ! Revealing the nuances of male-male aggressive behavior during competition over females (Baker and Herman 1984b, Helweg and Herman 1993, E. Herman *et al.* 2007).
- ! Documenting that affiliations between humpback whales in the breeding grounds (other than mother-calf pairs) tend to be transient (Mobley and Herman 1985).
- ! Documenting the effects of vessel traffic on humpback whale behavior (Bauer and Herman 1986).
- ! Showing that playback of humpback song to pods in Hawaiian waters resulted in few whales approaching the sound source compared to playback of social sounds from highly active competitive groups or a humpback feeding call recorded in Alaskan waters by Baker (1985). Importantly, neither mother-calf pods nor known females approached during song playback, indicating that unlike male song in some songbird

- species, male song in humpbacks does not appear to attract females to an individual singer (Mobley *et al.* 1986, 1988).
- ! Showing both shared and distinct themes in comparisons of male song across Japan, Hawaii and Mexico (Helweg *et al.* 1990).
  - ! Characterizing various aspects of humpback whale song and proposing sound production mechanisms (Helweg *et al.* 1992; Mercado *et al.* 2003, 2005, 2010; Green *et al.* 2007, 2011).
  - ! Demonstrating diurnal and seasonal variations in behavior and pod characteristics (Helweg *and* Herman 1994, Craig *et al.* 2002, Pack *and* Herman 2007b).
  - ! Characterizing the distribution, movements and spacing of male singers (Frankel *et al.* 1995).
  - ! Reporting the unusual nonagonistic behaviors by a male towards another male that died within a competitive group (Pack *et al.* 1998).
  - ! Showing that individual females when with calf tend to prefer waters off Maui and when without calf tend to prefer waters off Hawaii Island (Craig *and* Herman 2000).
  - ! Describing residency characteristics of individual whales in the breeding grounds (Craig *et al.* 2001).
  - ! Showing that males preferentially associate with females without calf (*i.e.*, those with a higher reproductive potential), rather than females with calf (*i.e.*, those with a lower reproductive potential), and that individual females tend to attract more escorts when they are without calf than when they are with calf (Craig *et al.* 2002).
  - ! Describing male sexual behavior in a variety of contexts (Pack *et al.* 2002a).

- ! Showing that male body size confers an advantage in competition (Spitz *et al.* 2002).
- ! Showing that individual females vary their migratory timing across years, depending on their reproductive status (Craig *et al.* 2003).
- ! Showing that maximum source levels of humpback song vary between units from 151 to 173 dB re 1  $\mu$ Pa, and high frequency harmonics extend beyond 24 kHz (Au *et al.* 2006).
- ! Showing that larger females tend to attract greater numbers of escorts and produce larger calves than do smaller females (Pack *et al.* 2009).
- ! Showing that in male-female dyads, mature females preferentially associate with large mature males, mature males are less discriminatory among females, and immature males and females tend to pair together (Pack *et al.* 2012).
- ! Showing that pursuit by male escorts is energetically costly to maternal females, and thus maternal females tend to segregate themselves and their calves in shallow waters to avoid male harassment (Craig *et al.* 2014).

Along the way, Lou co-authored a catalog of North Pacific humpback whale tail fluke images and life-history data (Perry *et al.* 1988); coedited a book, "Language and Communication: Comparative Perspectives" (Roitblat *et al.* 1993); traveled to Ecuador to carry out field research on the Amazon river dolphin in the Rio Largarto Cocha (Herman *et al.* 1996); published various syntheses of his work (Herman 1991, 2000, 2002c, 2006, 2009b, 2010; Herman and Pack 1994, 2001; Herman *et al.* 2008); worked with his daughter Elia to deploy National Geographic's Crittercam (suction cup mounted video, audio, and data logging tags) on humpback whales for the first time in a breeding ground

(E. Herman *et al.* 2007); was awarded with Adam Pack and Matthias Hoffmann-Kuhnt the American Psychological Association's *Division 6's F. A. Beach Comparative Psychology Award* for the Best Paper published in 1998 in the *Journal Comparative Psychology* (Herman *et al.* 1998); and saw KBMML's work featured in the United States and internationally in scores of newspaper and magazine articles such as *National Geographic* (1979, 2008, 2015), *People Magazine* (1979), the *New York Times* (1980), *Daily Telegraph* (1988), *Femina* (France) (1991), *Bart* (Japan) (1994), *TIME* (1996), *The Economist* (1996), *National Wildlife* (2002, 2003), *BBC Wildlife* (U.K.) (2003), *Smithsonian* (2008); as well as in numerous television and film documentaries, including *NOVA's "Signs of the Apes: Songs of the Whales"* (1983), the MacGillivray Freeman IMAX film *"The Discoverers"* (1993), the PBS documentary *"Dolphins with Robin Williams"* (1997), *BBC's Animal Minds* (U.K., 1999), *BBC's Wildlife on One with Sir David Attenborough: Dolphins-Deep Thinkers?* (U.K., 2003), and *National Geographic's "Humpbacks: Inside the Pod"* (2008).

In December of 2005, Lou retired from University of Hawaii, but not from writing and research. In tribute to the dolphins, Lou returned to the question he started with all those years ago: What is the large dolphin brain capable of? This led him to publish insightful works on dolphin rational behavior (Herman 2006), dolphin cognition (Herman 2010) and dolphin awareness of body and self (Herman 2012b). He also tackled the 32 yr of accumulated data on individually photographed humpback whales in Hawaii and in 2011 produced a seminal paper on long-term resightings of humpbacks (Herman *et al.* 2011). Two years later, Lou published a paper entitled *"Humpback whale song: who sings?"* in which he showed that both immature and mature males

participate in the chorus of humpback whale song on the breeding grounds (Herman *et al.* 2013). Lou's last two solo publications, completed during the final months of his life, represented the culmination of all that he had learned and taught others about dolphins and humpback whales. The first paper (Herman 2017) is an updated chapter in the third edition of the Encyclopedia of Marine Mammals that brings together the current state of knowledge on dolphin language abilities and cognition. The second paper, entitled "The multiple functions of male song within the humpback whale (*Megaptera novaeangliae*) mating system: review, evaluation, and synthesis" (Herman, in press), brings together the historical and most recent information on humpback whale song and discusses its place within the humpback whale mating system. This paper was also an opportunity for Lou to emphasize with new insights, his original lek theory of the humpback whale mating system, which he first described in his 1980 book (Herman and Tavolga 1980). In recognition of his achievements, in 2008, Lou's work was listed among the top 100 pioneering accomplishments at the University of Hawaii during its 100 yr history. And in 2012, he was awarded the University of Hawaii College of Social Sciences Award for Distinguished Retired Faculty.

Over the course of his research career, Lou continually demonstrated his gifts for innovation, keen insight and creative problem solving, whether it was designing a language system to communicate with dolphins (Herman 1980a, Herman *et al.* 1984), or working with graduate students to develop a new technique, called "underwater videogrammetry," to measure the body sizes of humpback whales at sea (Spitz *et al.* 2000). Perhaps one of the best examples of his never-ending ability to think creatively



occurred in 1985, when "Humphrey the Wrong Way Whale" lost its way up the Sacramento River. In a conference call of whale experts, it was Lou who suggested that instead of the aversive approach that had been tried unsuccessfully to redirect Humphrey, a feeding call that Lou's graduate student Scott Baker had recorded in Alaska (Baker 1985), and which had proven attractive to individual whales when played back in Hawaii (Mobley *et al.* 1988), could lure Humphrey back to sea. Lou and his staff put together the tapes and instructions and shipped them off to California, and on cue Humphrey turned and traveled to the source of the sound and out to the ocean over a 2 d period.

Lou leaves behind a professional and personal legacy. KBMML was where many students first "cut their research teeth." honing their skills in dolphin training and whale field observations, and learning the art of research design, hypothesis testing, data analysis and scientific writing. Lou challenged his students to follow his model and think outside the box when it came to designing studies and problem solving.

But perhaps most importantly, he had a profound impact on the lives of so many people—students, interns, volunteers—because of their exposure to all that he created. "Lou changed my life" is the most consistent theme echoed in the countless messages that have been received over the last couple of years from those who worked with him in various capacities and who themselves have followed a wide range of personal and professional paths. Even the experiences professional colleagues were afforded by Lou had profound personal impacts as noted by the late Stan Kuzcaj who wrote: "The invitation to collaborate

with him (Lou) on dolphin cognition and communication literally transformed my research career."

In one recent letter, Lou's former Ph.D. student, Paul Forestell, currently Provost and Vice President for Academic Affairs at Keuka College in Keuka Park, New York, wrote the following to Lou:

...(one) way we can gain immortality is through our ideas, and our intellectual "genes" that we pass on through our ability to teach. You should take great pride and solace in knowing there are so many of us wandering around promoting ideas and actions that are rooted in your cognitive "family tree." I am honored to be part of your intellectual heritage.

And as Phil Clapham wrote:

Lou was one of the early pioneers of research on living whales and dolphins, and those of us who followed in his footsteps owe him a great debt. Since the advent of non-lethal methods to study cetaceans, numerous scientists have contributed to our knowledge of these remarkable animals; yet it is unlikely that many of us could claim that the field today would be significantly different, and considerably less advanced, had we not worked within it. That is not true of Lou Herman.

Indeed, it is difficult to imagine what our understanding of dolphin intelligence and whale behavior would be like without the wealth of knowledge revealed from Lou's work. His discoveries will live on through the marvelous trail he has left and through those whom he inspired to carry on with his quest to understand the complexities of cetacean cognition and behavior.

To continue to support burgeoning minds in the field, the Herman family has set up the Louis M. Herman Scholarship Fund to support students engaged in cognitive and behavioral research of whales or dolphins. A. A. Pack may be contacted by e-mail for more information about the scholarship fund and how to make a contribution.

LITERATURE CITED

- Au, W. W. L., A. A. Pack, M. O. Lammers, L. M. Herman, M. H. Deakos and K. Andrews. 2006. Acoustic properties of humpback whale songs. *Journal of the Acoustical Society of America* 120:1103-1110.
- Baker, C. S. 1985. The population structure and social organization of humpback whales (*Megaptera novaeangliae*) in the central and eastern North Pacific. Doctoral dissertation, University of Hawaii, Honolulu, HI. 306 pp.
- Baker, C. S., and L. M. Herman. 1981. Migration and local movement of humpback whales (*Megaptera novaeangliae*) through Hawaiian waters. *Canadian Journal of Zoology* 59:460-469.
- Baker, C. S., and L. M. Herman. 1984a. Seasonal contrasts in the social behavior of the humpback whale. *Cetus* 5:14-16.
- Baker, C. S., and L. M. Herman. 1984b. Aggressive behavior between humpback whales (*Megaptera novaeangliae*) wintering in Hawaiian waters. *Canadian Journal of Zoology* 62:1922-1937.
- Baker, C. S., and L. M. Herman. 1985. Whales that go to extremes. *Natural History* 94:52-61.
- Baker, C. S., and L. M. Herman. 1987. Alternative population estimates of humpback whales (*Megaptera novaeangliae*) in Hawaiian waters. *Canadian Journal of Zoology* 65:2818-2821.

- Baker, C. S., and L. M. Herman. 1989. The behavioral responses of summering humpback whales to vessel traffic: Experimental and opportunistic observations. Final Report to the National Park Service, Alaska Regional Office, Anchorage, AK.
- Baker, C. S., L. M. Herman, B. G. Bays and W. F. Stifel. 1982. The impact of vessel traffic on the behavior of humpback whales in Southeast Alaska: 1981 season. Final Report to the National Marine Mammal Laboratory, National Marine Fisheries Service. Contract No. 81-ABC-00114.
- Baker, C. S., L. M. Herman, B. G. Bays and G. B. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in Southeast Alaska: 1982 season. Final Report to the National Marine Mammal Laboratory, National Marine Fisheries Service, Contract No. 82-ABC-00199.
- Baker, C. S., L. M. Herman, A. Perry, W. S. Lawton, J. M. Straley and J. H. Straley. 1985. Population characteristics and migration of summer and late season humpback whales (*Megaptera novaeangliae*) in Southeastern Alaska. Marine Mammal Science 1:304-323.
- Baker, C. S., L. M. Herman, A. Perry, et al. 1986. Migratory movement and population structure of Humpback whales (*Megaptera novaeangliae*) in the central and eastern North Pacific. Marine Ecology Progress Series 31:105-119.
- Baker, C. S., A. Perry and L. M. Herman. 1987. Reproductive histories of female humpback whales *Megaptera novaeangliae* in the North Pacific. Marine Ecology Progress Series 41:103-114.

- Bauer, G. B., and L. M. Herman 1986. Effects of vessel traffic on the behavior of humpback whales in Hawaii. Final Report to the National Marine Fisheries Services.
- Beach, F. A., III, and L. M. Herman. 1972. Preliminary studies of auditory problem solving and intertask transfer by the bottlenose dolphin. *The Psychological Record* 22:49-62.
- Branstetter, B. K., S. J. Mevissen, L. M. Herman, A. A. Pack and S. Roberts. 2003. Horizontal angular discrimination by an echolocating bottlenose dolphin (*Tursiops truncatus*). *Bioacoustics* 14:15-34.
- Branstetter, B. K., S. J. Mevissen, A. A. Pack, L. M. Herman, S. P. Roberts and L. K. Carsrud. 2007. Dolphin (*Tursiops truncatus*) echoic angular discrimination: Effects of object separation and complexity. *Journal of the Acoustical Society of America* 121:626-635.
- Braslau-Schneck, S. 1994. Innovative behaviors and synchronization in bottlenosed dolphins. M.S. thesis, University of Hawaii, Honolulu, HI. 134 pp.
- Calambokidis, J., G. H. Steiger, J. M. Straley, *et al.* 1997. Population, abundance, and structure of humpback whales in the North Pacific Basin. Draft final report to Southwest Fisheries Science Center, La Jolla, CA by Cascadia Research Collective, 218 1/2 West Fourth Avenue, Olympia, WA. 37 pp.
- Calambokidis, J., G. H. Steiger, K. Rasmussen, *et al.* 2000. Migratory destinations of humpback whales that feed off California, Oregon, and Washington. *Marine Ecology Progress Series* 192:295-304.
- Calambokidis, J., G. H. Steiger, J. M. Straley, *et al.* 2001. Movements and population structure of humpback whales in the North Pacific. *Marine Mammal Science* 17:769-794.

- Call, J., and M. Tomasello. 1994. Production and comprehension of referential pointing by orangutans (*Pongo pygmaeus*). *Journal of Comparative Psychology* 108:307-317.
- Cerchio, S., C. M. Gabriele, T. F. Norris and L. M. Herman. 1998. Movements of humpback whales between Kauai and Hawaii: Implications for population structure and abundance estimation in the Hawaiian Islands. *Marine Ecology Progress Series* 175:13-22.
- Craig, A. S., and L. M. Herman. 1997. Sex differences in site fidelity and migration of humpback whales (*Megaptera novaeangliae*) to the Hawaiian Islands. *Canadian Journal of Zoology* 75:1923-1933.
- Craig, A. S., and L. M. Herman. 2000. Habitat preferences of female humpback whales *Megaptera novaeangliae* in the Hawaiian Islands are associated with reproductive status. *Marine Ecology Progress Series* 193:209-216.
- Craig, A. S., L. M. Herman and A. A. Pack. 2001. Estimating residence times of humpback whales in Hawaii. Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary, Office of National Marine Sanctuaries, National Oceanic and Atmospheric Administration, U.S. Department of Commerce and Department of Land and Natural Resources, State of Hawaii. 22 pp.
- Craig, A. S., L. M. Herman and A. A. Pack. 2002. Male mate choice and male-male competition coexist in the humpback whale (*Megaptera novaeangliae*). *Canadian Journal of Zoology* 80:745-155.
- Craig, A. S., L. M. Herman, C. M. Gabriele and A. A. Pack. 2003. Migratory timing of humpback whales (*Megaptera*

- novaeangliae*) in the central North Pacific varies with age, sex and reproductive status. *Behaviour* 140:981-1001.
- Craig, A. S., L. M. Herman, A. A. Pack and J. O. Waterman. 2014. Habitat segregation by female humpback whales in Hawaiian waters: Avoidance of males? *Behaviour* 151:613-631.
- Frankel, A. S., C. W. Clark, L. M. Herman and C. M. Gabriele. 1995. Spatial distribution, habitat utilization, and social interactions of humpback whales, *Megaptera novaeangliae*, off Hawai'i, determined using acoustic and visual techniques. *Canadian Journal of Zoology* 73:1134-1146.
- Gabriele, C. M., J. M. Straley, L. M. Herman and R. J. Coleman. 1996. Fastest documented migration of a North Pacific humpback whale. *Marine Mammal Science* 12:457-465.
- Gabriele, C. M., J. M. Straley, S. A. Mizroch, et al. 2001. Estimating the mortality rate of humpback whale calves in the central North Pacific Ocean. *Canadian Journal of Zoology* 79:589-600.
- Green, S. R., E. Mercado III, A. A. Pack and L. M. Herman. 2007. Temporal structure in humpback whale (*Megaptera novaeangliae*) songs. *Aquatic Mammals* 33:202-213.
- Green, S. R., E. Mercado III, A. A. Pack and L. M. Herman. 2011. Recurring patterns in the songs of humpback whales (*Megaptera novaeangliae*). *Behavioural Processes* 86:284-294.
- Harlow, H. F., J. G. Miller and T. M. Newcomb. 1962. Identifying creative talent in psychology. *American Psychologist* 17:679.
- Helweg, D. A., and L. M. Herman. 1993. Observations of an S-shaped posture in humpback whales. *Aquatic Mammals* 18:74-78.

- Helweg, D. A., and L. M. Herman. 1994. Diurnal patterns of behaviour and group membership of humpback whales (*Megaptera novaeangliae*) wintering in Hawaiian waters. *Ethology* 98:298-311.
- Helweg, D. A., L. M. Herman, S. Yamamoto and P. H. Forestell. 1990. Comparison of songs of humpback whales (*Megaptera novaeangliae*) recorded in Japan, Hawaii, and Mexico during the winter of 1989. *Scientific Reports of Cetacean Research* 1:1-20.
- Helweg, D. A., A. S. Frankel, J. R. Mobley Jr. and L. M. Herman. 1992. Humpback whale song: Our current understanding. Pages 459-483 in J. R. Thomas, R. A. Kastelein and A. Ya. Supin, eds. *Sensory processes of marine mammals*. Plenum Press, New York, NY.
- Herman, E. Y. K., L. M. Herman, A. A. Pack, G. Marshall, C. M. Shepard and M. Bakhtiari. 2007. When whales collide: Crittercam offers insights into the competitive behavior of humpback whales on their Hawaiian wintering grounds. *Marine Technology Society Journal* 41:35-43.
- Herman, L. M. 1965. Study of the single channel hypothesis and input regulation within a continuous, simultaneous task situation. *The Quarterly Journal of Experimental Psychology* Volume XVII:37-46.
- Herman, L. M. 1969. Effects of second signals on response time to first signals under certainty and uncertainty. *Journal of Experimental Psychology* 80:106-112.
- Herman, L. M. 1975. Interference and auditory short-term memory in the bottlenose dolphin. *Animal Learning and Behavior* 3:43-48.



- Herman, L. M. 1979. Humpback whales in Hawaiian waters: A study in historical ecology. *Pacific Science* 33:1-15.
- Herman, L. M. 1980a Cognitive characteristics of dolphins. Pages 363-429 in L. M. Herman, ed. *Cetacean behavior: Mechanisms and functions*. Wiley Interscience, New York, NY.
- Herman, L. M., ed. 1980b. *Cetacean behavior: Mechanisms and functions*. Wiley Interscience, New York, NY.
- Herman, L. M. 1986. Cognition and language competencies of bottlenosed dolphins. Pages 221-251 in R. J. Schusterman, J. Thomas and F. G. Wood, eds. *Dolphin cognition and behavior: A comparative approach*. Lawrence Erlbaum Associates, Hillsdale, NJ.
- Herman, L. M. 1987. Receptive competencies of language trained animals. Pages 1-60 in J. S. Rosenblatt, C. Beer, M. C. Busnel and P. J. B. Slater, eds. *Advances in the study of behavior*. Volume 17. Academic Press, Petaluma, CA.
- Herman, L. M. 1988. The language of animal language research. *Psychological Record* 38:349-362.
- Herman, L. M. 1989. In which Procrustean bed does the sea lion sleep tonight? *Psychological Record* 39:19-49.
- Herman, L. M. 1990. Cognitive performance of dolphins in visually guided tasks. Pages 455-462 in J. A. Thomas and R. A. Kastelein, eds. *Sensory abilities of cetaceans: Laboratory and field evidence*. Plenum Press, New York, NY.
- Herman, L. M. 1991. What the dolphin knows, or might know, in its natural world. Pages 349-364 in K. Pryor and K. S. Norris, eds. *Dolphin societies: Discoveries and puzzles*. University of California Press, Los Angeles, CA.

- Herman, L. M. 2000. The realm of the senses. Pages 164-165 in T. Cahill, ed. *Dolphins*. National Geographic Society, Washington, DC.
- Herman, L. M. 2002a. Language learning. Pages 685-689 in W. F. Perrin, B. Würsig, C. M. Thewissen and C. R. Crumley, eds. *Encyclopedia of marine mammals*. Academic Press, New York, NY.
- Herman, L. M. 2002b. Vocal, social, and self-imitation by bottlenosed dolphins. Pages 63-108 in C. Nehaniv and K. Dautenhahn, eds. *Imitation in animals and artifacts*. MIT Press, Cambridge, MA.
- Herman, L. M. 2002c. Exploring the cognitive world of the bottlenosed dolphin. Pages 275-283 in M. Bekoff, C. Allen, and G. Burghardt, eds. *The cognitive animal: Empirical and theoretical perspectives on animal cognition*. MIT Press, Cambridge, MA.
- Herman, L. M. 2006. Intelligence and rational behaviour in the bottlenosed dolphin. Pages 439-467 in S. Hurley and M. Nudds, eds. *Rational animals?* Oxford University Press, Oxford, England.
- Herman, L. M. 2009a. Can dolphins understand language? Pages 3-20 in P. Sutcliffe, L. M. Stanford and A. R. Lommel, eds. *LACUS Forum XXXIV: Speech and beyond*. Houston, TX. Available at <http://www.lacus.org/volumes/index.php?volume=34>.
- Herman, L. M. 2009b. Language learning and cognitive skills. Pages 657-663 in W. F. Perrin, B. Würsig and J. G. M. Thewissen, eds. *Encyclopedia of marine mammals*. 2nd edition. Academic Press, New York, NY.

- Herman, L. M. 2010. What laboratory research has told us about dolphin cognition. *International Journal of Comparative Psychology* 23:310-330.
- Herman, L. M. 2012a. Historical perspectives. *Aquatic Mammals* 38:102-125.
- Herman, L. M. 2012b. Body and self in dolphins. *Consciousness and Cognition* 21:526-545.
- Herman, L. M. 2017. Language learning and cognitive skills. In B. Würsig, J. G. M. Thewissen and Kit M. Kovacs eds. *Encyclopedia of marine mammals*. 3rd edition. Elsevier, San Diego, CA.
- Herman, L. M. In press. The multiple functions of male song within the humpback whale (*Megaptera novaeangliae*) mating system: Review, evaluation, and synthesis. *Biological Reviews*.
- Herman, L. M., and R. C. Antinaja. 1977. Humpback whales in the Hawaiian breeding waters: Population and pod characteristics. *Scientific Reports of the Whales Research Institute, Tokyo* 29:59-85.
- Herman, L. M., and W. R. Arbeit. 1971a. Auditory frequency discrimination from 1-36 kHz in *Tursiops truncatus*. Pages 79-87 in *Proceedings of the Eighth Annual Conference on Biological Sonar and Diving Mammals*. Stanford Research Institute, Menlo Park, CA.
- Herman, L. M., and W. R. Arbeit. 1971b. Complex learning in the dolphin: Discrimination of successively presented auditory patterns and formation of discrimination learning sets. Final Report to the Naval Undersea Research and Development Center, Hawaii Division Contract N66001-70-C-0939. 39 pp.

- Herman, L. M., and W. R. Arbeit. 1972. Frequency difference limens in the bottlenose dolphin: 1-70 KC/S. *Journal of Auditory Research* 2:109-120.
- Herman, L. M., and W. R. Arbeit. 1973. Stimulus control and auditory discrimination learning sets in the bottlenosed dolphin. *Journal of the Experimental Analysis of Behavior* 19:379-394.
- Herman, L. M., and P. H. Forestell. 1985. Reporting presence or absence of named objects by a language-trained dolphin. *Neuroscience and Biobehavioral Reviews* 9:667-691.
- Herman, L. M., and J. A. Gordon. 1974. Auditory delayed matching in the bottlenosed dolphin. *Journal of the Experimental Analysis of Behavior* 21:19-26.
- Herman, L. M., and B. H. Kantowitz. 1969. Effects of second signals occurring after response selection on responses to first signals. *Journal of Experimental Psychology* 81:344-350.
- Herman, L. M., and B. H. Kantowitz. 1970. The psychological refractory period effect: Only half the double-stimulation story? *Psychological Bulletin* 73:74-88.
- Herman, L. M., and M. E. McCauley. 1969. Delay in responding to the first stimulus in the "psychological refractory period" experiment: Comparisons with delay produced by a second stimulus not requiring a response. *Journal of Experimental Psychology* 81:344-350.
- Herman, L. M., and P. Morrel-Samuels. 1990. Knowledge acquisition and asymmetries between language comprehension and production: Dolphins and apes as a general model for animals. Pages 283-312 in M. Bekoff and D. Jamieson, eds. *Interpretation and explanation in the study of behavior.*

- Volume 1. Interpretation, intentionality, and communication. Westview Press, Boulder, CO.
- Herman, L. M., and A. A. Pack. 1994. Animal intelligence: Historical perspectives and contemporary approaches. Pages 86-96 in R. Sternberg, ed. Encyclopedia of human intelligence. Macmillan, New York, NY.
- Herman, L. M., and A. A. Pack. 2001. Laboratory evidence for cultural transmission mechanisms. Commentary on Rendell and Whitehead. Behavioral and Brain Sciences 24:335-336.
- Herman, L. M., and W. N. Tavolga. 1980. The communication systems of cetaceans. Pages 149-209 in L. M. Herman, ed. Cetacean behavior: Mechanisms and functions. Wiley Interscience, New York, NY.
- Herman, L. M., and R. K. R. Thompson. 1982. Symbolic, identity, and probe delayed matching of sounds by the bottlenosed dolphin. Animal Learning and Behavior 10:22-34.
- Herman, L. M., and R. K. Uyeyama. 1999. The dolphin's grammatical competency: Comments on Kako (1998). Animal Learning and Behavior 27:18-23.
- Herman, L. M., F. A. Beach III, R. L. Pepper and R. B. Stalling. 1969. Learning-set formation in the bottlenose dolphin. Psychonomic Science 14:98-99.
- Herman, L. M., M. F. Peacock, M. P. Yunker and C. Madsen. 1975. Bottlenosed dolphin: Double-slit pupil yields equivalent aerial and underwater diurnal acuity. Science 139:650-652.
- Herman, L. M., P. H. Forestell and R. C. Antinaja. 1980. Study of the 1976/77 migration of humpback whales into Hawaiian waters: Composite description. Final Report to the U.S. Marine Mammal Commission, Report No. MMC-77/19. United

States National Technical Information Services, Arlington, VA.

- Herman, L. M., D. G. Richards and J. P. Wolz. 1984. Comprehension of sentences by bottlenosed dolphins. *Cognition* 16:129-219.
- Herman, L. M., J. R. Hovancik, J. D. Gory and G. L. Bradshaw. 1989. Generalization of visual matching by a bottlenosed dolphin (*Tursiops truncatus*): Evidence for invariance of cognitive performance with visual or auditory materials. *Journal of Experimental Psychology: Animal Behavior Processes* 15:124-136.
- Herman, L. M., P. Morrel-Samuels and A. A. Pack. 1990. Bottlenosed dolphin and human recognition of veridical and degraded video displays of an artificial gestural language. *Journal of Experimental Psychology: General* 119:215-230.
- Herman, L. M., S. Kuczaj III and M. D. Holder. 1993a. Responses to anomalous gestural sequences by a language-trained dolphin: Evidence for processing of semantic relations and syntactic information. *Journal of Experimental Psychology: General* 122:184-194.
- Herman, L. M., A. A. Pack and P. Morrel-Samuels. 1993b. Representational and conceptual skills of dolphins. Pages 273-298 in H. R. Roitblat, L. M. Herman and P. Nachtigall eds. *Language and communication: Comparative perspectives*. Lawrence Erlbaum Associates, Hillsdale, NJ.
- Herman, L. M., A. A. Pack and A. M. Wood. 1994. Bottlenose dolphins can generalize rules and develop abstract concepts. *Marine Mammal Science* 10:70-80.

- Herman, L. M., L. von Fersen and M. Solangi. 1996. The bufeo (*Inia geoffrensis*) in the Rio Largarto Cocha of the Ecuadorian Amazon. *Marine Mammal Science* 12:118-125.
- Herman, L. M., A. A. Pack and M. Hoffmann-Kuhnt. 1998. Seeing through sound: Dolphins perceive the spatial structure of objects through echolocation. *Journal of Comparative Psychology* 112:292-305.
- Herman, L. M., S. L. Abichandani, A. N. Elhajj, E. Y. K. Herman, J. L. Sanchez and A. A. Pack. 1999. Dolphins (*Tursiops truncatus*) comprehend the referential character of the human pointing gesture. *Journal of Comparative Psychology* 113:1-18.
- Herman, L. M., D. S. Matus, E. Y. K. Herman, M. Ivancic and A. A. Pack. 2001. The bottlenosed dolphin's (*Tursiops truncatus*) understanding of gestures as symbolic representations of its body parts. *Animal Learning and Behavior* 29:250-264.
- Herman, L. M., R. K. Ueyeyama and A. A. Pack. 2008. Bottlenose dolphins understand relationships between concepts. *Behavioral and Brain Sciences* 31:139-140.
- Herman, L. M., A. A. Pack, K. Rose, A. Craig, E. Y. K. Herman, S. Hakala and A. Milette. 2011. Resightings of humpback whales in Hawaiian waters over spans of ten to 32 years: Site fidelity, sex ratios, calving rates, female demographics, and the dynamics of social and behavioural roles of individuals. *Marine Mammal Science* 27:736-768.
- Herman, L. M., A. A. Pack, S. S. Spitz, E. Y. K. Herman, K. Rose, S. Hakala and M. H. Deakos. 2013. Humpback whale song: Who sings? *Behavioural Ecology and Sociobiology* 67:1653-1663.

- Hoffmann-Kuhnt, M. 2003. Visual and auditory vigilance in the bottlenosed dolphin. Doctoral dissertation. Freie Universität Berlin, Berlin, Germany. 175 pp.
- Madsen, C. J., and L. M. Herman. 1980. Social and ecological correlates of vision and visual appearance. Pages 101-147 in L. M. Herman, ed. Cetacean behavior: Mechanisms and functions. Wiley Interscience, New York, NY.
- Mercado, E., III, S. O. Murray, R. K. Uyeyama, A. A. Pack and L. M. Herman. 1998. Memory for recent actions in the bottlenosed dolphin (*Tursiops truncatus*): Repetition of arbitrary behaviors using an abstract rule. *Animal Learning and Behavior* 26:210-218.
- Mercado, E., III, R. K. Uyeyama, A. A. Pack, and L. M. Herman. 1999. Memory for action events in the bottlenosed dolphin. *Animal Cognition* 2:17-25.
- Mercado, E. M., III, D. A. Killebrew, A. A. Pack, I. V. B. Macha and L. M. Herman. 2000. Generalization of same-different classification abilities in bottlenosed dolphins. *Behavioural Processes* 50:79-94.
- Mercado, E., III, L. M. Herman and A. A. Pack. 2003. Stereotypical sound patterns in humpback whale songs: Usage and function. *Aquatic Mammals* 29:37-52.
- Mercado, E., III, L. M. Herman and A. A. Pack, A. A. 2005. Song copying by humpback whales: Themes and variations. *Animal Cognition* 8:93-102.
- Mercado, E., III, J. Schneider, A. A. Pack and L. M. Herman. 2010. A source-filter model of sound production by humpback whales. *Journal of the Acoustical Society of America* 127:2678-2691.



- Mizroch, S. A., L. M. Herman, J. M. Straley, *et al.* 2004.  
Estimating the adult survival rate of central North Pacific humpback whales (*Megaptera novaeangliae*). *Journal of Mammalogy* 85:963-972.
- Mobley, J. R., Jr., and L. M. Herman. 1985. Transience of social affiliations among humpback whales (*Megaptera novaeangliae*) on the Hawaiian wintering grounds. *Canadian Journal of Zoology* 63:762-772.
- Mobley, J. R., Jr., L. M. Herman and A. S. Frankel. 1986. Sound playback experiments with humpback whales in the Hawaiian wintering grounds. *Sea Grant Quarterly* 8:1-6.
- Mobley, J. R., Jr., L. M. Herman and A. S. Frankel. 1988. Responses of wintering humpback whales (*Megaptera novaeangliae*) to playback of recordings of winter and summer vocalizations and synthetic sound. *Behavioral Ecology and Sociobiology* 23:211-223.
- Mobley, J. R., Jr., G. B. Bauer and L. M. Herman. 1999. Changes over a ten-year interval in the distribution and relative abundance of humpback whales (*Megaptera novaeangliae*) wintering in Hawaiian waters. *Aquatic Mammals* 25:63-72.
- Morrel-Samuels, P., and L. M. Herman. 1993. Cognitive factors affecting comprehension of gesture language signs: A brief comparison of dolphins and humans. Pages 211-222 *in* H. R. Roitblat, L. M. Herman and P. Nachtigall, eds. *Language and communication: Comparative perspectives*. Lawrence Erlbaum Associates, Hillsdale, NJ.
- Pack, A. A., and L. M. Herman. 1995. Sensory integration in the bottlenosed dolphin: Immediate recognition of complex shapes across the senses of echolocation and vision. *Journal of the Acoustical Society of America* 98:722-733.

- Pack, A. A., and L. M. Herman. 2004. Dolphins (*Tursiops truncatus*) comprehend the referent of both static and dynamic human gazing and pointing in an object choice task. *Journal of Comparative Psychology* 118:160-171.
- Pack, A. A., and L. M. Herman. 2006. Dolphin social cognition and joint attention: Our current understanding. *Aquatic Mammals* 32:443-460.
- Pack, A. A., and L. M. Herman. 2007a. The dolphin's (*Tursiops truncatus*) understanding of human gaze and pointing: Knowing *what* and *where*. *Journal of Comparative Psychology* 121:34-45.
- Pack, A. A., and L. M. Herman. 2007b. Using electronic maps of real-time whale locations to mitigate vessel collisions with whales. Final Report to the National Fish and Wildlife Foundation, Washington, DC. 78 pp.
- Pack, A. A., D. R. Salden, M. Ferrari, D. Glockner-Ferrari, L. M. Herman, H. A. Stubbs and J. M. Straley. 1998. Male humpback whale dies in competitive group in Hawaii. *Marine Mammal Science* 14:861-873.
- Pack, A. A., L. M. Herman, A. S. Craig, S. S. Spitz and M. H. Deakos. 2002a. Penis extrusions by humpback whales (*Megaptera novaeangliae*). *Aquatic Mammals* 28:131-146.
- Pack, A. A., L. M. Herman, M. Hoffmann-Kuhnt and B. K. Branstetter. 2002b. The object behind the echo: Dolphins (*Tursiops truncatus*) perceive object shape globally through echolocation. *Behavioural Processes* 58:1-26.
- Pack, A. A., L. M. Herman and M. Hoffmann-Kuhnt. 2004. Dolphin echolocation shape perception: From sound to object. Pages 288-298 in J. Thomas, C. Moss and M. Vater eds. *Advances in*

- the study of echolocation in bats and dolphins. University of Chicago Press, Chicago, IL.
- Pack, A. A., L. M. Herman, S. S. Spitz, S. Hakala, M. H. Deakos and E. Y. K. Herman. 2009. Male humpback whales in the Hawaiian winter grounds preferentially associate with larger females. *Animal Behaviour* 77:653-662.
- Pack, A. A., L. M. Herman, S. S. Spitz, *et al.* 2012. Size assortative pairing and discrimination of potential mates by humpback whales in the Hawaiian breeding grounds. *Animal Behaviour* 84:983-993.
- Perry, A., C. S. Baker and L. M. Herman. 1985. The natural history of humpback whales in Glacier Bay, Alaska. Report to the National Park Service.
- Perry, A., J. R. Mobley Jr., C. S. Baker and L. M. Herman. 1988. Humpback whales of the central and eastern North Pacific: A catalog of individual identification photographs. Sea Grant Miscellaneous Reports, UNIHI-SEA GRANT-NR-88-02.
- Perry, A., C. S. Baker and L. M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: A summary and critique. Report of the International Whaling Commission (Special Issue 12):307-317.
- Povinelli, D. J., J. E. Reaux, D. T. Bierschwale, A. D. Allain and B. B. Simon. 1997. Exploitation of pointing as a referential gesture in young children, but not adolescent chimpanzees. *Cognitive Development* 12:423-461.
- Ralston, J. V., and L. M. Herman. 1995. Perception and generalization of frequency contours by a bottlenose dolphin (*Tursiops truncatus*). *Journal of Comparative Psychology* 109:268-277.

- Reiss, D., and L. Marino. 2001. Mirror self-recognition in the bottlenose dolphin: A case of cognitive convergence. *Proceedings of the National Academy of Sciences* 98:5937-5942.
- Richards, D. G., J. P. Wolz and L. M. Herman. 1984. Vocal mimicry of computer generated sounds and vocal labeling of objects by a bottlenosed dolphin, *Tursiops truncatus*. *Journal of Comparative Psychology* 98:10-28.
- Roitblat, H. R., L. M. Herman and P. Nachtigall, eds. 1993. *Language and communication: Comparative perspectives*. Lawrence Erlbaum Associates, Hillsdale, NJ.
- Salden, D. R., L. M. Herman, M. Yamaguchi and F. Sato. 1999. Multiple visits of individual humpback whales (*Megaptera novaeangliae*) between the Hawaiian and Japanese winter grounds, *Canadian Journal of Zoology* 77:504-508.
- Shyan, M. R., and L. M. Herman. 1987. Determinants of recognition of gestural signs in an artificial language by Atlantic bottle-nosed dolphins (*Tursiops truncatus*) and humans (*Homo sapiens*). *Journal of Comparative Psychology* 101:105-119.
- Spitz, S. S., L. M. Herman and A. A. Pack. 2000. Measuring sizes of humpback whales (*Megaptera novaeangliae*) through underwater videogrammetry. *Marine Mammal Science* 16:664-676.
- Spitz, S. S., L. M. Herman, A. A. Pack and M. H. Deakos. 2002. The relation of body size of male humpback whales to their social roles on the Hawaiian winter grounds. *Canadian Journal of Zoology* 80:1938-1947.

- Thompson, R. K. R., and L. M. Herman. 1975. Underwater frequency discrimination in the bottlenosed dolphin (1-140 kHz). *Journal of the Acoustical Society of America* 57:943-948.
- Thompson, R. K. R., and L. M. Herman. 1977. Memory for lists of sounds by the bottlenosed dolphin: Convergence of memory processes with humans? *Science* 195:501-503.
- Thompson, R. K. R., and L. M. Herman. 1981. Auditory delayed discriminations by the dolphin: Nonequivalence with delayed matching performance. *Animal Learning and Behavior* 9:9-15.
- Yunker, M. P., and L. M. Herman. 1974. Discrimination of auditory temporal differences by the bottlenosed dolphin (1-140 kHz). *Journal of the Acoustical Society of America* 56:1870-1875.
- Xitco, M. J., Jr. 1988. Mimicry of modeled behaviors by bottlenose dolphins. M.S. thesis, University of Hawaii, Honolulu, HI. 124 pp.
- Xitco, M. J., Jr., J. D. Gory and S. A. Kuczaj III. 2001. Spontaneous pointing by bottlenose dolphins (*Tursiops truncatus*). *Animal Cognition* 4:115-123.
- ADAM A. PACK**, Departments of Psychology and Biology, University of Hawaii at Hilo, 200 West Kawili Street, Hilo, Hawaii 96720, U.S.A. and The Dolphin Institute, PO Box 6279, Hilo, Hawaii 96720, U.S.A.; **ELIA Y. K. HERMAN**, State of Hawaii Department of Land and Natural Resources, 1151 Punchbowl Street #330, Honolulu, Hawaii 96813, U.S.A. and The Dolphin Institute, PO Box 6279, Hilo, Hawaii 96720, U.S.A.; **C. SCOTT BAKER**, Marine Mammal Institute and Department of Fisheries and Wildlife, Hatfield Marine Science Center, Oregon State University, 2030 SE Marine Science Drive, Newport, Oregon 97365, U.S.A.; **GORDON B. BAUER**, Division of Social Sciences, New College of Florida, 5800 Bay

Shore Road, Sarasota, Florida 34243, U.S.A.; **PHILLIP J. CLAPHAM**, Cetacean Assessment and Ecology Program, NOAA Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, Washington 98115, U.S.A.; **RICHARD C. CONNOR**, Biology Department, University of Massachusetts Dartmouth, 285 Old Westport Road, Dartmouth, Massachusetts 02747, U.S.A.; **ALISON S. CRAIG**, School of Applied Sciences, Edinburgh Napier University, Sighthill Court, Edinburgh, EH11 4BN, Scotland, United Kingdom; **PAUL H. FORESTELL**, Keuka College, 141 Central Avenue, Keuka Park, New York 14478, U.S.A.; **ADAM S. FRANKEL**, Hawaii Marine Mammal Consortium, PO Box 6107, Kamuela, Hawaii 96743, U.S.A. and Marine Acoustics, Inc. 2 Corporate Place, Suite 105, Middletown, Rhode Island 02842, U.S.A.; **GIUSEPPE NOTARBARTOLO DI SCIARA**, Tethys Research Institute, Via Benedetto Marcello 43, 20124, Milan, Italy; **MATTHIAS HOFFMANN-KUHNT**, Acoustic Research Laboratory, Tropical Marine Science Institute, National University of Singapore, 18 Kent Ridge Road, Singapore 119227; **EDUARDO MERCADO III**, Department of Psychology, University at Buffalo, The State University of New York, Buffalo, New York 14260, U.S.A.; **JOSEPH MOBLEY**, School of Nursing and Dental Hygiene, University of Hawaii at Manoa, 2528 McCarthy Mall, Honolulu, Hawaii 96822, U.S.A. and Marine Mammal Research Consultants, 520 Lunalilo Home Road #6106, Honolulu, Hawaii 96825, U.S.A.; **MELISSA R. SHYAN-NORWALT**, Department of Psychology, McMicken College of Arts & Sciences, University of Cincinnati, 7148 Edwards One, Cincinnati, Ohio 45221, U.S.A.; **SCOTT S. SPITZ**, Marine Mammal Research Consultants, 520 Lunalilo Home Road #6106, Honolulu, Hawaii 96825, U.S.A. and The Dolphin Institute, PO Box 6279, Hilo, Hawaii 96720, U.S.A.; **MOBY SOLANGI**, Institute for Marine Mammal Studies, 10801 Dolphin Lane, Gulfport, Mississippi 39503, U.S.A.; **ROGER K. R. THOMPSON**,

Department of Psychology & Biological Foundations of Behavior Program, Franklin & Marshall College, PO Box 3003, Lancaster, Pennsylvania 17604, U.S.A.; **LORENZO VON FERSEN**, Tiergarten Nuernberg, Am Tiergarten 30, D-90480 Nuremberg, Germany; **ROBERT UYEVAMA**, The Dolphin Institute, PO Box 6279, Hilo, Hawaii 96720, U.S.A.; **RANDALL WELLS**, Chicago Zoological Society's Sarasota Dolphin Research Program, % Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, Florida 34236, U.S.A.; **JAMES P. WOLZ**, The Dolphin Institute, PO Box 6279, Hilo, Hawaii 96720, U.S.A.

#### SUPPORTING INFORMATION

The following supporting information is available for this article online:

*Appendix S1.* Names of graduate students Lou Herman mentored, including degree(s) achieved and year(s) of completion.