Disappearing Act

What makes some coordination patterns more automatic than others?

In "Party Tricks," I asked you to form pistols with your two hands and move your index fingers rhythmically in either an in-phase or an antiphase pattern. Both patterns are easy to do and require no practice to perform effectively and efficiently. Now I want you to try something different. Using your finger pistols again, start moving in an in-phase pattern at a slow pace—say, one full cycle per second (1 Hz). Then slowly start to pick up the pace, gradually going faster and faster. You will find that it is rather easy to maintain the in-phase pattern. Now try the same thing beginning with the antiphase pattern at a slow speed, then gradually going faster and faster. If you perform like the students who do this in my classes, then at some point you will probably find that the antiphase pattern becomes more difficult to maintain; the stability of the pattern starts to fall apart. But something very interesting happens as the fingers are wiggled still faster and faster. Rather than the antiphase pattern completely disappearing into two randomly waving pistols, the pattern tends to be replaced by the in-phase pattern.

As was discussed in "Party Tricks," we have the capacity to move just these two simple degrees of freedom in an infinite number of independent ways. The in-phase and antiphase patterns appear to represent the most natural of this infinite repertoire of patterns. Moreover, when speed becomes a factor, we find that the in-phase pattern is the dominant solution, at least for this finger-wiggling task.

So, what is going on here? Several views have been forwarded, and each appears to be supported by research. According to one view, the coordination of multiple degrees of freedom is not directed by conscious intentions, as might be expected if commanded by the brain, as in a motor programming point of view. Instead, these patterns emerge, dissolve, and reformulate spontaneously depending on the self-organizing properties of the central nervous system and how the limbs interact with the environment and other conditions. According to this view, the decision about which pattern will dominate depends largely on how the general intentions of the performer interact with the self-organizing properties of the central nervous system.

An alternative view of these disappearing patterns is that they represent varying levels of learning, each associated with different attentional demand requirements (see "Gumbo" in chapter 6). In-phase and antiphase patterns can be performed while walking, while talking, and while walking *and* talking.

Researchers sometimes refer to actions of this type as automatic because they demand little or no attention for successful completion. The in-phase pattern appears to be consistent with the performance characteristics that we might expect from an automated pattern. It can be performed at very rapid speeds or together with other activities with little to no loss in performance capacity. In comparison, the antiphase pattern is less compatible with this view of automaticity: the pattern can be maintained only with increased attention at higher speeds or when combined with other activities, and even at that, performance will deteriorate. The tendency of the in-phase pattern to dominate the antiphase pattern is also consistent with the idea that we "regress" to a more highly learned, more automatic mode of control when placed in situations that push us to the edge of our performance capabilities.

A strikingly similar finding occurs in the control of gait. The two most common gaits in humans are walking and running, which propel us at different speeds. If we start walking at a slow speed and gradually walk faster and faster, we will want to switch to a running gait at about 4.7 miles per hour (2.1 m/s). Similarly, if we start running at a rapid pace and then go slower and slower, there will be a temptation to switch to a walking gait at roughly the same speed. The point at which this occurs is different for people of different shapes and sizes, but the transition is a natural response to increased energy demands because the gait we are using is no longer optimized for locomotion at that speed. However, if we intentionally continue to walk faster (or run slower) at speeds beyond the normal transition point, we will experience an increased variability in stride frequency and length.

The dissolution and reformation of coordination patterns reveals something quite interesting about the central nervous system. Although there is a tendency to associate variability with an increased likelihood of errors or accidents (e.g., see "The Calculator" and "The Gimme Putt" in chapter 3), this is not always the case. What we have discussed here is that the variability and error in the performance of certain patterns increase only when we intentionally try to resist a switch to a pattern that is better suited for the changed conditions (e.g., resisting the switch from antiphase to in-phase when moving faster and faster). Instead, when we let patterns dissolve and reformulate as new patterns, reductions in error are likely to occur. The conscious decision to resist the pattern dissolution is what results in the increased error. It seems as though sometimes our bodies are smarter than we are.

Self-Directed Learning Activities

1. What does pattern switching refer to in the context of movement coordination?
2. How does an energy demand view of locomotion coordination differ from an attention demand view?

From T.D. Lee, 2011, *Motor control in everyday actions* (Champaign, IL: Human Kinetics).

3. In the example, the antiphase coordination pattern disappeared and was replaced by an in-phase pattern as movement speeds increased. Why don't we start hopping when we run faster and faster?
4. Suppose, during the performance of a finger-wiggling task, you intentionally tried to switch from an in-phase pattern to an antiphase pattern (and vice versa). Which would be more difficult to do? How would you conduct such an experiment, and what measure of switching performance would provide the best indication of the relative difficulty of these two intentional switches?

Notes

- The switch from an antiphase pattern to an in-phase pattern is not obligatory at high speeds, but must be counteracted intentionally to fight the attraction to an in-phase pattern, as discussed in the following studies:

  Lee, T.D., Blandin, Y., & Proteau, L. (1996). Effects of task instructions and oscillation frequency on bimanual coordination. *Psychological Research, 59,* 100-106.

  Smethurst, C.J., & Carson, R.G. (2003). The effect of volition on the stability of bimanual coordination. *Journal of Motor Behavior, 35,* 309-319.

- Changing gait patterns in four-legged animals is another fascinating area of research and reveals that some animals switch among five or six gait patterns, and do so for varying reasons. The following references are essential reading in this area:

  Hoyt, D.F., & Taylor, C.R. (1981). Gait and the energetics of locomotion in horses. *Science, 292,* 239-240.

  Alexander, R.M. (2003). *Principles of animal locomotion*. Princeton, NJ: Princeton University Press.

Suggested Readings

Diedrich, F.J., & Warren, W.H. Jr. (1995). Why change gaits? Dynamics of the walk-run transition. *Journal of Experimental Psychology: Human Perception and Performance, 21,* 183-202.

Diedrich, F.J., & Warren, W.H. Jr. (1998). Dynamics of human gait transitions. In D.A. Rosenbaum & C.E. Collyer (Eds.), *Timing of behavior: Neural, psychological, and computational perspectives* (pp. 323-343). Cambridge, MA: MIT.

Kelso, J.A.S., Scholz, J.P., & Schöner, G. (1986). Nonequilibrium phase transitions in coordinated biological motion: Critical fluctuations. *Physics Letters A, 118,* 279-284.

Schmidt, R.A., & Lee, T.D. (2011). Coordination. In *Motor control and learning: A behavioral emphasis* (5th ed., pp. 263-296). Champaign, IL: Human Kinetics.