

OBITUARY

In Memoriam: Richard Allen Schmidt (1941 – 2015)

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Richard (Dick) Schmidt, intellectual leader in motor learning and control, and founder and founding editor of the *Journal of Motor Behavior*, died on October 1, 2015, after a lengthy illness.

EDUCATION

Dick majored in math and physical education as an undergraduate at the University of California, Berkeley. However, it was the research being conducted by Franklin Henry on motor control and learning that changed his life forever. Befriending Henry's students, including George Stelmach, Ron Marteniuk and Bert Carron, Dick realized that movement skills could be better understood through the application of a scientific method to their study. After completing his Masters degree at Cal with Joseph Royce, Dick moved to the University of Illinois to work, ostensibly, with Fritz Hubbard, in the Department of Physical Education. Perhaps, as importantly however, Jack Adams, a professor in the psychology department, mentored Dick. The manner in which Adams conducted experiments to tackle research issues such as warm-up decrement, short-term memory, and timing left an impression on Dick that would last throughout his career (Schmidt, 2011, 2015a).

EMPLOYMENT CAREER

Hired as an Assistant Professor in the Physical Education department at the University of Maryland in 1967, Dick moved on to positions at the University of Michigan in 1970, the University of Southern California in 1974, and to UCLA in 1980 (all in physical education/kinesiology departments). His final career move within the university system was to the department of psychology at UCLA (after the kinesiology department was dissolved), from which he retired in 1999. However, in 1994, Dick also assumed a new position as a human factors consultant (and later as principle scientist) at Failure Analysis Associates (later called Exponent). He left Exponent in 2001 to start his own human-factors consulting business, called Human Performance Research.

RESEARCH CAREER

Perhaps more than any other factor, Dick is renowned for the impact that he had on research in motor control and

learning. His impact was both theoretical and empirical and closely followed a path that had been left by Jack Adams in theory-building, conducting insightful reviews, and designing clever experiments.

Dick's empirical contributions expanded over five decades and included the contributions of many graduate students and colleagues. His reviews included articles on anticipation timing (Schmidt, 1968, 1971) and augmented feedback (Salmoni, Schmidt & Walter, 1984, Schmidt, 1991) that not only summarized the current state of the science but also provided researchers with many reasons and novel methods to challenge long-held views. Dick also published large-scale reviews in three books on motor control and learning: *Motor Skills* (Schmidt, 1975a), *Motor Control and Learning* (Schmidt, 1982), and *Motor Learning and Performance* (Schmidt, 1991). The latter two books are now both in their fifth editions and have been translated into 12 different languages.

Arguably, Dick's most significant impacts were theoretical contributions. In response to some of the limitations inherent in Adams' closed-loop theory (Adams, 1971), and buoyed by the restricted views offered by then-current views on motor programs (e.g., Keele, 1968), Dick published the schema theory in the *Psychological Review* (Schmidt, 1975b). Schema theory suggested that rapid, discrete movements were controlled by a two-state memory process. One memory process, the generalized motor program, was responsible for ordering the sequence and relative timing of sub-actions within a movement. The other memory process, the recall schema, provided the details for instantiating a particular instance of the motor program. A corollary process, the recognition schema, could be used after a movement's completion to assess its success. The impact of schema theory on research was immediate and immense: the Science Citation Index honored schema theory as a "citation classic" only 8 years later (Schmidt, 1983). Google Scholar currently calculates the number of citations for this one paper at more than 2700. More recent conceptualizations of what computational neuroscientists refer to as structural learning has its roots in schema theory and its predictions about variable practice (Braun, Aertsen, Wolpert, & Mehring, 2009). Moreover, the roots of forward models of motor control (Wolpert, Miall, & Kawato, 1998) were firmly established in the "anticipated sensory

*The order of authors two through four was determined using a random number generator.

consequences” feature of schema theory. These are but a few of the legacies of Dick’s theoretical impact.

His next major theoretical contribution challenged the often held belief that the speed-accuracy trade-off, known as Fitts’ Law (Fitts, 1954), was the result of limitations in visual feedback processing. Dick and his students posited that the inherent variability in the motor program execution processes produced a linear speed-accuracy trade-off (Schmidt, Zelaznik, Hawkins, Frank & Quinn, 1979). This was quite a novel idea, and ushered in the era in which variability in motor processes is the subject of investigation. The notion that people learn to control their signal-to-noise ratio in the motor program currently popular in motor neuroscience has its forgotten origins in the Schmidt et al. (1979) theory.

By the early 1980s, Dick had shifted much of his research attention back to issues concerning motor learning, and tackled augmented feedback, particularly knowledge of results (KR) as a prime target. Earlier, Dick had cautioned researchers that immediate performance changes are sometimes poor indicators of learning (Schmidt, 1972), and this key distinction between performance and learning formed the basis for re-evaluating the role served by augmented feedback. Salmoni, Schmidt and Walter (1984) found that some of the so-called “Laws of KR” were not laws of learning, but rather of immediate performance changes. When put to test in retention and transfer, many of these “laws” were not supported, and even reversed in some cases. This re-evaluation of the literature naturally led to a series of experiments with students and colleagues leading to important theoretical ideas that challenged long-held views about how KR “worked” and hypotheses about how to test new constructs. Several studies from Dick’s lab demonstrated for the first time that learning was enhanced by reducing the feedback frequency (Winstein & Schmidt, 1990), providing summary or average feedback (Schmidt, Lange, & Young, 1990; Young & Schmidt, 1992), or delaying feedback (Swinnen, Schmidt, Nicholson, & Shapiro, 1990). Moreover, findings that a reduced feedback frequency affected generalized motor program and parameter learning differently (Wulf, Schmidt, & Deubel, 1993) provided direct evidence for the dissociation of the two constructs first posited in schema theory. Those of us who were fortunate enough to be a part of this exciting time in Dick’s lab, understood the importance of the learning-performance distinction, but did not appreciate how prescient this was for neurobiologists who were to begin working in the area of learning and memory (Cahill, McGaugh, & Weinberger, 2001).

Before his move from UCLA to Failure Analysis Associates, Dick had been contacted by the Audi automotive company regarding a series of lawsuits it faced concerning so-called “sudden acceleration” accidents. The typical accident occurred when a driver initiated a driving session from a cold start, moving the automatic gear from Park into Reverse or Drive, and from which the car then accelerated wildly out of control. Typically, drivers claimed that their

foot had been on the brake during the entire episode, yet curiously, post-accident analyses revealed no defect in the car’s braking system. Dick examined the evidence and put together a comprehensive analysis for driver-error as the probable cause, based on his analysis of the relevant human motor control and perception research (Schmidt, 1989, 1993). Not surprisingly, it was this application of research to help understand human factors issues, which had earlier played such an important role in Jack Adams’ career (e.g., Adams, 1988), that consumed much of Dick’s academic interests towards the end of his career. When Toyota’s braking system came under scrutiny in recent years, Dick reminded readers of the earlier lessons learned from Audi in a New York Times op-ed piece, aptly titled “Braking Bad” (Schmidt, 2010). Most recently, Dick encouraged researchers to seriously consider the prospect that two-foot driving – using the left foot to brake and the right foot to accelerate, might alleviate driver-errors that are prone to one-foot operation of the pedal controls (Schmidt, 2015b).

JOURNAL OF MOTOR BEHAVIOR

Quite simply, there would be no *Journal of Motor Behavior* without the efforts of Dick Schmidt. Motor behavior had been a prominent research area in psychology for decades, especially given the needs for skilled pilots in the two World Wars. However, by the 1960s much of the impetus for motor skills research had given way to the cognitive revolution, especially in psychology labs. And this shift in focus made it more difficult for motor behavior researchers to find a home for their papers in psychology journals. Clearly, there was a need for a specialized journal devoted to motor behavior research. Early in 1969, at 28 years of age, and together with his father Allen, who owned a printing company, and brother Craig, who served as managing editor, Dick launched the first issue of *JMB* in 1969. Dick served as the journal’s editor and the editorial board consisted of a who’s who of prominent motor skills researchers of the day. Dick remained as Editor until 1980, at which time publication of the journal was assumed by a non-profit organization called HELDREF (the Helen Dwight Reid Education Foundation). The role previously assumed by Dick was now managed by a trio of co-editors, Ron Marteniuk, Karl Newell and Scott Kelso.

PERSONALITY

Dick’s famous quote to his students was “Words have meaning.” He encouraged his students and then cajoled and criticized loose writing in which the sentence was ambiguous. Although, many students were stung by Dick’s criticisms we all learned how to think and write as scientists. Dick was also very competitive. He always had a drive to win in sports and athletic competitions, and in the lab. For the 1979 *Psychological Review* paper, we often served as our own subjects. After each experiment, Dick would

always declare that he “beat” Jim Frank and I (HNZ) as laboratory performers. He would do cartwheels while running with one of us (HNZ), just to make it clear how much in reserve he had. We would take our defeats graciously. GW remembers Dick as a post-doctoral advisor on whose support and advice she could always count – and who would be able to remind her of her password (at a time when e-mail was still new, and many years later). Aside from being an academic mentor, he was a caring friend who would go to the trouble of driving across Los Angeles to check out used cars. The result was GW’s purchase of a 1963 Plymouth Valiant. He even gave her a used coffee mug when she moved from Dick and Gwen’s house into her first apartment in West L.A. She is still using it after 30 years.

During his illness Dick refused to be depressed. He was the scientist to the end. Just days before his death, he discussed new studies with us and asked interesting questions. He was introspecting on his throwing errors while playing with his dog. His interpretation led him to believe he had found new insights on motor program control. He was looking forward to writing up these insights as a case study (tentatively titled *Motor control: A view from a wheelchair*).

Perhaps most of all we will miss his warm friendship and sense of humor. It was not uncommon for Dick to call and, without saying hello, just launch into his latest “walks-into-a-bar joke” (e.g., a horse walks into a bar; bartender says “why the long face?”). Or, in response to a drink request, say “just enough bourbon to cover the ice, but put in *lots* of ice.” That sense of humor stayed with him to the end. In his own words he said this: “He died on [date TBD] after a long battle with neurological degenerative ailments, CBD (cortico-basal degeneration), PSP (progressive supranuclear palsy), and APD (atypical Parkinson’s disease) or as he would say, he died of TLAs (three-letter acronyms).”



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