is to press one of four buttons when one of four lights comes on; the problem for the subject is to decide which button to press in response to which light. Thus, the decision about which button to push is paramount, and the "how" of pushing the button is clearly secondary in importance. While many discrete skills have large verbal–cognitive components, there are certainly examples of discrete skills that are highly "motor" as well.

Continuous movements—defined as those that have no recognizable beginning and end, with behavior continuing until the movement is arbitrarily stopped—are at the opposite end of the continuum (in figure 2.1). Swimming, running, and steering a car are examples of tasks that have arbitrary ends. Continuous tasks tend to have longer movement times than do discrete tasks (they might even continue all day). This, however, should not be taken as basic to their definition.

A common class of continuous skills, both in everyday experience and in the laboratory, involves tracking tasks. The tracking task is characterized by a pathway (track) that the individual intends to follow and a device that the person attempts to keep on the track via certain limb movements. In steering a car, for example, the track is the road, and the device is the car, steering wheel, and so on. A very common laboratory example involves two cursors on a computer monitor. One of the cursors is moved by the experimenter (or by the computer), and it can move in either a predictable or an uncertain way on the screen. The second cursor is moved by the subject via a hand control, and the subject's task is to minimize the distance (or error) between the two cursors.

Two kinds of tracking tasks are used commonly in motor behavior research: *pursuit* tracking and *compensatory* tracking. In pursuit tracking, experimenter-produced actions of the target and the subject's own movements are both displayed. The previously mentioned task of steering a car is a good example of pursuit tracking. In compensatory tracking, the experimenter-produced variations in the track are combined with the subject's movements to produce a single displayed value, and the subject's goal is to maintain this value at some constant location. Practical examples of compensatory tracking are often seen in aircraft instruments, such as the glide slope indicator. Here only the difference between the proper altitude and the actual altitude is displayed; and when the pointer is in the middle of the screen, the pilot's altitude is correct. Compensatory tracking tasks are almost always more "difficult" than pursuit tracking tasks, particularly if the behavior of the track is irregular and unpredictable.

Tracking tasks also vary in terms of the aspect of the display that the subject controls. The most simple is the zero-order, or positional, display. If the subject moves the handle from one position to another and then stops, the indicator on the display moves a proportional amount and also

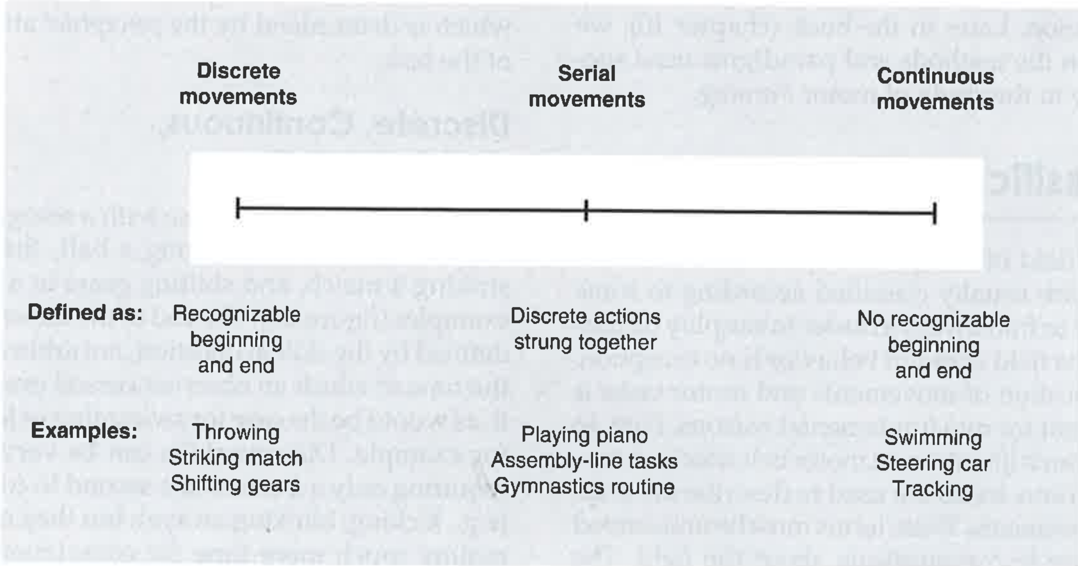

FIGURE 2.1 The discrete/serial/continuous classification for motor behavior.

stops; that is, the handle movements control the *position* of the pointer. In *first-order*, or velocity control, movement of the handle causes changes in the *velocity* of the pointer. Moving the handle further in one direction causes the velocity of the pointer to increase in the same direction, and stopping the handle movement off center results in a constant velocity of pointer movement. In a second-order task, the movements of the control produce changes in the pointer's *acceleration*. Keeping the handle centered produces zero acceleration, but moving the handle to a new position off center accelerates the pointer in the same direction. Each of these kinds of tracking tasks is used in research, and there are real-world examples of each in various control systems (see Poulton, 1974, for more details).

One final type of tracking task is step tracking. In this task, the track "jumps" from one fixed location to another, often unpredictably, and the subject's task is to move the control as quickly as possible to correct this sudden change in the track's location. Step tracking tasks can be either pursuit or compensatory.

Serial movements are neither discrete nor continuous, but usually are comprised of a series of individual movements tied together in time to make some "whole." These types of movements appear in the center of the continuum in figure 2.1 because they can be rather long in duration but are not stopped arbitrarily. Examples are starting a car, preparing and lighting a wood fireplace, and many tasks involved in production lines in industry. Serial tasks can be thought of as a number of discrete tasks strung together, and the order (and sometimes timing) of the actions is important.

Open Versus Closed Skills

Environmental predictability during the performance provides another basis for classifying movement skills (Poulton, 1957; Gentile, 2000). *Open skills* are those for which the environment is constantly (perhaps unpredictably) changing, so that the performer cannot effectively plan the entire movement in advance (figure 2.2). A good example is the penalty shot in ice hockey. While skating toward the goalie, the player may make a general decision about whether to go left or right, but the final decision may depend on what the goalie does. Another example is driving on a busy freeway. Although you may make a general plan about what you want to do, such as pass another car, your precise plans must be left flexible enough to deal with unexpected actions of other drivers. Success in open skills is largely determined by the extent to which the individual is successful in adapting the planned motor behavior to the changing environment. Often this adaptation must be extremely rapid, and the effective responder must have many different actions ready to implement.

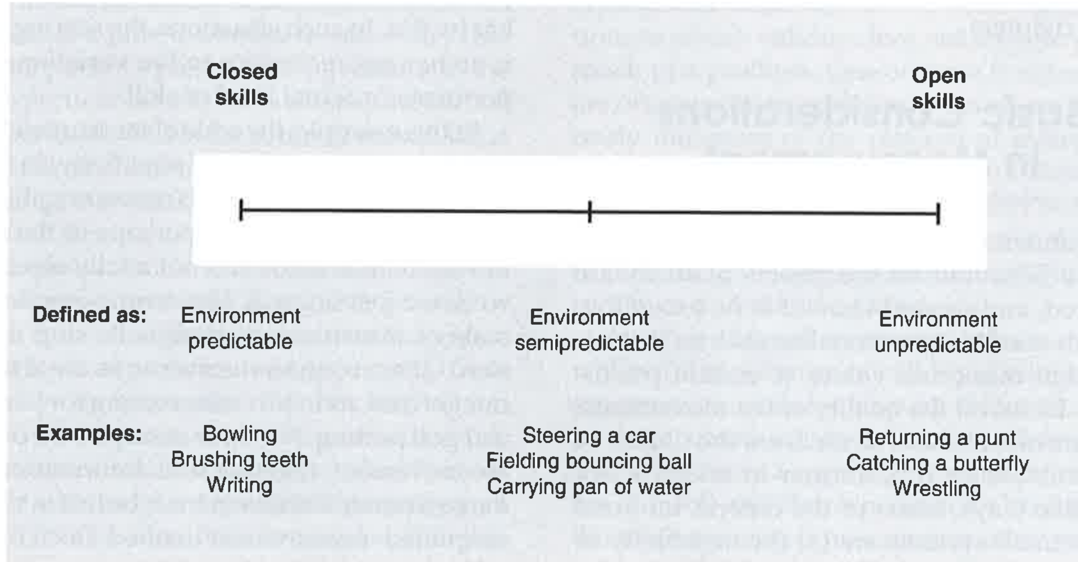

FIGURE 2.2 The open/closed continuum for motor behavior.