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E Pluribus Unum—From DNA to Social Systems: Understanding Physical Activity Through an Integrated Perspective

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The latter half of the 20th century witnessed the dramatic rise of specialization in the subdisciplines of kinesiology, which resulted in scholarly development, but fragmentation. A need is articulated herein for an "issues-based" approach to research that will attract scholars from multiple subdisciplines, address compelling challenges of social significance, and foster a strong professional identity. Two examples of integrative approaches, embodied as centers, are developed in both the health- and performance-related areas of kinesiology. Initially, the multilevel research possibilities relevant to a Center for Physical Activity and the Dementias are discussed and followed by the possibilities for a Center for the Study of Elite Performance. The benefits of an integrative approach to societal interests and the discipline of kinesiology are described.

In a recent address, Rikli (2006) presented the Fortieth Amy Morris Homans Commemorative Lecture in which she summarized her concerns for the discipline of kinesiology and cited the fragmentation of the field and the disappearance of a disturbingly high number of academic departments offering doctoral programs throughout the United States. In short, she raised a serious problem. In developing her argument, Rikli cited the number of disparate national associations devoted to the various academic specialties (e.g., American Society of Biomechanics [ASB], the American College of Sports Medicine [ACSM], and the North American Society for the Psychology of Sport and Physical Activity [NASPSPA], etc.) and their widespread geographical locations with no centralized coordinating efforts. As such, she decried the absence of a national organization or umbrella organization under which the various subdisciplines (e.g., biomechanics, sports medicine, motor behavior, exercise science, sport psychology, socio-cultural studies, and pedagogy) would find a common home. In contrast to the state of affairs in kinesiology, Rikli highlighted the cohesive nature of the national organizations of other academic fields such as the American Psychological Association, the American Chemical Society, and the Gerontological Society of America, which are characterized by well-defined missions (i.e., understanding and enhancing human behavior, understanding the make-up of materials, and understanding the aging process and the

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factors that influence it, respectively) that provide clarity and unity of purpose to their members and to the larger society.

I believe that the fundamental issue lying at the core of the Homans lecture, as delivered by Rikli (2006), was that of provincialism or myopia in the way that we as teachers and scholars (i.e., the faculty in our various departments of kinesiology across the country) define our interests and professional identity. Although certainly not true in every case, there appears to be an institutionalization of the cultures in the various subfields of kinesiology such that the research questions and methodological approaches are often limited in scope to the singular perspectives and tools of that specialty. There is typically little to no cross-collaboration. For example, there is an abundance of evidence that physical activity results in beneficial health consequences, but participation is still relatively low in the U.S. population (U.S. Department of Health and Human Services, 1996). In an attempt to address this issue and raise the level of participation, exercise psychologists sometimes rely on the variance accounted for by various personality constructs. However, other issues that bear on the problem such as compromised mobility in the elderly (e.g., orthopedic complaints and compromised balance; Bean, Bailey, Kiely, & Leveille, 2007), social concerns such as the architectural design of communities (e.g., lack of sidewalks and community layout; Owen et al., 2007), and even genetic factors that dispose one to an active or sedentary lifestyle are typically ignored (Bryan, Hutchison, Seals, & Allen, 2007). The problem is multifaceted and demands a convergent approach but is generally addressed in a parallel manner by the various silos of subspecialties. Of course, such specialization is necessary and fruitful in scholarly efforts as science is reductionistic in nature but is incomplete in addressing the scope of the problem.

Much of the impetus for such a model of development in kinesiology might date back to the concerns articulated by some concerning the lack of a scholarly identity in our field (Conant, 1963) and the classic rebuttal of Henry (1964) that appeared in the *Journal of Health, Physical Education, and Recreation* titled “Physical Education—An Academic Discipline.” Henry’s position certainly provided a catalyst for scholarly development, but the building of the subdisciplines and the achievement of scientific recognition from the parent disciplines has come at a cost regarding the identity for the overall field of kinesiology. It appears that the fragmentation was largely the result of necessary (and well-intentioned) efforts. Such a constrained approach, however, might have thwarted the focus on that which makes us unique—physical activity (Newell, 1990). To illustrate, I can remember when I was a graduate student learning about the personality constructs that characterize high-level performers, but I was completely frustrated by the lack of any efforts to join these constructs with the moving body. In other words, *why* or *how* did these personality characteristics influence the dynamics of muscle activity and limb motion? And, if they did not, then what was the relevance to kinesiology? The quality of the research was without question, but the research was incomplete in terms of the kinesiological perspective.

Unfortunately, there is an irony in the attainment of such excellence in our science and scholarship, as many prestigious departments of kinesiology have disappeared or been absorbed into other units on their campuses. This unanticipated development is likely the result of a lack of “identity” or perceived common cause, despite the excellence of research and scholarship in the various subspecialties.

There is no question as to the scientific maturity that has been achieved by our field as supported by the recently attained recognition of kinesiology by the National Research Council of the National Academies of Science. It might be that the building of such silos was inevitable and that it is only now that we are positioned to conduct more-integrative approaches. But, again, this noteworthy development has come in an era coinciding with the disappearance of virtually all doctoral programs west of the Mississippi (Rikli, 2006). As such, it seems that some sort of change in the culture of our field makes good sense.

On a more optimistic note, Rikli (2006) also raised a compelling vision of a highly integrated or cohesive discipline in which the various subspecialties would converge and inform one another on issues centering on physical activity—the core consideration of kinesiology whether it is considered as an independent variable (e.g., the impact of resistance training on skeletal muscle) or as a dependent variable (e.g. the impact of cerebellar dysfunction on limb coordination). In fact, she went so far as to provide a name for the administrative unit that would embody this approach—the American Kinesiology Association—and suggested that it would reasonably be located in the nation's capital, Washington, DC, to facilitate its political voice. I sincerely applaud Rikli for specifying an administrative model of integration in such a bold and pragmatic manner. In essence, the report of her Homans address had a profound effect on me, and I would like to build on the remedy that she outlined.

I should note that I have personally held the view of an integrative approach of kinesiology centered on physical activity throughout my career. It is interesting to me that when asked about my professional identity when I interviewed for my current position in exercise and sport psychology at the University of Maryland some 25 years ago, I answered that I was "a physical educator who focused on behavioral issues in my research." (Note: I would now use the term *kinesiologist*). Murial Sloan, an Academy fellow who was the chair of our department at the time, responded with "I like that answer." Compared with the lukewarm reception such a declaration had evoked at other interview sites, I felt that I had found a home. To this day I believe that this issue of integration of the various subdisciplines in kinesiology is a core concern for our field—not only for the maintenance of our academic units on the various college and university campuses across the country, but because it can *better serve the needs of our society* and help in addressing problems of theoretical and practical significance that are best addressed by kinesiology.

It is interesting that the issue of fragmentation within academic specialties is not unique to the field of kinesiology, and similar concerns have been raised by others (Glass & McAtee, 2006). For example, health behavior has been described as a resultant product of multiple layers of influence ranging from the genomic and molecular levels to the global economic and geopolitical levels. In this manner, health behavior is an outcome determined by the integrity of various tissues and organs and the affordances enabled by constitutional integrity (i.e., health and disease states define one's potential to practice certain health behaviors such as involvement in physical activities), as well as the opportunities and constraints exerted by family considerations, community, and governmental policies. In a specific illustration of this perspective, Williams et al. (2001) explained the risk of cardiovascular disease by joint consideration of genetic, biochemical, and environmental factors. The point raised by these authors is that a single level of analysis is incomplete and lacks explanatory power to meaningfully predict health behavior or disease states.

So how can this concern be addressed in kinesiology? Before answering that question I would like to acknowledge that progressive and integrative approaches to kinesiological problems are currently being pursued. For example, Bryan and colleagues (2007) have recently reported a transdisciplinary model involving the integration of genetic, physiological, and psychological factors to explain participation in physical activity, and there are most certainly other such exemplars. As such, I am optimistic that a change in our culture is afoot, but it needs more-deliberate and consistent effort. More specifically, I would like to address the question raised above by developing specific examples of integrative research in two major aspects of kinesiology—the (a) health-related and (b) performance-related dimensions of our field—and how such integrated approaches can address critical issues of broad social significance essentially related to physical activity and motor behavior. The multidisciplinary nature of our field, which has been problematic in regard to fragmentation, is also ideally suited to integrative problem solving owing to the multiple perspectives and complementary vantage points that can be brought to bear on given issues. See Figure 1. As such, we are naturally positioned to capitalize on an integrative, problem-solving approach, and the content of our field, as it relates to such current issues as inactivity and health, provides additional opportunity for us to capitalize on the need to address important topics. On a practical or administrative note, I propose that the relevance of kinesiology to societal challenges in the areas of sport, health, and physical fitness can largely be achieved through the creation of centers within our departments to foster such collaborations.

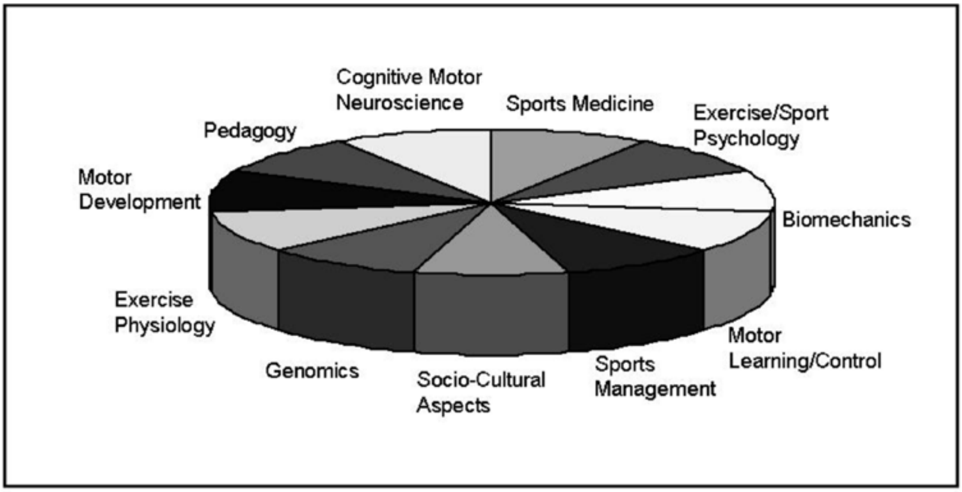

Figure 1 — A view of the component subdisciplines of kinesiology that offer the potential for integrated approaches to health- and performance-related problems based in physical activity.

The Partnership of Basic Research and Socially Relevant Centers of Study

In my opinion, the essence of kinesiology is the study of the moving body with biomechanics, motor control/neural and metabolic processes arguably as essential core knowledge components and the moving body being understood in the context of health, ergonomic, psychological (e.g., competitive sport and stressful military settings), philosophical, social, management, policy, pedagogical, and, more recently, genetic considerations. I also believe that the essential nature of kinesiology is to seek answers to the basic questions of how and why we move and that the generation of such knowledge largely rests on specialization. We do not need to replace the model of the last 40 years—it has served us well. However, we need more balance between specialization and integrative partnerships. I believe that this can be achieved with more attention to issues or problems that cut across our subdisciplines and the creation of formalized centers to study such broad issues (i.e., the big questions) in our departments, schools, and colleges within the university. There are numerous advantages to such centers. These would include the pooling of resources and technical expertise, enhanced communication between colleagues, and the support of benefactors and federal agencies who see relevance to the issues. There are disadvantages to be sure, such as the threat to the emergence of the independent scholar, which is a hallmark characteristic of the tenure and promotion process at most universities. That is unlikely to change. However, such centers can provide connectedness to the big issues of social relevance and would, by nature, require a level of cooperation and teamwork across specialties as necessitated by such superordinate goals. Such an approach will naturally foster communication and creativity and provide necessity to the vision of the “umbrella home” articulated by Rikli (2006). Importantly, I would offer that the topics addressed by these centers *should not define the field of kinesiology* because the issues (e.g., promoting physical activity or exercise and aging) will come and go in and out of fashion as the needs of society change, but such centers can act as intellectual and scholarly resources (a collection of experts) to address activity-related problems and thereby serve the public. In a sense, they provide *connectedness to real-world issues* and, thus, social relevance of kinesiology. As an analogy, one can think of the centers as satellite entities that hover closely and are temporarily tethered to the basic science thrust of kinesiology. (See Figure 2.) A critical feature of these centers, however, is that physical activity is at the core of each.

The possible foci range from issues of public health such as childhood obesity to those of elite sport performance and military preparedness in which individuals must perform complex cognitive-motor skills under extreme psychological pressure. Such an approach would also serve to enhance our possibilities for external funding beyond those associated with our basic and highly specialized efforts, and we cannot ignore the need for resources to support our students, acquire technology, and grant the faculty time to conduct their scholarly efforts. Ironically, I also believe that such cross-disciplinary efforts will likely strengthen our specialties, as opposed to weaken them, because new techniques and principles that apply to one field may be applied to others (e.g., the cross fertilization of studying efficiency in brain

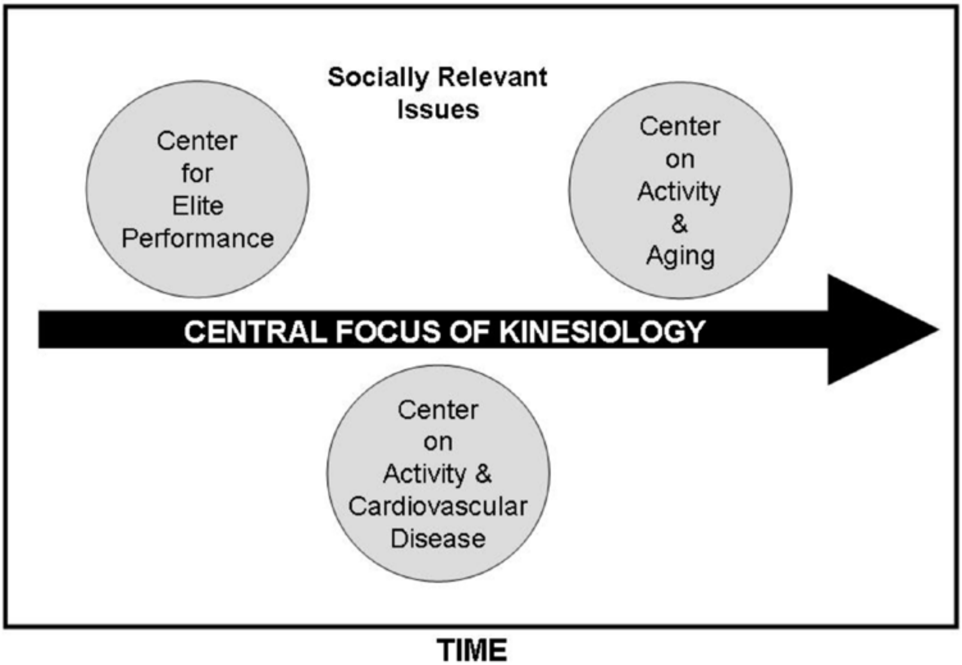

Figure 2 — The transcendent thrust of basic research in kinesiology, as represented by the arrow moving over time, complemented by "satellite" centers of study to investigate socially relevant issues involving physical activity.

dynamics [within motor behavior] leading to effective coaching and teaching styles [within pedagogy]). I would also like to point out that such centers can be formal or informal organizations. The former would naturally emerge as partnerships within a group of scholars as determined by shared interests, and the latter would be officially recognized by the university and require compliance with certain rules and regulations such as minimal levels of funding support, etc. It might be that the former is a reasonable way to start, and it would naturally involve the intrinsic motivation of the faculty. Over time, such a collective might highly influence the hiring of new faculty interests, eventually be formalized, and impact the identity of a given department. Sometimes such centers might emerge across departments, such as the cooperative efforts between faculty members housed in the departments of Psychology and Kinesiology at the University of Illinois, a recognized leader in the study of exercise and the aging brain (Kramer et al., 1999). I would also note that the detailed distinction between centers and institutes might vary from university to university, but the concept of a collective effort on particular issues holds in either case.

Examples of possible centers based on critical foci related to physical activity include (a) physical activity and obesity, (b) mobility and health, (c) physical activity and the cardiovascular system, (d) physical activity and the brain, (e) physical activity and accelerated learning, (f) the study of sport and superior performance, and, importantly, (g) physical activity and child development. As apparent from these topics, one can see tremendous latitude in the potential topics and possible inclusion of technologies ranging from electron microscopy to community-based exercise promotion.

A Health-Related Example: The Center for the Study of Physical Activity and the Brain—The Dementias

I will illustrate with a timely example on the link between physical activity and mental disease. More specifically, dementia is a progressive disorder affecting the cognitive abilities such as memory and reasoning and presents along a continuum from mild to severe conditions including age-associated memory impairment (AAMI), mild cognitive impairment (MCI), and incident dementia with such typologies as Alzheimer's disease (AD), vascular-type dementia (VTD), fronto-temporal (FTD), and that of Lewy body (LBD), with AD being the most common. Normal age-related change in the brain is marked by initial decline in the frontal region of the brain, which affects short-term memory and other executive-type functions (West, 1996). In contrast, the etiology of Alzheimer's Disease begins with neuronal degeneration in the memory-related areas of the brain, namely in the medial temporal and hippocampal regions, progressing to the temporal-parietal regions, and finally to the entire cerebral cortex including the frontal executive regions (Braak & Braak, 1991). The individual is incapacitated at this final stage and has no knowledge of their surroundings and no recall of past events. The histological characterization of the affected brain tissue includes the beta-amyloid plaques that interfere with extracellular interneuronal communication, as well as the neurofibrillary tangles located in the cytoplasm of the neuron that compromise intracellular transport. The fact that the progression of AD begins with degeneration of the hippocampus is a critical aspect for physical activity intervention because animal-based work summarized by Cotman and Engesser-Cesar (2002) reveals that the hippocampal region is privileged for the neurobiological benefit of exercise.

Such a center offers the opportunity to focus on an issue of great societal importance because recent estimates place the incidence of dementia (or impairment of cognitive function) as high as 10% of the U.S. population over the age of 65 years when mild cases are included (Clark & Karlawash, 2003). With the growing population of seniors or "baby boomers" in the United States, the numbers of demented elderly could be as high as 30 million men and women by the year 2030—roughly the size of the population of Canada. In addition, these numbers would be greatly enhanced by the caregivers and family members affected. The statistics are staggering, and this issue could be addressed from a number of kinesiological perspectives as will soon be described. In addition, from a management perspective and the concerns of department chairs and deans, such cross-disciplinary efforts hold greater likelihood of funding or sponsorship from federal agencies, such as the NIH, that currently favor the model of interdisciplinary research and a multilevel translational approach—from bench to bedside. Furthermore, such centers of excellence are likely to attract outstanding faculty members in light of the opportunities to work efficiently with others as part of a team, the available technology, and access to study participants. Such a center would enhance visibility for the academic unit and provide valuable service to the community if part of its overall mission.

The question for this kinesiology-based center is: Can we delay or prevent the onset of cognitive impairment via physical activity? If asked this question 10 years ago, I would have been extremely skeptical about answering in the affirmative, but developments over the past decade are promising and support the usefulness of physical activity as a significant factor in this disease. Furthermore, the levels of analysis to answer such a question involve numerous areas of the field. For example, exercise epidemiologists have noted patterns of association between physical activity and the prevalence of cognitive decline and dementia (Laurin, Verreault, Lindsay, MacPherson, & Rockwood, 2001). Such field observations are an ideal starting point from which to initiate more basic, controlled experimental studies to include investigations at the level of genetics (DNA microarrays to assess gene expression), cell physiology/histology, animal studies of systems physiology, and clinical trials involving human subjects. The latter could focus on cognitive outcomes and neuroimaging, as well as investigation of controlled community programs based on sound principles of exercise training. Finally, the relevant interests transcend to the development of relevant social policy to include designing the built environment and promotion of physical activity. Such an approach relates nicely to the arguments mentioned earlier by Glass and McAtee (2006). Numerous possibilities would be spawned to assess complementary concerns in the areas of diet, nutrition, and stress and how they interact with physical activity and the etiology of AD. For example, Epel et al. (2004) recently reported the impact of caregiving on the aging process and the impact on DNA (i.e., telomere shortening). Physical activity might be particularly beneficial to the baby boomer generation as they care for elderly parents with dementia. So a diverse team of specialists is needed, but they are all tied together like the spokes of a wheel to a common hub—physical activity and healthy aging of the brain. The specialists could include exercise physiologists ranging from biochemists and molecular biologists to systems physiologists, as well as exercise psychologists ranging from psychophysiologists studying brain dynamics to experts in motivational processes, to name just a few. Of course, expertise is needed beyond the traditional offerings of kinesiology from other disciplines in the physical sciences and medicine such as computer specialists in brain imaging technology, neuroradiologists or physicians who can diagnose pathology from the images generated from study participants, as well as engineers involved in signal processing. As such, one viable model is that of a university-based center. The Beckman Institute at the University of Illinois is an example of this approach. The work of such a group would have broad appeal and could be communicated to the American Kinesiology Association, the American Medical Association, a host of other scientific societies and, ultimately, to policy makers in the state legislatures and the congress.

To illustrate how all of the various lines of investigative work converge on this problem, I will start by reference to the work on exercise-induced release of neurotrophins, more specifically, brain-derived neurotrophic factor (BDNF) that was summarized by Cotman and Engesser-Cesar (2002) in *Exercise and Sport Sciences Reviews*. The term *neurotrophic* literally translates to "brain nourishing," and there is strong evidence of the up-regulation of BDNF messenger RNA in the cytoplasm of nerve cells in the animal brain as a result of physical activity. Furthermore, investigators have observed a strong positive dose–response relationship in certain strains of rats, a finding which reinforces the causal connection between the exercise stimulus and this remarkable brain response. The BDNF increase facilitates neuronal repair and synaptogenesis, enhancing their viability. Remarkably, and based on the work of Fred Gage and colleagues, exercise in rodents even promotes neurogenesis or the generation of new neurons in the animal brain (van Praag, 2006). Such a response (and adaptations over time) could be a major contributor to a biologically based cognitive reserve that would counteract the emergence of clinical symptoms of memory impairment and dementia. In this way, the neurotrophic and neurogenic response, if it occurs in humans, would act as a buffer against the deleterious effects of accelerated aging and disease-related processes. Again, it is particularly important to note that the hippocampus—the origin of the progression of AD etiology—is the primary brain region where this effect occurs. The utility of a physical activity–induced hippocampal benefit or linkage between musculoskeletal activity and memory makes good sense from a survival perspective. In this regard, our early ancestors would have had to remember critical features about various locations in their environment as they moved around, such as availability of food or threat, as well as recall the navigational routes to return to or avoid those locations in the future. (Cotman, personal communication, 2003).

Also important, the biochemical and histological changes just noted translate or emerge in the animal's behavior as noted by Rhodes et al. (2003), who observed superior memory-based performance in the Morris water maze—this task typically involves water immersion and location of a submerged platform in a pool of water that enables the animal to rest and maintain their head above the surface of the water. In other cases, the animal must navigate various radial arms emanating from a central spot in a pool of water to locate food and "dry land." Comparisons between sedentary and exercising animals (i.e., those with a running wheel located in their cage) revealed shorter trial latencies and numbers of trials in the wheel runners to solve the challenge and find (remember) the target locations. In essence, the physically active animal is smarter! Of interest, this work is complementary to that of other investigators (Isaacs, Anderson, Alcantara, Black, & Greenough, 1992) who have noted vascular adaptations in the brains of animals including mice and nonhuman primates. This work also holds great promise for dementia, particular of the vascular type. At any rate, such work has fascinating implications for the human brain if it responds to exercise in a similar manner to that of nonhuman species, especially for those at increased risk of dementia. Such an effect in the human brain would hold enormous implications for the public's health.

Indirect evidence for such an effect was provided by Colcombe et al. (2003), who examined the relationship between aerobic capacity and brain tissue density of the gray and white matter in older men and women who were subjected to tests of aerobic capacity (VO_{2max}) and neuroimaging to assess the structural anatomy of the brain. Using a technique called voxel-based morphometry (VBM) these investigators determined the density of neural tissue in various regions of interest (ROI) from the magnetic resonance imaging (MRI). They confirmed that the areas at greatest risk of age-related decline were the prefrontal lobes and the temporal–parietal association regions of the cerebral cortex, but, more important, they reported sparing of these regions with exercise. That is, there was a positive relationship between aerobic capacity and brain tissue density that was pronounced in the regions at greatest risk of age-related decline. It is uncertain whether such an effect in the human brain is the result of BDNF because the up-regulation is chiefly limited to the hippocampal region, and such investigation is largely precluded in humans because direct genetic analysis would require samples of brain tissue from the participants for assay. A previous personal communication with Dr. Cotman revealed, however, that BDNF is up-regulated in other regions of the animal brain, so the possibility that the enhanced tissue density observed by Colcombe and colleagues was the result of BDNF remains. At any rate, such a finding in the area of human exercise studies nicely complements the animal-based work of Cotman and others (Cotman & Engesser-Cesar, 2003), as described previously, and illustrates the benefit of multilevel approaches to kinesiology-based issues.

Building on this theme of convergent research efforts to understand the link between exercise and the dementias is the consideration of genetic polymorphisms to account for variations in brain adaptations to exercise. For example, Strittmatter et al. (1993) were one of the first groups to report the link between the e4 variant of the apolipoprotein APOE gene on chromosome 19 and increased incidence of AD. More specific, APOE acts as a cholesterol transporter in the brain (and throughout the body) and has three common allelic variations: e2, e3, and e4, of which the latter poses a liability in terms of neuronal cell maintenance and repair. Such a liability is particularly problematic for older men and women who might suffer from AD because carriers of e4 would be less likely to buffer the disease and would likely report symptoms at an earlier age of onset than noncarriers. This possibility is strongly supported by the fact that over 50% of those clinically diagnosed with AD show the presence of the e4 allele (Patrella, Coleman, & Doraiswamy, 2003). In a test of the efficacy of physical activity to protect against this genetic liability, Schuit, Feskens, Launer, and Kromhout (2001) recently reported a prospective epidemiological investigation with 60- to 70-year-old men in the Netherlands who were subjected to assessment via the Mini Mental States Exam (MMSE), a common test of cognitive function in older individuals and characterized for amount of daily physical activity in the form of walking, cycling, gardening, etc. The study participants, who were dichotomized into those who were active less than an hour a day and those who were active more than an hour each day, were assessed again via MMSE after 3 years had passed after the initial testing. Schuit and colleagues made a remarkable observation noting a protective effect of physical activity in e4 carriers. More specific, the relatively sedentary e4 carriers showed significant decline in their performance on the MMSE, whereas the physically active carriers showed a dramatic attenuation of cognitive decline such that they resembled the noncarriers who showed little decline in MMSE scores whether they were physically active or not. Although the study results are tantalizing in their own right, the major point here is that the animal work cited previously (neurobiological benefits of exercise) can guide epidemiological work in humans related to physical activity and dementia. It is not clear to me whether the efforts of Schuit et al. were guided by the pioneering work of Cotman (Cotman & Engesser-Cesar, 2002), Gage (van Praag, 2006), Greenough (Isaacs et al., 1992), Spirduso

(Spirduso, 1983), Dustman (Dustman, Emmerson, & Shearer, 1994), and Kramer (Kramer et al., 1999), but cooperative work as facilitated by the center concept would surely facilitate such multilevel thinking and provide a rationale for strong directional theorizing. Furthermore, the work of Tong, Shen, Perreau, Balaza, and Cotman (2001) in which they employed gene microarrays and which appeared in the literature coincident with the report by Schuit et al., showed that a number of genes become expressed or "turned on" in response to exercise stress. Exercise most certainly changes the internal milieu of the body in many ways, such as hyperthermic effects, elevations in catecholamines, increased cardiovascular activity, changes in autonomic balance, and heightened blood lactate. In addition, the motor processes mediated by various structures located in the central nervous system in and of themselves might promote gene expression, and there are also significant alterations in various neurotransmitters that might turn on the DNA. Finally, such a finding holds profound implications for the need to consider population specificity in the exercise and aging brain relationship and that exercise might be essential medicine for some people (Deeny et al., in review)!

The team approach to exercise and the dementias by which the problem is approached at different levels of analysis also extends to technical issues (Small et al., 2000). For example, neuroimaging data have revealed differences in brain activity years before the onset of any behavioral symptoms of dementia (Reiman et al., 2004). As such, it is critical that neuroscientists and behavioral scientists communicate because detection of the benefits of exercise might be exclusive to neuroimaging during the early stages of disease and clearly revealed by psychological testing at later stages. Such differential sensitivity might be the result of compensation whereby particular areas of the brain that are compromised are assisted by recruitment of additional brain regions during the negotiation of a given mental challenge, thereby masking any behavioral deficit. However, this means that significant dynamic changes are occurring in the brains of men and women that are invisible to behavioral assessment. For example, Reiman et al. observed profound changes in brain metabolism in young carriers of the APOE e4 allele (i.e., hypometabolism relative to noncarriers), even in their 20s and 30s, that otherwise appeared asymptomatic in terms of neuropsychological testing. Using the right tools at the right time might be very revealing of critical brain processes and meaningful changes in the brain, and such a revealing strategy is much more likely with collaborative efforts. This approach might reveal that exercise can exert ameliorative (i.e., neurotrophic and angiogenic) effects on critical brain structures and activation patterns at an early stage of disease and delay or prevent dementia by building cognitive reserve and counteracting the debilitating effects of plaques and tangles. In this manner, there might be a window of time or opportunity by which exercise could provide a powerful form of preventive medicine. The fleshing out of such a robust remedy would necessitate a clinical trial involving a cohesive group of geneticists, neuropsychologists, neuroscientists, exercise physiologists, fitness trainers, exercise psychologists, statisticians, nutritionists, etc. all working together to address the efficacy of physical activity to manage this terrible disease.

Using such a team approach, we are addressing this issue in our current work by studying the interactive effect of exercise (i.e., physical activity history) and genetic susceptibility (cognitively intact middle-aged carriers and noncarriers of APOE e4) on the response of the cerebral cortex with a form of neuroimaging termed magnetoencephalography (MEG) that is employed while the study participant is challenged with various mental tasks involving executive and memory processes (Deeny et al., in review). The dynamic activity of the working cortex is followed during the encoding of letter strings and the subsequent recall of probe letters that are classified by the subjects as "matches" (letters that were contained in the previous string) and "nonmatches" (letters that were not contained in the string). The technology, which assesses the tiny magnetic fields generated by the electrical activity from the neuronal activity in the brain, has a high degree of temporal resolution allowing one to see the activation of the various regions of the cortex from millisecond to millisecond (i.e., every one thousandth of a second). This exquisite resolution has revealed that physically active carriers of the e4 Alzheimer's susceptibility gene show a similar pattern of response in the brain (right temporal cortex) during recall to that observed in noncarriers, whereas the sedentary carriers exhibit relative hypoactivation or a decrement in the amplitude of response. The results strongly support the benefit of exercise on the aging brain in this at-risk population that would not otherwise be revealed with more-conventional psychological assessment involving cognitive testing. In fact, no differences were observed in the reaction or percentage of correct responses to the memory probes so that a comparison confined to that level of analysis would indicate no benefit of exercise on the brain. Furthermore, failure to partition the MEG data on the basis of genetic grouping would have prevented revelation of benefits of exercise on the brain because the analysis revealed the interaction just described with no main effect of physical activity history. Such a study also provides a rather conservative test of the benefits of exercise on the brain because the study participants are all high-functioning and asymptomatic for dementia, and yet benefits to the brain were still observed—benefits that might become more and more important as time passes and normal aging and perhaps disease take their toll. In essence, the efforts described so far suggest that early detection of disease processes and appropriate initiation of physical activity during a window of opportunity could have substantial mental health benefits. Even more relevant possibilities for the research to address this issue lie in the assessment of the effects of exercise on brain processes in those who are actually suffering from cognitive impairment. Longitudinal investigations of the efficacy of exercise interventions for those characterized by AAMI and MCI could conclusively determine whether physical activity provides a useful prophylactic in clinical populations. Such an approach could target specific brain regions such as the hippocampus in an attempt to determine whether an activity-induced neurotrophic effect occurs in humans that would explain any observations of attenuated cognitive decline (i.e., exercise intervention groups show cognitive sparing versus sedentary controls). See Figure 3.

The integrative or multilevel convergent approach to this issue also extends to considerations for the built environment such as the design of senior housing communities and in terms of government policy toward support for parks, senior centers, etc. Such work holds relevance to major public health initiatives such as "Physical Activity and Health—A Report of the Surgeon General" (1996), as well as the former government-supported initiative titled the "Decade of the Brain." Although the importance of the work on exercise and the aging brain is evident, there are major implications for child development and physical education. The need for attention to children is underscored by the obesity epidemic. According to

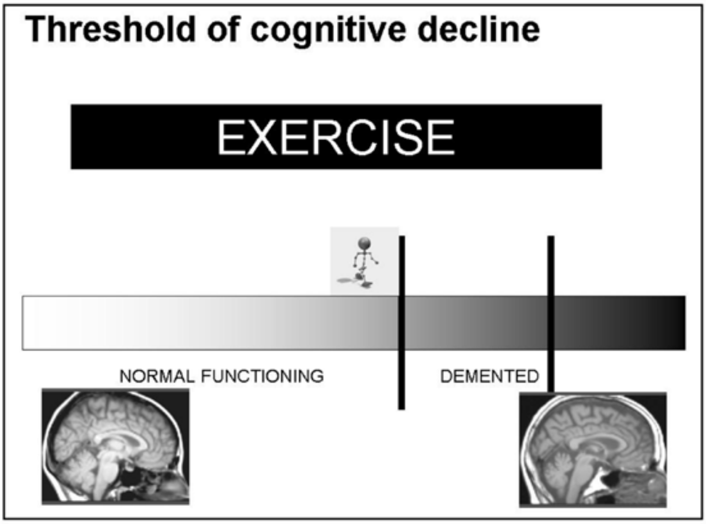

Figure 3 — The threshold of cognitive decline is elevated as a result of neurobiological benefits of physical activity resulting in delay of the onset of symptoms of dementia.

the Centers for Disease Control and Prevention, 16% of children (over 9 million) 6–19 years old are overweight or obese. Importantly, the childhood obesity rate has more than doubled since 1980 for children age 6–11 years, and it has more than tripled for children age 12–19 years during that same time period (Centers for Disease Control and Prevention, n.d.). Attention to this issue is essential for physical health and well-being, but a more-integrated approach to the benefits of physical activity in children also reveals the benefit of physical activity for more than weight reduction. For example, Hillman, Castelli, and Buck (2005) recently reported that fit children show superior neuroelectric patterns of brain response to mental challenge, and Castelli, Hillman, Buck, and Erwin (2007) report that fitness is associated with academic achievement in elementary school children. In addition, it might be that early patterns of physical activity are critical to cognitive reserve in the aging brain, a sort of "investment hypothesis" as based on the "Nun studies," which showed that cognitive abilities in Catholic nuns during their adolescence were negatively related to the incidence of AD late in life (Snowdon, Greiner, & Markesbery, 2000). In that sense, physical activity at critical stages of development might be facilitative for both academic achievement and protection from disease. Such effects truly support the concept of *mens sana in corpore sano* (a healthy mind in a healthy body) and might hold great weight with policy makers who decide the fate of physical education in the school systems.

A Performance-Related Example: Center for the Study of Elite Performance

Equally important opportunities beyond the integrative research in the health-related aspects of kinesiology lie in the performance-related aspects of our field. This approach can yield deeper understanding of elite athletic performance, as well as that of other populations such as military personnel and first responders who must execute cognitive-motor skills under intense psychological pressure. The societal interests range from the International Olympic Committee to the United States Department of Defense and Homeland Security, as well as those interests of major government agencies and corporations connected to human factors and work-site health.

Such an approach, in which physical activity or skilled motor behavior lies at the core, could be achieved through a Center for the Study of Elite Performance. The vision of optimal performance would necessitate the efforts of behavioral geneticists, sport psychologists, experts in motor control and behavior, cognitive and affective neuroscientists, biomechanicians and exercise physiologists, as well as pedagogues and applied sport psychologists. Such expertise would span knowledge ranging from motor-unit activity to leadership and teaching styles or, as one of my dear colleagues once characterized it, "brain breath and brawn" (Cram, personal communication, 2000). For example, in accord with the concerns stated by Rikli (2006), sport psychologists and those in motor control both study skilled motor behavior, but, despite this shared interest, rarely do they communicate with one another. The sport psychologist typically describes skilled motor behavior without reference to the nervous system and the motor apparatus, and the motor control theorist typically describes the neural processes underlying motor behavior with exquisite detail but little to no acknowledgment of emotion or motivation playing any role. Of course, any coach, athlete, or elite military personnel surely knows that execution of skilled motor behavior rarely, if ever, exists within an emotional vacuum. However, the taxonomies (and associated fractionated professional organizations) to which we subscribe have little to do with the way that nature works, and such divided approaches will always fall short of fully understanding the phenomenon of interest. The essential nature of sport psychology (use a different term here?) is the relationship between psychological states and emergent quality of neuromuscular activity and kinematic qualities. As such, it would seem that the convergence of sport psychology, motor control, and biomechanics is ideally suited to address and explain how emotion and cognition impact movement. There has been little subscription to such an approach to date, although notable examples are studies by Beuter and Duda (1985) and Weinberg and Hunt (1976). The former involved assessment of the kinematic qualities of gait in children who were subjected to psychological stress, and the latter involved assessment of EMG activity of specific muscles of the upper extremity during a throwing motion with an emphasis on the timing of agonistic and antagonistic action under varying conditions of arousal/anxiety. See Figure 4.

More specific, the fundamental issue for the center could be "What is the essential nature of superior cognitive-motor performance *and* what happens under pressure?" This is an exciting topic and one that could be contextualized within

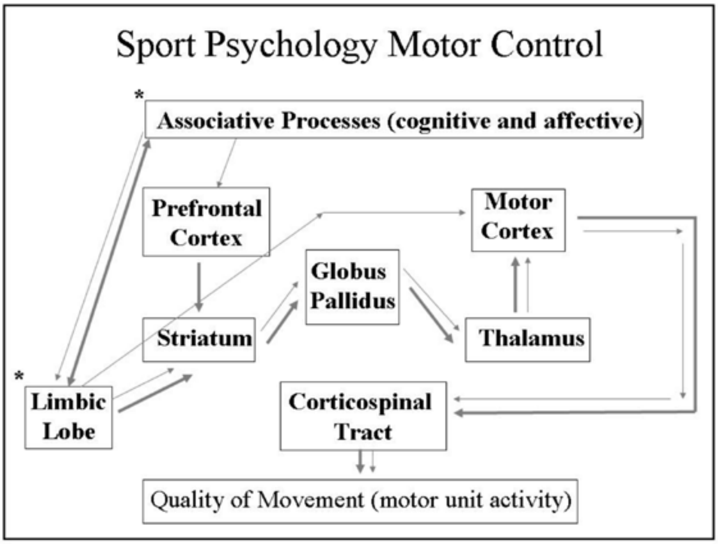

Figure 4 — The convergence of sport psychology constructs (i.e., higher associative or cognitive processes and motivation) and motor control structures comprising the "motor loop" to influence the quality of musculoskeletal activity.

broader themes such as economy or efficiency of action. In this regard, Sparrow (2000) argued that the dynamics of coordinated muscle activity are organized on the basis of principles of minimization of energy expenditure, in a process of constraints imposed by both task and environment. In other words, skilled motor performance is characterized by economy of action. Lay, Sparrow, Hughes, and O'Dwyer (2002) provided empirical support for this notion through their observation of attenuated EMG and more-consistent production of force in the upper extremities as study participants practiced a rowing motion with an ergometer over time. Of course, Daniels (1985) began much of the thinking in this regard with the concept of running economy, whereby, elite distance runners consumed less oxygen per unit of body mass relative to those who were less accomplished. We have also observed the economy of skill in our own program of work on brain dynamics during motor performance. We have typically employed a marksmanship task with which study participants are challenged to successfully execute a demanding visuo-motor aiming task. The self-paced task is ideal in many ways because it involves the goals of postural stability, focused attention, emotional control, and an objective performance outcome that is easy to score. Importantly, the study participants do not move, thus negating artifact and enabling recording of multiple psychophysiological signals of interest (e.g., EEG, EMG, ECG, psychoendorine responses, kinematic time series, and aiming trajectories in the case of optical tracking units). It is typical that expertise in this task, which captures essential principles that we believe generalize to many other performance situations, is accompanied by regional relaxation in the cerebral cortex and lowered intercortical communication (i.e., lower EEG coherence) relative to that seen in novices (Hatfield & Hillman, 2001).

To characterize the integrated approach to human performance, one could envision elite athletic performance (e.g., a sprinter at peak velocity in the 100 m event) as a symphony of coordinated motor-unit expression during which the cerebral cortex exhibits highly refined cortico-cortical communication between the thinking regions of the brain and the frontal motor regions. That is, the mind is quiet and focused with attenuation of any activity that is nonessential to the performance. In phenomenological terms, the performer experiences "flow" (Csikzentmihalyi, 1975, 2003). This neurological and mental state would be accompanied by decisiveness of the executive commands to the subcortical basal ganglion region and the motor cortex (i.e., the motor loop) with subsequent activation of the prime movers and dynamic coordinated action (i.e., relaxation) of the antagonistic muscles resulting in orchestrated metabolic processes and alterations in autonomic balance and endocrine activity resulting in high-quality kinematics, efficient force production, and adaptive performance outcomes. One could see the need for a virtual plethora of kinesiological specialists but all focused on the convergent issue of understanding the essential nature of high-level performance with an overarching theme such as economy to knit the pieces of the puzzle together. There might be other themes such as adaptiveness or flexibility of strategy (a diversified strategy in the nervous system to respond effectively to changing environmental conditions) that one could argue to characterize elite performance, but the point is that the research team sees the "forest as opposed to the trees."

What is terribly exciting about this approach is the tremendous sharing of perspectives by movement scientists or kinesiologists. Exercise physiologists would converse with neuroscientists, sport psychologists, and biomechanicians in a common effort. Those interested in the phenomenological aspects of performance, who are focused on the subjective experience of the performance, would converse with those involved with signal processing of bioelectric time series recorded from the brains, the muscles, and the hearts of the study participants. Wouldn't it be wonderful if the management of such a project were characterized by periodic meetings in which the individual scientists shared their findings with those of the other members of the team with unity of purpose? Furthermore, each participant in the research process would only be useful in that he or she is a highly specialized expert within their discipline—there is no question that specialization is the hallmark of our scientists. However, the call here is for more balance between our specialized research efforts and that requiring the team perspective. Addressing important scientific questions is the fundamental goal of this integrative approach, but a wonderful side effect of the process would be a greater clarity and cohesion within the ranks of kinesiology.

The possibilities are endless with regard to expanding the scope of considerations to the social environment and how it impacts the mind and body of the performer. Such possibilities include topics ranging from competitive stress to the impact of teaching and coaching communication styles on athletic performance. In fact, even individual differences in the dispositional nature of the performer in their response to stress could be studied from a multilevel perspective since new developments in functional neuroanatomy have identified a partnership between the frontal cortex and the subcortical limbic system (i.e., primarily the amygdale) resulting in fear-related circuitry that putatively interacts with the motor apparatus. Excessive brain activity (neuromotor noise) causes increased recruitment of motor units and decreased coordination between agonists and antagonists as opposed to studies of expertise that reveal quiet, refined cortical state (see the following), and excess cortico-cortical communication can cause a traffic jam in the brain, loss of focus, etc. Again, such a development illustrates another example of an opportunity for joint effort between the sport psychologist, the affective neuroscientist, and other kinesiologists to further explain how the emotional mind impacts the moving body. In essence, such a partnership might further our understanding of why and how one chokes under pressure (Beilock & Carr, 2001).

To illustrate the potential partnership between such disparate fields as social psychological aspects of sport performance and biomechanics, consider some recent work that we have had the good fortune to conduct with the cooperation of the United States Naval Academy (USNA) and the Army Reserve Officer Training Corps (ROTC). The goal of this effort is to determine the impact of competitive stress on motor performance, and it is being approached by drawing on expertise from a multitude of perspectives in kinesiology, social psychology, neuroanatomy and brain dynamics, motor behavior, stress physiology, kinematics, and the associated technical aspects of signal processing. The study involves a comparison of pistol shooting performance under alone and competition conditions. As such, the investigation involves manipulation of the psychological environment to assess the impact on the mind and body in an attempt to further understand the resultant quality of motor performance. In the former, the study participant is given a liberal period of time to do their best with no social evaluation of the performance. In the latter, an elaborate competitive scheme is implemented in which simultaneous recordings of brain activity and autonomic responses in two competitors are monitored with the imposition of time stress, the presence of a superior officer, and public posting of one's score that also contributes to a team composite, all placing additional peer pressure on the participant. One critical aspect of the study is the link between psychological state, brain dynamics, and the stability of the aiming trajectory. At one level, we assess confidence and focus via self-reported inventories, and at another level, we assess the magnitude of communication patterns between various areas of the brain. In this regard, an anxious athlete, who would report higher scores on the state anxiety inventory (Spielberger, Gorsuch, & Lushene, 1970), would also be characterized by neuromotor noise (i.e., nonessential input to the motor planning regions owing to "over thinking") that can be quantified in terms of excessive EEG coherence. Such volatility in the brain would then result in greater variability in the aiming trajectory as captured by laser tracking technology over the aiming period. As predicted, this is what the data reveal, and it necessitated the collective wisdom of a number kinesiologists each contributing by way of their own individualized expertise.

Although the current culture of silos is a challenge to overcome, I believe it will happen with creative thinking and, importantly, with substantial sponsorship and monetary support. I believe that those possibilities are there. One set of specific and concrete experiences that has shaped my thinking are various meetings that I have attended as sponsored by the Defense Advanced Research Projects Agency (DARPA), which is a research organization within the Department of Defense devoted to development of technologies and basic knowledge that have relevance to human factors and military need. In fact, the Internet was born and developed with the sponsorship of DARPA. This organization holds periodic meetings in which scientists from various backgrounds meet to discuss and brainstorm ideas. I attended a recent meeting in which the theme was that of accelerated learning. I was impressed with the integrative ideas that surfaced in the various working groups, and one example, which could be characterized within the scope of social neuroscience, illustrated the exciting possibilities for the discipline of kinesiology. More specific, the participants discussed the notion of simultaneous neuroimaging of critical brain regions while study participants worked simultaneously on a problem that required cooperative effort. One participant outlined a scenario in which tasks would be presented simultaneously to individuals in a number of sophisticated scanners in which they could see and hear one another through virtual reality displays! Such a study would require sophisticated and expensive magnetic resonance imaging technology and image processing expertise in addition to psychological expertise at a number of levels (e.g., personality, social and cognitive neuroscience), but with the very real possibility of such support, I was struck by the potential opportunities to combine fundamental social psychological concepts with functional neuroanatomy in an attempt to further understand *how and why* social factors such as team cohesion and leadership style impact human performance. More specific, I thought of the opportunity to "see" the emotional circuitry of the brain (i.e., frontal and limbic regions) and the cerebral cortex at work in individuals working alone under psychological stress in comparison with that observed while working within a cohesive team setting. One could also study the impact of leadership style and social reinforcement on brain activity, as well as examine the impact of leadership style on individuals who differ in terms of basic personality constructs such as trait anxiety (Spielberger et al., 1970). I could only imagine the possibility of viewing the activation patterns of the frontal executive regions and the memory-related areas of the temporal lobes as study participants were directed to accomplish their tasks in an encouraging and supportive manner versus a critical and more-punishing style of leadership. One could well imagine the military interest in the psychology of teamwork, given the nature of combat assignments, but the same principles also hold for coaching and teaching of physical education settings.

I thought back to my days as a graduate student at Penn State University when I was exposed to the work of Carron and Ball (1977) on team cohesion and performance in Canadian intercollegiate ice hockey teams and the cross-lagged panel technique they employed that revealed greater influence flowing from earlier team performance (i.e., win/loss record) to subsequent cohesion than vice versa (i.e., cohesion had significant, but less, influence on subsequent performance). This was insightful work but certainly leaves open a number of possibilities as to *why* success leads to greater cohesion or *why* cohesion influences subsequent sport performance. Could it be that cognitive load, which can be operationalized in terms of cerebral cortical activation, is reduced resulting in attenuation of nonessential cortico-cortical communication with motor-planning regions? Could the same type of process be operating when coaches focus on positive instruction and make use of liberal reward when instructing their athletes? I thought again of the work of Tharp and Gallimore (1976) in which they described the teaching style of John Wooden, the great basketball coach at UCLA, as that of stressing the "what to do" as opposed to "what not to do" and how that might translate into remarkable economy of brain processes resulting in a "cool head" and the ability to perform well under pressure. This type of integration between social psychology and cognitive neuroscience and brain imaging would also extend nicely to the leadership concepts regarding compatible and incompatible coach–athlete dyads (i.e., could it be that an incompatible coaching style interferes with the athlete's needs and emerges as a "noisy" cortex?), as well as the construct of psychological momentum advanced by Iso-Ahola and Mobily (1980). Could it be that perceived success reduces excess traffic in the brain allowing one to focus and, thereby, capitalize on the brain dynamics leading to further success? Such integrative work might well define the kinesiological study of elite performance in the 21st century and capture the essential nature of integrative possibilities that can serve to better answer the big questions in our field.

I would also point out that the technical advancements currently emerging in wireless electroencephalography (EEG) and electromyography (EMG), as well as 3-dimensional monitoring of dynamic movement of the extremities, allow for even further integration of biomechanical assessment with the psychological and neural assessments. Such an approach would allow for assessment of performance ranging from manipulation of the psychological environment to kinematic qualities of limb effectors. Far into the future, it would be fascinating to image the cerebral cortical activity of the football place kicker while he or she is on the field of play while quantifying the muscle activation patterns and velocity and trajectories of limb movement. One can also imagine the possibilities that a research team composed of biomechanicians, stress physiologists, psychologists, and cognitive neuroscientists, accompanied by colleagues in such diverse fields as engineering and counseling psychology, could address such as the impact of personality factors, psychological training, and leadership style on the neural, physiological, and mechanical processes of the hypothetical place kicker. In regard to personality, new horizons in the area of behavioral genetics also offer meaningful insights into individual differences in temperament and the ability to manage arousal and cope with stress. For example, Hariri et al. (2002) and Pezawas et al. (2005) recently described the impact of a polymorphism in the promoter region of the serotonin transporter gene (5-HTT) on the emotional circuitry of the brain. More specific, those who carry the short-form allele (s) show relative hyperreactivity of the amygdaloid complex in the limbic lobe when challenged with fear-eliciting stimuli when compared with those who carry the long-form allele (L) for whom the architecture of the brain and synaptic activity is conducive to management of arousal and fear. Such a genetic blueprint might in large part explain the psychological construct of trait anxiety as described by Spielberger et al. (1970). Again, one can imagine the team of researchers described above joined by experts in kinesiogenetics to further explain athletic performance under challenging conditions. It would be particularly relevant to the interests of kinesiologists to determine the manner in which the emotional circuitry of the brain influences the motor processes, and the comparison of neural processes in such genotypes might be particularly informative. Such an approach presents a meaningful alternative to the traditional views of the arousal–performance relationship based on a convergence of subdisciplines and, in this specific example, what might be increasingly characteristic of sport psychology in the 21st century.

Although the examples described above on physical activity and the dementias and the study of elite performance are primarily based in issues related to exercise and sport psychology, the basic notion of the integrative approach extends to many other interests in the field. Moving away from the psychological area, one could envision the impact of a strength-and-conditioning program on the quality of movement patterns on the track, swimming pool, and athletic field by subscription to such an integrative approach in the area of human performance. Furthermore, the development of virtual reality and refinement of such technologies will offer enhanced opportunity to simulate sport- and military-specific scenarios that are conducive to detailed assessment of physiological and kinematic processes.

Concluding Remarks

Before concluding, I would also like to extend the discussion of the relevance of the integrated approach to kinesiology to the field of sport management. It is an important concern because sport management, ideally, and similar to physical education, can serve as a primary conduit to deliver kinesiological knowledge to the consuming public. As one who holds one of my two master's degrees in sport management and as a keen observer of the complexion of this field, I believe that there is a critical need for a more-integrative approach of this specialty—a kinesiologically based approach to sport management rather than a predominant management-based perspective that is simply applied to sport. I believe that a number of graduate programs fall short of a strong alliance with other subdisciplines. The kind of sport management program that could emerge in this century is one in which the curriculum would be based on the subdisciplines of kinesiology as contextualized within management science. To illustrate such an approach, I would resort to an example. Imagine a leader of a large youth sport organization (e.g., Pop Warner football) who holds advanced training in motor development, sport psychology, exercise physiology, sport medicine, pedagogy, and sport history and philosophy accompanied by coursework in accounting, economics, and management and leadership theory. Of course, the specifics of the coursework and the nature of the scholarly research project would vary somewhat, but this approach in which sport management is fundamentally seen as a professional application of kinesiology would enable the development of sport managers (those who are experts in physical activity) rather than managers who just happen to work within a sport setting. The latter is characteristic of those programs in which the sport management program is not well integrated with the field. The latter can make a unique management contribution that considers principles of child development, the impact of resistance training, the impact of coaching styles on the learning process, and is mindful of fundamental kinesiological issues as they foster communication and attend to the financial matters (i.e., the business aspects of the sports organization) of their organizations. Such sport managers might find themselves just as comfortable at a meeting of the American College of Sports Medicine as they would at the North American Society for Sport Management.

In conclusion, I believe that kinesiology has shown incredible scientific advancement over the last 40 years. I have had the good fortune to experience the transformation of the field as I began my graduate training in the mid 70s and experienced first-hand the emergent specialization of the subdisciplines and the acceptance of kinesiology by scholars in other fields, but that growth has come at a cost. Ironically, the increased specialization, which has fractionated the field, has also played a major role in the field's academic coming of age. I agree with a number of my colleagues that are present at this meeting (and whose papers appear in this issue of *Quest*) that specialization is critical to our scientific development—it is a good thing, and it is the way of science. In no way do I advocate for a training of generalists in the field of kinesiology in the 21st century; what I do advocate is a complementary emphasis on physical activity–related issues. This could be accomplished by incorporation of centers and institutes that are focused on socially relevant concerns. Such a balance will accommodate the specialized research that has been the hallmark of our field, as well as the integrative efforts exemplified in this article. Much of the science that essentially defines kinesiology transcends the transient contemporary issues that will come and go on the scientific landscape (e.g., I believe that the issues of childhood obesity and the dementias will one day be solved and new challenges, foreign to us now, will divert our attention). As such, these timeless and transcendent efforts, not the fashionable ones, are and should be central to kinesiology. However, a more deliberate emphasis on contemporary concerns (e.g., issues of public health) will better connect us to prospective students, the general public, and policy makers. That is not a trivial concern, and it might be the link that drives extramural funding (NIH, DoD, NSF, NASA, private foundations) and the support of university administrators for our departments. Ironically, such a healthy infrastructure also provides the environment for scholarly specialization because our units thrive and are seen as strong and relevant. I once read a book by Clampett (1991) in which he argued that communication is the essential quality of viable organizations. Integrative research, by nature, compels communication, fosters a common identity, and facilitates the growth and development of the constituents because of the sharing of ideas and new ways of thinking—this fosters creativity and new perspectives within the specializations. On a very practical level, participation of the faculty in such integrative centers can also lead to heightened and more-efficient scholarly productivity, and various departments around the country could become recognized as centers of expertise on particular issues, thus enhancing their recognition beyond the general identity of any kinesiology department. Of course, departments are already highly recognized for the unique expertise of individual faculty members, and that will continue, but it could well be enhanced by the approach advocated here.

So I will close by endorsing Rikli's (2006) vision of the 2010 American Kinesiology Association meeting. I believe that her thoughts are timely and critical to the vision of kinesiology that will unfold during the 21st century. More and more we witness the recognition of the importance of physical activity to the health and well-being of the nation, and we witness the tremendous influence that effective performance of motor and sport skills holds for physical and personality development of our youth, as well as the critical need to assist those who must perform complex cognitive-motor skills in the military and emergency services. The field of kinesiology is uniquely positioned to (a) address these very important concerns while it also (b) addresses the fundamental science of movement (and in its cultural and historical contexts). The two interests are mutually dependent on each other.

The integrative approach is highly relevant to these interests and to the integrity of our field, and I believe that we, as a field, are very well poised to capitalize on this opportunity. I do hope to attend the inaugural meeting of the AKA (along with my colleagues in the other subdisciplines), and I believe that such an "umbrella" culture will further ensure the health and vitality of kinesiology. This development, when it occurs, and in the spirit of R. Tait McKenzie, will allow us to pass on the torch to those that follow the current generation of kinesiologists and physical educators and further ensure the vitality and relevance of our field.

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