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Studying Environmental Influence on Motor Development in Children

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Abstract

There is a good argument that in order to truly understand the influences that shape child motor development, one must consider environmental influences that reflect the multilevel ecological contexts that interact with the changing biological characteristics of the child. Although there are theories typically associated with motor development that mention environmental influence (e.g., constraints, affordances), none provide the comprehensive framework comparable to the works of Bronfenbrenner (1979, 2005). With this paper, we address the need for environmental considerations, highlight Bronfenbrenner's work and application to the field of motor development, and provide examples for research using two contemporary themes.

Over the last 25 years, there has been a substantial increase in the presence of motor development research in top-tier journals of human development, psychology and neuroscience. This trend is due in large part to acknowledgement that level of motor development is a critical factor in child behavior. Additional evidence for this emergence is the observation that aspects of motor development are mentioned with increasing frequency in broad-based theoretical treatises within the fields of cognitive psychology, developmental neuropsychology, developmental psychobiology, and neuroscience (e.g., Andres, Olivier, & Badets, 2008; Fernandino & Iacoboni, 2010;

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Johnson, Spencer, & Schöner, 2008; Piek, Dawson, Leigh, & Smith, 2008). Contemporary research has answered numerous questions concerning how the body learns and controls movement, and what effects movement has on human development (e.g., physical growth, muscle, bone, cardiorespiratory system, and cognitive ability).

Although some mention in prominent theories of motor development is given to environmental factors, to a much greater extent, focus has been on the biological determinants of behavior, with the goal of gaining an understanding of the processes that underscore the dynamic and self-organizing properties associated with perception and action. However, few researchers would disagree with the notion that in order to truly understand the complex nature of human motor development, environmental determinants should be considered. This aspect of study represents the primary intent of this paper. Here, we will briefly address the need for environmental considerations, suggest a framework for study, and provide examples for research using two contemporary themes.

According to Lerner (2002), human development is the product of changing relations between the developing person and his or her changing multilevel environmental contexts. Understanding how biological levels dynamically interact with levels of contexts (aka, contextualism) stresses the interrelation of all levels. Complementing this general view of development, Gabbard (2008) defines motor development as the study of change in motor behavior [and underlying processes] as influenced by biological and environmental factors; that is, the interaction of changing biological systems and environmental contexts.

The importance of considering the environment in the study of motor development was emphasized in several works of Thelen; for example, "The first assumption of the dynamic approach is that developing organisms are complex systems composed of very many individual elements embedded within, and open to, a complex environment" (Smith & Thelen, 2003, p. 343), and "… the coherence [of perception and action] is generated solely in the relationships between the organic components and the constraints and opportunities of the environment" (p. 344). In 2000, the National Academies addressed the issue of environmental effect by noting "Research indicates that early relationships are especially critical and that cultural values and practices provide the context for these bonds" (Shonkoff & Phillips, 2000). More recently, in 2009

the International Journal of Sport Psychology devoted an issue to ecological approaches to studying cognition and action in sport and exercise. One of the theoretical views discussed was the works of Bronfenbrenner (Krebs, 2009); the focus of the present article.

Bronfenbrenner's Bioecological Theory

Bronfenbrenner's bioecological theory (1979, 1988, 1992, 2005, Bronfenbrenner & Morris, 2006), describes the hypothesized (varied) systems of the environment and the interrelationships among the systems that have the potential to shape the individual. In 1979 he proposed that the ecology of human development was "the scientific study of progressive, mutual accommodation between an active, growing human being and the changing properties of the immediate settings in which the developing person lives" (p. 21). From this perspective, he designed a systemic model to illustrate the four levels of the environment. An illustration of the four systems is shown in Figure 1.

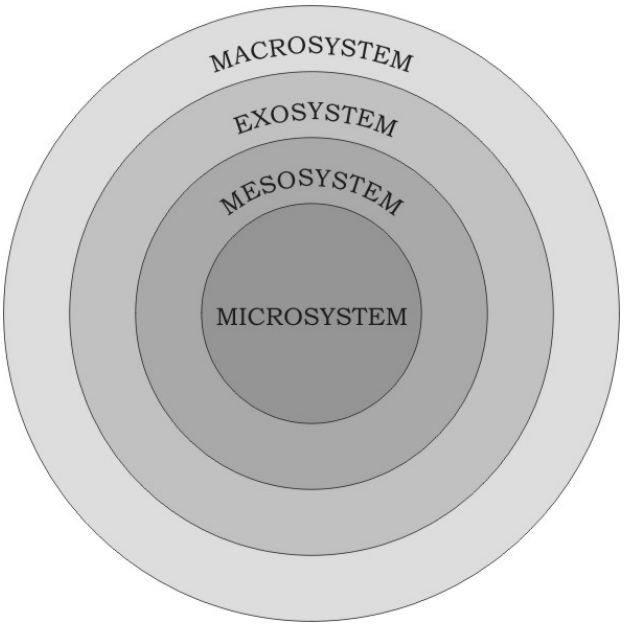

Figure 1. An Illustration of Bronfenbrenner's *Bioecological Theory*

Although early versions of the model did not focus on the biological aspects of the individual at the core of the model, most writings inferred that the environment and biology influenced individual development. The model emphasizes the broad range of situations and contexts individuals may encounter as described by four distinct systems: the microsystem, mesosystem, exosystem, and macrosystem. In brief, these systems represent the environmental settings and relationship ranging from the home, to the community, and to the culture in which one lives. Aside from the more obvious influence of the home, a relevant example is city government (parks), which is responsible for the quality of play and recreational opportunities, such as youth sports, playgrounds, and swimming facilities. Also included in this framework are sociohistorical contexts. For example, females of today are much more likely to participate in athletic endeavors than they were 20 years ago. As will be discussed in a subsequent section, settings and events within systems represent 'affordances;' opportunities for developing and maintaining motor skill.

Bronfenbrenner viewed a child's development within the context of the system of relationships that form his or her environment. The model describes complex "layers" of the environment, each having a potential effect on a child's development. A more recent update of the model highlights the child's own biology as a primary agent (i.e., the PPCT model to be described in a subsequent section). The interaction between factors in the child's maturing biology, his immediate family/community environment, and the societal landscape fuels and guides development. Change or conflict in any one layer may cause a ripple effect on other layers. To study a child's development, we must look not only at the child and his or her immediate environment, but also at the interaction of the larger environmental context, which provides affordances for growth and development. A summary of the systems follows. We do wish to note that with earlier versions of the model (before 1995), Bronfenbrenner included the 'Chronosystem' (not shown here), which at the time was designed to reflect past influences of the other systems on the person. For example, the longitudinal effects of parenting, school physical education, or social trends on adult physical activity. Bronfenbrenner included this system after analyzing paradigms used in research in human development and noted that the concept of "time" was predominately treated as being

synonymous with chronological age. With the goal of using time not only for describing individuals according to age, but also for ordering and explaining events in their historical sequence and context, he proposed the chronosystem; a construct that was later dropped and fused with the now popular Process-Person-Context-Time (PPCT) model introduced in 1995.

Microsystem.Here people can readily engage in face-to-face interaction; the most immediate and earliest influences are the family, along with local neighborhood or community institutions such as the school, religious institutions and peer groups, as well as the specific culture with which the family identifies. For example, parents provide toys and opportunities to move and learn in physical environments. Other influential opportunities (affordances) are provided by schools (e.g., physical education, fitness and sport activities) and the local neighborhood (playgrounds, parks pools, walk and bike trails).

Mesosystem. This comprises the interrelations among two or more contexts within the microsystem. For example, the connection between the child's family, school, church, and neighborhood. Each of the contents in the microsystem affects each other. Perhaps this can best be explained in the context of living communities. Places where the child's welfare is a consideration at multiple levels. For example, single-mothers maybe assisted with keeping their child active by an after-school program, community youth sports, and church activities.

Exosystem. This refers to one or more settings that do not involve the developing person directly as an active participant. The exosystem includes things like television and acquaintances. These are things they do not have an active role in, but might affect them indirectly. For example, television viewing can have a strong impact on a child's attitude toward physical activity and a healthy lifestyle. Fortunately, more programs and advertisements are incorporating the 'active body' and 'healthy eating' ideals. And as inferred with the next system (macrosystem), much of this promotion comes via political action.

Macrosystem. This is the societal, cultural, and global influence. The macrosystem consists of the overarching pattern of micro-, meso-, and exosystem characteristics of a given culture, subculture or other broader social context, including laws and governmental policies. For example, political influence may provide needed mandates for physical education and resources for active

environments; this applies to the local, state and national levels. National and state programs for education and health can have a huge impact on child development.

The PPCT Model

Whereas the systems model (Figure 1) theoretically represents broad-based influences on and options for studying human development, the likelihood of undertaking such a venture in its entirety is arguably not feasible for most researchers (we view the model as a general framework for variable selection). With the idea of providing a more applicable model with focus on the individual, Bronfenbrenner (1995) introduced the Process-Person-Context-Time (PPCT) model; a model that in recent years has garnered the attention of the research community interested in the environment influence on human (biological) development. More specific, this construct encompasses particular forms of interaction between organism and environment, called proximal processes, which operate over time, and are posited as the primary mechanism producing human development. The power of such processes to influence development is a function of the characteristics of the developing person, and the immediate and more remote environmental context and the time periods, in which the proximal processes take place. The model allows for examination of:

Process: fused and dynamic relation of the person and context

Person: biological, cognitive, and emotional characteristics

Context: nested levels or systems of the ecology

Time: multiple dimensions of temporality. Bronfenbrenner referred to time as the historical period through which the person lives, and the timing of biological and social transitions as they relate to the culturally defined age, role expectations, and opportunities occurring throughout the life course.

Research Using the Model

A literature review indicates that several dissertations / theses, books, and a few journal publications have reported variations of

Bronfenbrenner's model(s) with attention to: health (e.g., diabetes, alcohol / substance abuse, mental health, pediatric injury, etc) (Liles & Juhnke, 2008; Schwebel & Brezausek, 2007; Swick & Williams, 2006; Yu & Stiffman, 2007; Garcia & Saewyc, 2007), social development (Barrow, Armstrong, Vargo, & Boothroyd, 2007; Logsdon, Hertweck, Ziegler, & Pinto-Foltz, 2008), and cognitive aptitude (Harden, Turkheimer, & Loehlin, 2007).

In regard to the general field of motor behavior, a few studies have been reported on the timely issue of physical activity (Gilmer, Harrell, Miles, & Hepworth, 2003; Salmon & Timperio, 2007) and children's sport (Bengoechea & Johnson, 2000; Côté & Hay, 2002; Stefanello, 1999). For example, Tudge, Odero, Hogan, and Etz (2003) used the PPCT to focus on the relations between school-relevant activities (including play) of preschool-aged children and teachers' subsequent perception of the children's competence once they had entered school. They observed 3-year-olds' engagement in everyday activities (Process) and their initiation of those activities (Person) over a period covering the equivalent of an entire waking day. Children were drawn from two social classes (Context). The preschool observations were followed by two consecutive years of teacher reports of academic competence following entry into elementary school (Time). Of more direct relevance to the movement domain and the suggestion of models like Bronfenbrenner's, Salmon and Timperio (2007) conducted a review of the literature regarding the environmental effects on children's physical activity. Their findings were that several contextual factors have been reported. For example, safety concerns (e.g., road safety, crime and concerns about strangers), social interaction (e.g., child peers, neighborhood relationships, other children live in neighborhood close by), and urban design (e.g., connectivity of streets, access and availability of public open spaces and sports facilities). The authors went on to state that unfortunately, no single report has been published using a broad-based ecological model (such as Bronfenbrenner's model). Furthermore, they recommended that "there is a need for conceptual models that take such complexities into account, and need for multilevel study designs that incorporate individual-level influences, proximal social influences and influences within the broader environment in order to better understand physical activity behavior"(p. 196).

However, in reference to more basic child physical growth and motor development issues, surprisingly, reports are in short supply.

This void seems especially perplexing given the developmental (time related) nature of the field.

Using the Model with Studies of Motor Development

In addition to the theme issue in the *International Journal of Sport Psychology*, other researchers have pointed-out the promise of Bronfenbrenner's model in understanding the environmental effect on motor behavior. For example, Bengoechea (2002) noted in *Quest* that "Bronfenbrenner's model provides a comprehensive and dynamic conceptual framework for understanding human development" (p. 1). In the author's review of Bronfenbenner's work with application to the study of sport talent development, Krebs (2009) noted that the PPCT design with the emphasis on the discovery process, had not yet been tested in the field of the sport sciences.

It is not uncommon for contemporary developmentalists to consider two other environmental theories with the study of children's motor development; both of which, complement Bronfenbrenner's systems perspective and PPCT model.

Gibson's Ecological Perspective (1988, 2002), which typically focuses in the infant's perception of environmental stimuli and opportunities, derives the concept of affordances. The environment provides affordances that invite and challenge the child to perceive and act on information. In addition to the more obvious set of affordances such as toys, materials, apparatus, and availability of space, stimulation and nurturing by parents (and others) provide the additional component of events. The notion of affordances emphasizes that there is an ecological fit between the individual and the situation. The study of affordances in perception and as agents for change has been given considerable attention in the motor development and ecological psychology literature. Arguably, affordances in the environment via the various systems are one of the basic constructs in Bronfenbrenner's model. For example, the family and community and what it affords the child.

Newell's Constraints Model (Newell, 1986) combines both the biological and ecological systems perspective. This is applied by describing the constraints to behavior in reference to the individual, the task to be performed, and the environment in which it is to be executed. With this model, the term constraint refers to factors that either facilitate or restrict development. Underscoring this view is the perspective that new motor behaviors emerge as a result

of changing individual (organismic), environmental, and task constraints. Environmental constraints can be related to the physical environment or sociocultural factors. This may include gravity (terrain), surface, space, temperature, and characteristics of the home. For example, the space and terrain that an infant has available to move in is a constraint on the development of locomotion. A major difference between this model and Bronfenbrenner's work is the multi-systems framework that arguably provides a better delineation of environmental contexts. More specific, the Constraints model was designed to focus on the person and his or her 'immediate' interactions with equipment or the environment, not factors creating or influencing the environment. For example, specific effects of the microsystem (family, community) and macrosystem (cultural, political action) that could be change agents. However, the Constraints model combined with considerations of the multilevel and complex nature of ecological systems (described by Bronfenbrenner), hints at considerable promise for quality broad-based research.

Although each of the three models—Gibson's, Constraints, and Bronfenbenner's—has unique features and intentions for use, there is a key similarity worthy of note. Each stresses the importance of studying human development in context of the environmental setting and specific task. From another perspective, perhaps it is not too far out of reason to view Bronfenbenner's PPC and perhaps even T (Time), as constraints to development. However, Bronfenbenner's model, with its broad scope, arguably affords additional detail for studying the developmental course via 'process' interacting with the individual, and the construct of 'time.' Furthermore, when making a general comparison of Bronfenbrenner's model with the application of Gibson's work, the element of 'time' also seems to favor the former.

The following are two application examples for the PPCT model using what may be described as 'frontier' motor development issues (obviously, these are examples, not a definitive list).

Environmental influence on fundamental motor skill ability and later physical activity level in children. With the national interest in obesity levels in children and adults, researchers have sought to examine factors that may play a role in the attainment and continuance of physical activity across the lifespan—fundamental motor skill ability has been mentioned as one of those factors (e.g., Barnett, van Beurden, Morgan, Brooks, & Beard, 2009; Hardy,

King, Farrell, Mcniven, & Howlett, 2009; Wrotniak, Epstein, & Dorn, 2006). Considerations for research include:

- *Person*—assessment of fundamental motor skills (e.g., running, throwing, catching, jumping) and physical fitness variables (e.g., cardiorespiratory endurance, muscular endurance, flexibility, body composition).
- *Process*—type, duration and frequency of play, sport, physical education, and recess; including physical education and youth sport instruction.
- *Context*—family characteristics (socioeconomic status, number of parents in the home, number of siblings, parent education, parents physical activity levels, parent attitudes toward and knowledge of physical fitness and motor skills, daycare activity, community resources (facilities [play affordances], access, safety, crime, urban design).
- *Time*—systematic assessment (e.g., every three or six months) of the above variables over a designated timeframe (e.g., preschool to grade school to adolescence).

The relation between early motor development and cognitive ability. The literature indicates that there is a resurgence of interest in the role of early motor development in cognitive ability and academic performance (e.g., Bumin & Kavak, 2008; Piek et al., 2008; Wuang, Wang, Huang & Su, 2008). With that in mind, the following research considerations seem relevant:

- *Person*—assessment of birth status (e.g., gestational age, birthweight), fine- and gross-motor ability, and cognitive and academic aptitude and ability.
- *Process*—type, duration and frequency of play (in- and outdoor), sport instruction, school instruction (both academic and physical education), and recess.
- Context—family characteristics (e.g., socioeconomic status, number of parents in the home, number of siblings, parent education), and affordances in and around the home (e.g., toys, equipment, playgrounds, parks, and daycare).
- *Time*—systematic assessment (e.g., every three or six months) of the above variables over a designated timeframe (e.g., infancy to preschool, to grade school to adolescence).

Final Remarks

The primary intent of this paper was twofold: one, to bring attention to the need for studying and gaining a better understanding of environmental effects on child motor development; and second, to highlight a promising theoretical framework for that endeavor. For those that are students of research and active researchers looking for a theoretical framework and strategy for studying and understanding motor development from the perspective of the changing (biological) individual and multilevel environmental influence, Bronfenbrenner's views provide an array of options. Underscoring the importance of such endeavors is the reasonable notion that to change developmental status and foster positive future behaviors, one must identify and understand direct and indirect influences on human development. For those not interested in conducting research, this information also has applications. For example, teachers, administrators, and program directors interested in enhancing child development, and in this case, motor development, can use this information to affect change from a multi-level approach. What does the child need from the family, school, community, and government? Each context (local community) and person is likely to be unique. To approach the question from a diverse perspective, a diverse and multi-level framework is needed; such as that described here.

Perhaps Bronfenbrenner said it best when stating, "No society can long sustain itself unless its members have learned the sensitivities, motivations, and skills involved assisting and caring for other human beings" (2005, p.14).

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