

CONCEPTIONS OF COORDINATION

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Movement analysts ranging from spectators and sportswriters, to teachers and coaches, to biomechanists and kinesiologists, to neuroscientists and roboticists believe that coordination is a desirable aspect of performance. Yet, there has been little coordination among movement analysts in the effort to understand and improve coordinated movement. Perhaps our disjointed activity is due in part to our diverse conceptions of coordination. If so, identifying and clarifying the various meanings of coordination may enable movement analysts to cooperate on the topic of coordination. Thus, the purpose of this paper is to ask and address a series of questions: What is meant by *coordination*? Are the meanings similar or different for professionals and non-professionals, for scholars and practitioners? Are the meanings complementary or contradictory for researchers in various fields? Is there a common thread of meaning that could be used as both a basis of communication as well as a basis for research?

DEFINITIONS AND DESCRIPTIONS OF COORDINATION

When the word coordination was first recorded in 1605, it meant "orderly combination" (Barnhart Dictionary of Etymology, 1988). Though the basic meaning of coordination has not changed over the centuries, the contemporary meaning of coordination has become increasingly associated with harmonious and skillful movement: To wit, in Webster's New World Dictionary (1988) coordination is defined as the "harmonious adjustment of action, as of muscles in producing complex movements." In the fourth edition (1984) (but not the third edition (1962)) of Roget's International Thesaurus, *coordination* and *timing* are listed as synonyms of *skill*; and *coordinated* and *well-coordinated* are listed as synonyms of *skillful*. However, the only listings under coordination that might apply to skillful movement are balanced, harmonious, and integrated. The Chambers Dictionary of Synonyms and Antonyms (1989) does not include an entry for coordinated, but it includes the term *uncoordinated* with the following synonyms: awkward, bumbling, clumsy, disconnected, disjointed, disorganised, inept, jerky, rough, spasmodic, unconcerted, uncontrolled, ungainly, and ungraceful. Additional synonyms from Roget are: blunderer, boggler, botcher, bull in a china shop, bungler, butterfingers, cumbrous, fumbler, gawky, haphazard, heavy-handed, hit-or-miss, inelegant, maladroit, muffer, oafish, sloppy, stiff, unmanageable, and unwieldy.

Given that there are ten times more antonyms than synonyms of coordination in common language, and given that the positive connotations are less vivid than the negative ones (cf. harmonious skater vs. ungainly skater; integrated kicker vs. spas-

modic kicker), it appears that non-professional movement analysts are more engrossed with poor coordination than good coordination. Further, the variation among these connotations implies that the common conception of coordination can be depicted as a continuum (Figure 1). In general, most examples of movement should range between coordinated and clumsy, but some examples of movement may transcend clumsiness and appear chaotic.

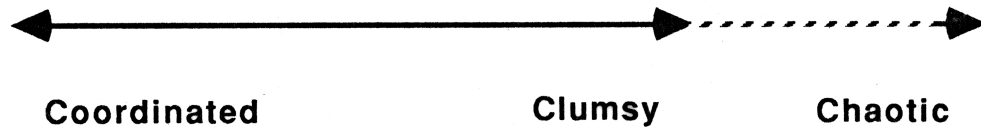


Figure 1. Common conception of coordination.

Is the professional usage of the term coordination consistent with the common, or non-professional, conception of coordination? Yes and not really. Webster's connection between harmony and human movement has been accented in the physical education literature for teachers and coaches. For example, coordination has been defined as the "harmonious movement of independent body parts" (Dictionary of the Sport & Exercise Sciences, 1991); "the ability to integrate muscle movements into an efficient pattern of movement" (Schurr, 1980), and "the use of muscles in such a manner that they work together smoothly and effectively rather than hinder one another" (Hunter, 1966). Roget's association of coordination and skillful movement was echoed by Schurr: "Coordination makes the difference between good performance and poor performance." Also, Wilmore (1977) related coordination to athletic exemplars: "Neuromuscular coordination reflects the ability of athletes to perform their sports activities or events with a smooth, balanced, and fluid motion."

While many practitioners in physical education describe coordination in terms of harmony or skillfulness, some scholars in physical education are more apt to emphasize the pattern of movement. For instance, "coordinated actions of the human body are executed by the controlled application of muscular forces which produce distinctive patterns of segment motions" (Putnam, 1991, p. 130). And coordination is "the relationship among movement variables that constrains them into a behavioral unit." Further, a *coordination variable* is a "factor that, when changed, necessitates a new pattern of coordination. For example, a sprinter encountering a hurdle must change from a running step to a leap or hurdle step" (Dictionary of the Sport & Exercise Sciences, 1991).

Other scholars in physical education appear to focus their descriptions of coordination-

dination on what units of movement are being integrated. To illustrate this point, modifiers have been added to the following definitions of coordination. *Intertask* coordination involves "integrating specific muscle actions into efficient movement skills (e.g., combining a step with a hop and alternating your feet to get a skipping movement)" (Curtis, 1982). *Interception* coordination requires "accurate location of objects in space and precise positioning of body parts to make contact with objects in space" (Sage, 1971, p. 167). And *interception* coordination entails "the perfect co-ordination of hand and eye" (Oxford Advanced Learners Dictionary of Current English, 1989). *Interlimb* coordination causes "different parts, limbs, etc. to function together efficiently [such as to] co-ordinate one's movements when swimming" (Oxford Advanced Learners Dictionary of Current English, 1989). *Intersegmental* coordination is "behavior of two or more joints in relation to each other to produce skilled activity" (Schmidt, 1988).

What is coordination in biomechanics and kinesiology? To date the general emphasis has been on intersegmental coordination as opposed to intertask, interception, or interlimb coordination; and the specific emphasis has been on the sequencing and timing of segments (cf. Bobbert & Ingen Schenau, 1988; Bunn, 1972; Hudson, 1986; Kreighbaum & Barthels, 1990; Morehouse & Cooper, 1950). Some of these scholars have described sequencing and timing on a continuum with poles of early/late or simultaneous/sequential movement; and some have drawn attention to the importance of contextual factors (e.g., the strength of the performer and the velocity of the task). Although there has been speculation about the sequencing and timing of unskilled performers, the majority of research into sequencing and timing has been conducted with skilled performers.

To review the use of coordination by professionals in physical education, it appears that most seem to share the conclusion that individual muscles operate collectively to produce patterned movement. However, there is confusion about what is being coordinated (i.e., segments, limbs, objects, tasks) and what is being valued. That is, practitioners seem to value harmony and skill in a manner similar to that of non-professionals, and researchers seem to value integration of parts with little regard for the unskilled or harmony. In fact, researchers seem to have little harmony in which parts (e.g., segments, objects) to value. Perhaps scholars in the exercise sciences could learn from scholars in other sciences. For example, the medical definition of coordination is "harmonious activity and proper sequential action of those parts which cooperate in the performance of any function" (Blakiston's Gould Medical Dictionary, 1979). And *coordinated-axis control* in robotics is described by "the robot axes reach their endpoints simultaneously, thus giving the robot's motion a smooth appearance" (McGraw-Hill Dictionary of Science & Technical Terms, 1989). In other words, for these scientists, harmony and skill are integrated with sequencing and timing, and the parts can be either general (i.e., those parts) or specific (i.e., robot axes).

SUMMARY AND CONCLUSIONS

Espenschade and Eckert provided the most complete conception of coordination in 1967: "An individual is said to show good coordination when he moves easily and the sequence and timing of his acts are well controlled. This essential element of motor performance is not readily measured objectively although high achievement in any event implies good coordination" (p. 165). If movement analysts are to move beyond 1967 and become coordinated, it seems reasonable that we should: 1) develop objective measurements of sequencing and timing, particularly intersegmental sequencing and timing, inasmuch as intersegmental coordination is foundational to the other forms of coordination (i.e., interlimb, interception, intertask); and 2) develop measurements that integrate harmony and skill with sequencing and timing and that consolidate the common and contextual continua of coordination.

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