Using a simple reaction time (RT) paradigm, Dickstein and colleagues showed that bilateral rapid elbow flexion results in prolonged RT and movement time (MT) relative to unilateral rapid elbow flexion in patients with hemiparesis and in subjects without neurologic impairment. The authors' rationale for choosing RT and MT to quantify motor performance was that "optimal control of movement initiation and movement speed is required for normal functional performance." What is unclear about this rationale is the meaning of "optimal control." The authors suggested that the prolongation of RT and MT in the bilateral task is indicative of less-than-optimal control. In this commentary, we focus on two issues. First, we offer an alternative interpretation of these findings and argue that "optimal control" is task specific and that the bilateral temporal coupling appears to be quite normal in these patients with hemiparesis. Second, we discuss a methodological option that could provide critical information related to the locus of RT effects.

Temporal interlimb interactions have been observed in a variety of studies in which one of two simultaneously moving limbs is unexpectedly blocked, weighted differently, or required to perform a more difficult task. The perturbed limb affects the unperturbed limb by slowing the response, prolonging the electromyographic (EMG) burst, or altering the kinematic trajectory.

Interlimb interactions also have been observed in patients with hemiparesis during repetitive upper or lower limb movements and during locomotion. Cohn found an interlimb interaction in subjects with hemiparesis performing bilateral supination-pronation movements of the forearm. He noted that when bilateral movements were performed, the paretic limb decreased the movement facility of the nonparetic limb. In Belmont and colleagues' experiment, adults with left-sided hemiparesis performed unilateral and bilateral repetitive ankle flexion and extension movements as fast as possible for 10 seconds. A marked rate reduction occurred for each limb in the bipedal condition in contrast to the unipedal condition, and the nonparetic limb slowed to a much greater extent than did the paretic limb. These findings have now been replicated by Dickstein and colleagues. Similarly, during walking, Peatt observed a bilateral alteration in the relative durations of stance and swing periods, with the greatest alteration seen in the nonparetic limb.

Thus, as Dickstein et al and others have observed, the interlimb interaction in the individual with hemiparesis is such that the nonparetic limb assumes a temporal pattern similar to that of the paretic limb. These findings are analogous to the results of Kelso and colleagues' bimanual aiming experiment with subjects without neurologic impairment in which the limb with the easy task assumed an MT compatible with that of the limb performing the more difficult task (ie, low index of difficulty) assumed an MT compatible with that of the limb performing the more difficult task (ie, high index of difficulty). These robust findings in both subjects with and without brain damage suggest that the optimal control of bilateral movements is quite different from the optimal control of unilateral movements. It appears that the timing of bilateral movements depends on the timing of the slowest limb, suggesting that there is one internal clock controlling these kinds of movements. Interlimb coordination appears to be constrained by the slowest element.

The authors stated that "the relative slowing of the patients' MT in comparison with that of the control subjects was even more accentuated in the bilateral task." A significant group 

The specificity of training literature suggests that bilateral exercises cannot be expected to improve unilateral UE performance. Although the authors concluded that "bilateral exercises cannot be expected to increase the speed at which the paretic UE is moved," it should be emphasized that practice of bilateral UE movements has been shown to reduce the MT of each limb during bilateral movements in subjects without neurologic impairment. We would expect a similar finding for patients with hemiparesis; however, to our knowledge, this hy-
pothesis remains to be empirically tested.

Simple RT and MT are variables of motor control that reflect critical movement-related central processing capabilities that have a long and well-established foundation in psychological science. The authors argued that such variables of motor performance are almost absent when it comes to the evaluation and treatment of patients with hemiparesis. We would agree that the focus of most clinical physical therapy evaluations of subjects with hemiparesis seems to be on the more peripheral effector problems exhibited by the paretic limbs. Thus, current evaluation findings provide little insight into critical central processing deficits to which therapy must be targeted. From this perspective, it is refreshing to see an approach that provides some insight into these critical information-processing capabilities in individuals with brain damage.

The authors stated that the simple RT paradigm obviates the need to preprogram the movement during the RT interval, and thus the increase in RT in the patients with hemiparesis probably reflects a “nonspecific deficiency.” The RT interval is known to consist of both central (ie, premotor RT) and peripheral (ie, motor RT) components. The premotor RT is the interval from the stimulus to the onset of EMG activity and reflects central processes of perception and decisions related to movement parameters. In contrast, the motor RT is the interval from the first change in the EMG activity to the onset of movement and reflects processes associated with the musculature itself. From a methodological perspective, had the authors fractionated RT into these two components using EMG activity of the elbow flexor muscles, a clearer picture of the locus of slowing in the subjects with hemiparesis might have been revealed.

The authors should be commended for a study that used definitive measures of central movement-related processes and that certainly adds to the knowledge pertaining to motor control of individuals with brain damage. The clinician is cautioned, however, to interpret these findings in light of principles of motor control, including those of interlimb coordination, specificity of training, and effects of practice.

Carolee J Winstein, PT, PhD
Assistant Professor
Department of Biokinesiology and Physical Therapy
University of Southern California
2250 Alcazar St, CSA 208
Los Angeles, CA 90033

Patricia S Pohl, PT
Research Assistant
Department of Biokinesiology and Physical Therapy
University of Southern California

References