International Journal of Sport Psychology
Vol. 40 - N. 1 - January-March 2009

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2009 Subscription Rates:
Individual: 100,00 Euro (125,00 Euro by priority mail).
Institutions: 140,00 Euro (160,00 Euro by priority mail).

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Autorizzazione del Tribunale di Roma n. 13404 del 24 giugno 1970 - Direttore responsabile: Luigi Pozzi - Trimestrale - sped. abb. post. - 45% - art. 2 comma 20/b L. 662/96 - Filiale di Roma

Finito di stampare nel mese di gennaio 2009 dalle Arti Grafiche Tris, s.r.l.
via delle Case Rosse, 23 - 00131 Roma
Preface to “Ecological approaches to cognition in sport and exercise”

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This special issue describes the major conceptions of what it means to follow an “ecological approach” and how these conceptions apply to understanding, intervention and assessment of human activity in sport and exercise contexts. Harry Heft (2001) identified Roger Barker (1903-1991), Egon Brunswik (1903-1956), James Gibson (1904-1979) and Urie Bronfenbrenner (1917-2005) as the mentors of the leading schools of thought in ecological psychology. Obviously selection of intellectual mentors is always a debatable issue in the philosophy of ideas. When Isaac Newton was asked to explain his contributions to science he modestly acknowledged the work of those who preceded him by suggesting that he was merely ‘standing on the shoulders of giants’. But which giants to acknowledge is a vexing issue in any area of science? In this special issue we concur with Heft (2001) that the leaders of these schools of thought in ecological psychology are pre-eminent enough to initiate discussions about ecological approaches to studying sport and exercise behaviour.

Difficulties in selecting mentors of ecological psychology’s main schools of thought also apply to the selection of their students. Therefore, following the same criteria, we invited contributions from some of the leading advocates of these schools with a history of some involvement in the sport and exercise sciences. These invited contributors were asked to synthesise how their preferred theoretical approach can help develop understanding of cognition in sport and exercise contexts. Each author was asked to address questions such as: Why and how do people act as they do in behavioural contexts?; How does “your” preferred theoretical approach compare with other approaches in the field?; What are the methodological concerns and/or typical methods used in “your” approach?: What are the implications of “your” preferred approach for engaging in sport and physical activity?; and, What are key issues to be resolved in future research? Naturally, four completely different views were expressed by our invitees, and it is up to the reader to interpret strengths and weaknesses in arguments.
Besides being leading academics in ecological psychology, the invited authors for this special issue have also been noted for their interest in sport performance and exercise. For example, Michael Turvey obtained his first degrees in physical education as did Ruy Krebs. Both of these authors have contributed several research and theoretical papers to the field of sport psychology. Kaminski has been interested in the sport experience for some time (e.g., Kaminski, 1982), but Hammond became interested in sport performance mainly because of his passion for sailing. His collaborator for the special issue article, Bob Bateman, is a professional tennis coach.

One interesting link between these authors is that all of them had direct contact with the pioneers of their preferred school. We think it is worth highlighting Kenneth Hammond’s description (personal communication, 11th April, 2007) of how he met Egon Brunswik and how he started influencing Ken’s work:

“I saw him in 1939 or 1940 when I was an undergraduate at Berkeley and he was a professor, though I did not take a class from him then. When I came to Berkeley in 1945 after the war, I did take classes and seminars from him and became acquainted with him, intellectually and personally. He was a very hard taskmaster. I did not do my dissertation with him because I was afraid I would never finish it if I did. I was married and had 2 children and could not afford to go on for years. Assistantships and fellowships were rare in those days and I had to support my family. I got my Ph.D in 3 years because I had to. But I became quite close to him and we corresponded after I left Berkeley”.

Michael Turvey (personal communication, 11th April, 2007) described his first contact with James Gibson as follows:

“I adopted Gibson’s perspective in 1965, as a Ph.D student in experimental and physiological psychology after reading Gibson’s chapter “Perception as a function of stimulation” in the Koch volumes. My central concern was: How could people and animals move so successfully in environments cluttered with stationary and moving objects and how could they reproduce skilled acts so reliably, if visual perception, at bottom, was (a) questionable as standard theories suggested, and (b) logically separate from, and indirectly related to, movements as standard theories presumed? It took me almost 10 years to understand how one did Gibson’s ecological perspective on perception-action experimentally. I met Gibson and Shaw in the early 1970s about the time I had begun the enterprise of developing a law-based approach to action compatible with direct (law based) perception. I visited Gibson at Cornell and he visited me (and Shaw and Mace) at Connecticut. He posed many questions and offered many suggestions about the perception-action enterprise and provided much encouragement.”

Gerhard Kaminski (personal communication, 4th April, 2007) also followed a different path in gaining contact with Roger Barker:

“The person by whom I got my first information about the Barkerian research was, as far as I remember, Kripal S. Sodhi. I met him when I continued my study in 1950-1952 at
the newly founded Free University in West Berlin. He had good connections to psychologists in the USA, especially to Wolfgang Köhler. He told us about “Midwest and its children”. Shortly afterwards, I made substantial use of this fascinating new approach in my doctoral thesis, published in 1959 as “Das Bild vom Anderen” (The picture of the other), though in a purely theoretical way, so far. Much later, in 1987 (June 3-5), I visited Roger and Louise Barker (and also Paul Gump) who were still living in Oskaloosa (“Midwest”) near Kansas City University. Louise drove me through the small town with their van and acted as a tourist guide familiarizing me with the most significant “landmarks” of the traditional “Midwest” research period. We had some written communication before and after the visit, but we had no real cooperation since Barker was no longer involved in research at that time”

Ruy Krebs contacted Urie Bronfenbrenner in the 1990s, wanting to know more about Bronfenbrenner's approach, and about the ecology of human development. They had several academic exchanges which resulted in a book about Bronfenbrenner’s approach to human development, published in Brazil (Krebs, 1995 “Urie Bronfenbrenner e a Ecologia do Desenvolvimento Humano”). Each section of this book was commented upon and revised by Bronfenbrenner himself before its publication. After that, they continued to be in contact, until Bronfenbrenner's death in 2005.

Perhaps even applied sport psychologists might still be somewhat surprised by Barker's assertion that better predictions about human behaviour could be made from knowledge about ‘place of occurrence’ information than from personality test data (see Barker, 1987). Indeed Barker was calling the attention of psychologists to the power of context to influence behaviour.

In this special issue on “Ecological approaches to cognition in sport and exercise” we advocate support for Barker’s conjecture, and we point to many other compelling reasons for such a compilation of insights including:

1) the need for clear theoretical guidance. Although there are many intervention programmes in sport and exercise psychology, the large majority of them continue to be based on no theoretical framework in particular, and consequently lack any clear motivation in interpreting, understanding and analysing behaviour. This issue aims to help specialists in the field of sport and exercise understand some of the major ecological models of behaviour with which to work;

2) the need for correspondence between ecological theorizing and practice. It is important to emphasize applications of theoretical ideas as well as theoretical advancements. Translation of theoretical ideas into practice needs to deal with assessment design and implementation as well as interventions in sport and exercise settings;
3) the need for combining and comparing ecological conceptions. In order to evaluate different conceptions, sport and exercise psychologists need to understand the similarities and differences among perspectives.

To help readers draw conclusions on these similarities and differences, leading sport scientists, sport psychologists, exercise psychologists and human movement scientists have been invited to comment on the varied approaches to ecological psychology. Interestingly, the different strands of thought related with ecological psychology do not have a tradition of engaging in dialogue with each other. This special issue provides an opportunity for this exchange of views. It is far more common for ecological and organismic (i.e. cognitive science) perspectives to exchange arguments (e.g. Fodor & Pylyshyn, 1981; Turvey et al., 1981; see Abernethy & Sparrow, 1992; Davids et al., 1994; Summers, 1998 for examples in sport) than for different schools of thought related with ecological psychology to discuss similarities and differences among themselves.

But now it’s up to the reader to judge… and act!

I could not finish without acknowledging the important contribution of the colleagues that invisibly shaped this special issue: Stuart Biddle, Jia Yi Chow, Harry Heft, William Mace, António Palmeira, Pedro Passos, James Sallis, Jeff Summers, Rob Withagen, Bernhard Wolf. I would like to emphasise and thank the guiding help of Keith Davids in advertising my role as guest editor.

I would also like to thank all the authors of the papers in this special issue for sharing their valuable insights on sport and exercise psychology.
Ecological approaches to cognition and action in sport and exercise: Ask not only what you do, but where you do it

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In recent decades, concepts and ideas from James J. Gibson's theory of direct perception in ecological psychology have been applied to the study of how perception and action regulate sport performance. This article examines the influence of different streams of thought in ecological psychology for studying cognition and action in the diverse behavioural contexts of sport and exercise. In discussing the origins of ecological psychology it can be concluded that psychologists such as Lewin, and to some extent Heider, provided the initial impetus for the development of key ideas. We argue that the papers in this special issue clarify that the different schools of thinking in ecological psychology have much to contribute to theoretical and practical developments in sport and exercise psychology. For example, Gibson emphasized and formalized how the individual is coupled with the environment; Brunswik raised the issue of the ontology of probability in human behaviour and the problem of representative design for experimental task constraints; Barker looked carefully into extra-individual behavioural contexts and Bronfenbrenner presented insights pertinent to the relations between behaviour contexts, and macro influences on behaviour. In this overview, we highlight essential issues from the main schools of thought of relevance to the contexts of sport and exercise, and we consider some potential theoretical linkages with dynamical systems theory.

KEY WORDS: Barker, Bronfenbrenner, Brunswik, Dynamical systems, Direct perception, Gibson, Mental representation

Introduction

Recently, Eisenberg (2007) recounted how biological systems could be described and modelled as physical 'devices', a useful strategy for considering the design of experimentation on system structure and function. However, if such a methodological approach failed to include analysis of the environments of targeted biological systems, then experimental work might lack relevance. In

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similar vein, research and practice in sport and exercise psychology has been dominated by an organismic-centric methodology and theorizing (i.e. characterised by a narrow focus on describing internal mental states and processes of individual performers) (see Tenenbaum and Eklund (2007) for an overview of research in sport and exercise, or Bar-Eli and Raab (2006) and Williams and Hodges (2004) for specific discussions about cognition and action in sport).

In Neisser’s seminal text “Cognition and Reality”, cognition is defined as “the activity of knowing: the acquisition, organization, and use of knowledge. It is something that organisms do and in particular something that people do” (1976, p. 3, italics our emphasis). With this definition one of the founders of the “cognitive revolution” challenged the traditional idea of cognition as something internal to an individual, a sort of private mental state that resides passively in the brain. Instead Neisser (1976) envisioned cognition as an activity, considering it as something that people do. In human behaviour the act of ‘doing’ never occurs in a vacuum. To do is always to do something somewhere, as the sub-title to this article denotes. A key point reinforced in this special issue is that cognitive activity cannot be defined, studied, understood or interpreted without reference to the environment, i.e., it relates to how an organism attains a functional relationship with the world. To understand cognition psychologists cannot search solely within the boundary imposed by the cutaneous surface of the body. Both the individual and his or her environment participate as equal partners in providing both the criteria and the resources for biological adaptation (Anson et al., 2005; Davids et al., 1994; Davids et al., 2001, Davids et al., 2006, Handford et al., 1997). This basic notion can be exemplified in performance of interceptive actions in sport by understanding that when a player is negotiating objects and surfaces of his/her environment, “to see the distance-to-contact is to see the work required, to see the time-to-contact is to see the impulse forces required, to see the direction to-contact is to see the torques required” (Turvey & Shaw, 1995, p.158). A crucial claim of ecological psychology is that psychologists must describe and measure the environment of an individual before posing questions on how an individual may achieve knowledge about that environment. This important argument has major implications for understanding how cognition, perception and action in humans and animals underpin their interactions with important events, objects and individuals in their environments. Indeed, this sentiment is captured in the title of this article, a literary paen to William Mace’s (1977) countenance for psychologists to: ‘Ask not what’s inside your head, but what your head’s inside of”.

Actually, this particular theoretical position may not be so awkward for applied sports practitioners to understand. For example, it would be crystal clear to them that cognition, perception and actions in team sports differ
from cognition, perception and actions in wilderness activities, that behaviour in gymnastics is different from behaviour in wrestling, that performing in a football team is substantially different than performing in a dance troupe, that jogging on a regular basis is different than training for a 5000 m competition. Coaches and applied sport psychologists understand that what matters is how to know, perceive and act in a specific context, and that these behavioural processes do not occur in a vacuum. Even exercise psychology, although eminently based on internalist models (Biddle et al., 2007), is manifesting a small but increasing interest in ecological approaches (e.g., Sallis & Owen, 2002; Sallis et al., 2006). But perhaps even applied sport and exercise psychologists might still be somewhat surprised by Barker’s assertion that better predictions about human behaviour could be made from knowledge about ‘place of occurrence’ information rather than from personality test data (see Barker, 1987). In this way Barker was drawing the attention of psychologists to the power of context to influence behaviour.

We envisage that many sport and exercise psychologists, are not so much concerned about theory coherence, but are more interested in making things work, i.e., ensuring that athletes demonstrate adaptive behaviours in sport contexts or enhancing the motivation of individuals to exercise across the lifespan. Indeed this emphasis on achievements and behavioural outcomes, as the platform for the interaction between organism and environment, is based on a functionalist perspective that characterizes ecological psychology in general. However, it is important to acknowledge that its main schools of thought part company on exactly how to carry out this enterprise. Heft (2001) identified Egon Brunswik (18 March 1903-1956), Roger Barker (31 March 1903-1991), James Gibson (1904-1979), and Urie Bronfenbrenner (1917-2005) as the mentors of the leading schools of thought in ecological psychology. But what did each school of thought mean by the term ecological psychology? This paper builds on existing material which has previously examined the relevance of Gibson’s (1979) insights for performance and acquisition of skill in sport (e.g., Davids et al., 1994; Handford et al., 1997; Araújo et al., 2004) by evaluating the potential influence of the main schools of thought in ecological psychology for contributing to theory development and practice in sport and exercise psychology.

**Four ecological psychologies**

The relationship between the schools of thought in ecological psychology is very different from that between the various schools of thinking in
other areas of psychology such as psychoanalysis, behaviourism, or cognitive psychology (Sommer, 1994). In these latter areas there has been a history and tradition of frequent academic encounters and verbal sparring among representatives from different schools. Nothing like these arguments can be found in the literature between Gibsonians, Brunswikians, Barkerians or students of Bronfenbrenner.

This state of affairs is even more curious when it is observed that these four pioneers were exposed to common theoretical influences which can be traced back to Kurt Lewin, and to a minor extent to Fritz Heider. In a positive or negative way, Lewin influenced the four principals of ecological psychology (see Bronfenbrenner, 1979; Barker, 1979; Brunswik, 1966, 1955; Gibson & Crooks, 1938), as reported by other observers in the field (e.g., Heft, 2001, Ash, 2001; Hammond, 1966, Sommer, 1994, Vicente, 2003). There have also been other specific, and even deeper, influences for each of the individual schools of thought in ecological psychology. For example, even though James Gibson’s originality has to be noted, he acknowledged (1979) the key influences of Edwin Holt (behaviourism), Kurt Koffka (Gestalt psychology) and William James (functionalism and pragmatism). Barker (1979) has described in detail the way he was influenced by Kurt Lewin who, indeed, encouraged him in founding the Field Station in Oskaloosa, where he studied social dynamics. But he was also highly influenced by his wife Louise Barker who, as a biologist, familiarized him with ecological science perspectives and methodology in the biological sciences. Urie Bronfenbrenner (1979) has also publicly acknowledged his Lewinian influence as well as the influence of Barker and co-workers. Egon Brunswik, in his turn, obtained his main influences from Fritz Heider and Karl Bühler a leading psychologist, active in the Vienna Circle (Ash, 2001). In sum, there was no beginning point called ‘ecological psychology’, nor a common core that later divided into different positions. Lewin’s theory may be considered a “kick off”, but all four positions are quite different from that adopted by Lewin. Brunswik may hardly be considered to have any common ground with him, but perhaps precipitated by their ongoing disagreement, he was probably the first person using the phrase “ecological psychology”¹, when commenting on the term “psychological ecology” proposed by Lewin (1943; perhaps Brunswik heard it for the first time in the Symposium on “Psychology and Scientific Method,” held in 1941, where both were speakers). Brunswik stated that: “a statistical analysis of intra-environmental correla-

¹ We are aware that other authors, such as Willy Hellpach (1924), have used related phrases like “Psychologie der Umwelt” (Environmental psychology) before Brunswik.
tions would be termed ‘psychological ecology’ whereas the organism’s proper adjustment to such correlations, to be expressed in terms of achievement, would be ‘ecological psychology’”. (Brunswik, 1943, p.259). Indeed, Brunswik’s pioneering thinking was evidenced when he brought to psychology the question of the relevance of probability on human behaviour. But it is worth noting some other key points of divergence and convergence between the ecological schools, as we discuss next.

**A brief account of the position of each of the four theorists**

_Egon Brunswik_. Brunswik’s (1952, 1956) ecological approach to perception and cognition embraces uncertainty as a characteristic of both the environment and the organism, an idea that was captured by the symmetrical shape of his ‘lens model’. The model is based on the premise that organisms detect information from the environment in the form of multiple imperfect indicators of some unobservable state of the environment (e.g., the inferences that a coach makes about opposition tactics in the week prior to a match; or anticipation of the future intentions of an athlete predicated on body orientation or positioning information prior to movement initiation). Put simply, cues, or indicators, are those features of objects or events that athletes can use to infer those aspects of important objects or events that are not directly available. For Hammond (1966) there are so many of these cues, and they rarely are perfectly dependable in their ability to indicate those impalpable aspects of an object or event that one is trying to infer.

Brunswik labelled variables as distal or proximal, according to their positions in causal chains connecting the environment with the organism. In perception, the causal chain extends from the environment to the organism: 1) the distal variable is a remote property of the environment (e.g., the size of an object); 2) proximal variables (also called “cues”) refer to the patterns of stimulation that meet the perceptual organs of the organism (e.g., retinal images of the object approaching the eye). Regarding action, the causal direction extends from the organism to the environment: 1) proximal variables (also called “means”) refer to body movements or events, and 2) distal variables indicate remote “effects” or “ends” (Goldstein, 2004). Brunswik’s (1956) perspective presupposes that the organism intends to be as empirically accurate as possible in its perceptions and actions about environmental objects and events. Accurate perception and effective action are matters of “achievement”. However, for the organism, the only information directly available to it is proximal cues, and the only performances that are directly
controllable by the organism involve its own motor processes (proximal means). Following this line of thinking, the lens model provides a way of measuring the degree of adaptation between the organism’s behaviour and the structure of the environment. For this to be possible, the environment side of the model provides a referent for evaluating the fitness of an individual’s behaviour.

In general, the lens model addresses the probabilistic relationships between the distal descriptors available to an organism, and the ‘cues’ actually picked up by the organism. Brunswik argued that individuals cannot perceive distal properties directly, but instead must judge distal events from the imperfect (i.e., probabilistic) perceptual variables provided by proximal stimuli. He created the term ‘ecological validity’ to refer to the correlation between the proximal stimuli available to the individual and the distal properties of interest in studies of human behaviour. Thus ecological validities of cues refer to their potential utility for organisms in their local environment. In addition to providing a quantitative environmental model, Brunswik (1956) provided a quantitative model of organismic functioning, the form of which parallels the environment model (e.g., Cooksey, 1996; Hammond, 1996). The organism judges the state of the environment by combining the proximal cues in some manner, so as to infer the status of the distal descriptors (e.g., the goalkeeper’s decision to move to the left after anticipating the trajectory of ball flight, based on information from the feet and leg motion of the kicker). On different trials, organisms select different subsets of cues, attributing to those different weights. According to Brunswik, for an organism to decide on action, the only information sources directly available to it are the cues, which must be used and combined in opportunistic, context-specific ways to yield stabilized and robust organism-environment relations. This ability was termed ‘vicarious functioning’ by Brunswik, referring to exchangeability of means to an end, or of the variable pathways to achieve the same desired state. Judgmental accuracy or achievement is assessed by the correlation between judgment and criterion values (distal descriptors).

The methodological side of the lens model is what Brunswik (1956) called “representative design”. It refers to the arrangement of conditions in an experiment so that they represent the behavioural context to which the results are intended to apply. Contrary to traditional views in science, Brunswik argued that to hold all variables constant, except one, was to remove research from its relevant context, influencing the validity of empirical observations. According to Brunswik, behaving individuals must cope with the multiple, noisy situations, which occur in specific environments. Only by representing those ‘irregular’ (but utterly common) conditions to a
behaving organism can psychologists discover how it achieves a patterned relation with its environment despite the uncertainty engendered. Lack of representative design might signify that the behavioural processes studied in empirical research may have been unintentionally altered in such a way that the results from a specific experiment are not representative of the functional behaviours in participants’ environments. Consistent with his theory of probabilistic functionalism, Brunswik argued that the description of a task in testing hypotheses should be provided by estimating the ecological validity of cues, the intercorrelation among cues, and the overall uncertainty in the task. Any sample of situations in behavioural contexts would lie within these boundaries. This was the method Brunswik used to develop task constraints to capture and reproduce environments in a representative manner in controlled experiments.

Roger Barker. Barker developed an ecological psychology, later renamed ecobehavioral science, which would provide concepts and methods for understanding the lawful ways in which environmental contexts structure the everyday social behaviour of individuals. For Barker, psychology neglected descriptive, naturalistic research, limiting it from: 1) developing a systematic identification and categorization of psychology’s basic phenomena; 2) limiting information about their frequency of occurrence; and 3) information about the context in which these phenomena can be observed, (see Heft, 2001)

Barker and Herbert Wright opened a research office in a small town in Midwest of America which served as their base of investigations of daily life. The initial functions of the field station were primarily to collect naturalistic data. Their policy demanded methods for studying free-ranging persons; in such a way that researchers become “transducers of human behaviour and environment” (Barker, 1987, p.27). Subsequently, specifically elaborated surveys (1968) become an important addition to this approach. These records in the field station appear to comprise a string of events in the form of a narrative sequence of observable actions by a single child and the environmental features and persons with which the child interacted. Importantly Barker (1966) commented that “one cannot study the environment of behavior in general” (p.324), and when he analysed the records of these “behaviour streams”, patterns and structures began to appear. Behaviour occurred in episodic units, which are marked by a goal-directed activity that has a beginning, a directionality, and an end. In addition to the structure of behaviour episodes, Barker and co-workers were concerned with identifying the environmental antecedents of behaviour episodes. This aim was achieved by
assessing whether there was congruence between a contiguous environmental event, such as an action by another person and an ensuing behaviour episode. Their main conclusion was that “some attributes of behaviour varied less across children within settings than across settings within children” (Barker, 1968, p.4).

These patterns of action pointed to a higher order environmental structure with respect to which behaviour of different children was congruent. Barker called this environmental structure a “behaviour setting”. Barker (1966) argued that behaviour settings can be identified and described reliably without an explicit theory and by means of survey techniques. As Barker noted, the sciences which deal with the proprieties of the environment directly, and not “propaedeutically” (in his words) as in psychology, do not find them to be chaotic or only probabilistic in their occurrence. Barker demonstrated that the “behaviour setting” has a regularity and structure that constrains behaviour in predictable ways. The phrase “behaviour setting” was deemed to include the following properties (Barker, 1968; Heft, 2001):

1) It is a phenomenon that occurs as a function of the interaction between individuals (not a scientist construction for an experiment); 2) It has a specifiable geographical location; 3) It has temporal boundaries (beginning and end points) that are self-regulated by the individuals implied; 4) Its boundaries can be perceived (discriminable). A person is aware of entering and leaving a behaviour setting; 5) It is in a state of dynamic stability (quasi-stable), preserving a certain pattern; 6) It exists independently of any single person’s experience of it (i.e., behaviour settings are identifiable by independent observers); 7) Occupants’ actions are interdependent.

This list of behaviour setting properties is not exhaustive, and it is sufficient to begin considering the dynamic properties of these ecological entities. According to Barker, behaviour settings are “circumjacent” to (i.e., they surround) individual behaviour. Conversely, individual behaviour is one component part of a behaviour setting. Individuals, as well as behaviour objects (“milieu”), are “interjacent” components of a behaviour setting. Moreover, a behaviour setting comprises a particular pattern of relations (social dynamics) generated and maintained by its occupants. It is the relation among the interjacent components (i.e., persons and objects) that generate and maintain the circumjacent setting. It is in this sense that a behaviour setting is self-regulating. Reciprocally, as a higher order dynamic structure, a behaviour setting constrains action possibilities of its occupants. Importantly, behaviour settings do not determine individual behaviour; they constrain it. And by limiting possibilities, they create opportunities for individual choice within its framework (Heft, 2001).
Although Barker discovered and articulated an essential extra-individual ecological structure, little has been said about the individual. As Barker (1987, p.31) asked: “What psychological mechanisms insure that people conform to the characteristic standing behaviour patterns of the settings they enter?: What motives and abilities are needed to enter, to alter, and to create behaviour settings, and how can they be nurtured?”. Indeed, in some of his last writings, Barker (1987) identified two different, although necessarily related, paths of analysis of the individual through the data. One path leads to the environment independent of a person but that affects the person and the behaviour. A second path leads to the surrounds that are part of a person with direct effects on behaviour. As for the first, some behaviour episodes are initiated and terminated by attributes of the behaviour setting, and some events may not be directly experienced by the individual, and which are extended into more remote layers of the setting. The second path provides events (some actions directed to the individual, or some actions experienced by the individual although observable by others) that are solely selected by the individual and are not features of behaviour setting operations.

In sum, Barker found that it was possible to predict behaviour better from places than from people, and that behaviour in places is more stable (i.e. predictable) than the people (i.e., who is going to be there). For example, independently of whomever is the attacking player (attacker, defender, goal-keeper) in front of the adversary goal keeper in the opposition penalty area in a soccer game, the behaviour will most probably result in a shot at goal. The point is for Barker: people are replaceable parts of places. Finally Barker and colleagues found places to be as distinctive for people as for behaviour: “places themselves sort and select occupants regardless of their wishes. Behavior comes not only as the behavior of particular persons, but also as the behavior of particular places.” (Barker, 1987, p.29).

James Gibson. Gibson’s ecological approach to perception and cognition dismisses dualism of mind and body (and more generally environment and organism) and emphasizes the mutuality of an organism and its environment. For Gibson, perceiving is defined as the means by which an organism maintains contact with its environment. It is a phenomenon to be understood in terms of lawful regularities and symmetry principles defined at the ecological scale of organisms and environments, rather than in terms of mental states or formal languages of representation and computation (e.g., Turvey et al., 1981). The essentials of the approach are that: Information is specific to the environmental properties (comprising surface layouts, objects, and events); and perception is specific to information. Hence, perception is specific to the
environment (Turvey & Shaw, 1999). Gibson’s (1979) ecological approach attempts to identify the specificity between the structured energy distributions (informational variables) available to a perceptual system and the environmental properties causally responsible for that structure. This specificity is what is meant by information (the structure informs about what it is). Moreover, Gibson’s approach asserts the directness of perception in the sense that the specificity of perception to information dispenses with any intervening special process, such as inference or recourse to representations. That is, for every property perceived, there is a property of the structured energy to which the perceived property maps uniquely. For Gibson the process of detecting information is carried out by a functional system distributed throughout an organism. Adjustments of peripheral organs, such as turning the eyes and head, play as significant a role in direct perception as the activity of the brain and the nervous system. Awareness of the environment is based on the adjustment of the organism’s entire perceptual system to the information surrounding it. This adjustment includes a range of processes, all of which may be described as the simultaneous extraction of persisting and changing properties of stimulation, invariants despite disturbances of the array of information (Gibson, 1979). The invariant is a higher-order property of the stimulus array that exists whether the organism knows it or not, and whether the organism attends to it or not. Observers can perceive themselves, their environments, and the changing relationship between themselves and their surroundings. This adjustment of the perceptual system requires component processes such as delimiting the range of variables in stimulation, establishing co-variations of information across different perceptual systems, distinguishing information specifying the self from information specifying the environment, and extracting information of the affordances of the objects, places, events and other people in one’s habitat (Gibson, 1966).

The most important concept in Gibson’s (1979) theory is that of affordance. Affordances are a way of describing the environment independently of the stimulation available to inform perception. This description of the environment is not achieved in terms of physics (e.g., mass, length, time), but in functional terms that are psychologically relevant. Thus, affordances are goal relevant descriptions of the environment. The concept of affordance plays a crucial role in Gibson’s theory because the elimination of dualism is accomplished by measuring the physical properties of the environment using a frame of reference defined by the organism’s action capabilities. In short, the existence of information provides for the possibility of direct perception because it potentially allows functional meaning (i.e., affordances) to be per-
ceived directly. Moreover, direct perception occurs when organisms are actively attuned to an invariant in the environment, thereby allowing them to perceive an affordance directly (Gibson, 1979). Improvement in perceiving in any given situation follows from the discovery of, and attunement to, information. The specificities in any given situation – the lawful regularities between aspects of surface layout or self-movement and macroscopic properties of structured energy distributions – vary from embracing more than or less than the property of interest to the property of interest only. That is, with respect to learning to perceive an environmental property, the perceiver progresses from under- and over-differentiating the ambient energy distribution, to differentiating it precisely (Gibson & E. Gibson, 1955, see Jacobs & Michaels, 2007 for perceptual learning).

Following this reasoning it is not surprisingly that for Gibson, what cognitive psychologists call psychological processes (associating, organizing, remembering, recognizing, expecting, and naming) are processes he treated as incidental to cognition (i.e., the developing process of information pick up). Gibson (1966) argued that these processes were first conceived as operations of the mind upon the deliverances of sense, and they still carry some of this implication. However, Gibson never argued that indirect (mediated) perception (or awareness) was impossible, but he made a strong distinction between perception based on information (in his words knowledge of the environment) and perception based on language, pictures and other symbols (in his words knowledge about the environment) (Gibson, 1966, p.91). For Gibson, direct perception, or “knowledge of” the environment, is not formulated in pictures or words, for it is the knowledge that makes the formulation of pictures and words possible. However, even though it is tacit, this knowledge of the environment obtained through direct perception is not personal, subjective or private. Information is available in the environment, and it can be picked up by many observers. Humans developed the ability to act so as to make other humans aware of relevant environmental facts. In these cases, the information on which direct perception can be based is selectively adapted and modified in an optical or vocal display. The value of these selected samples of information lies not in the displays themselves, but in what they refer to or represent. These mediators are representations; they do not have affordances as objects do, but rather have ‘referential meaning’ (Reed, 1991). The great variety of processes involved in indirect perception therefore has in common a simultaneous awareness of the mediator and what it represents. The role of indirect forms of cognition is not to create knowledge out of merely potentially meaningful input, nor even to select meanings to assign to inputs, but to make others aware, to share knowledge (Reed, 1991).
Urie Bronfenbrenner. Bronfenbrenner’s bioecological model is an evolving theoretical system for analysing the role of environment in shaping human development through the life course (Bronfenbrenner, 2005). The specific profile of Bronfenbrenner’s model of human development is its interdisciplinarity and integrative focus on youth and its explicit interest in applications to policies and programs pertinent to enhancing youth and family development (Bronfenbrenner & Morris, 2006). A central assumption of the model is that through the life course “human development takes place through processes of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate external environment” (Bronfenbrenner & Morris, 2006, p.797). For Bronfenbrenner biological factors and evolutionary processes not only set limits of human development but also impose imperatives regarding the environmental conditions and experiences required for the realization of human potentials. The defining dimensions of the bioecological model are process, person, context and time, which have interactive relationships. The specific components of these dimensions to be included in a given investigation should be those that, from a theoretical perspective, are maximally relevant to the research question under investigation and complementary to each other in relation to the given developmental outcome (Bronfenbrenner & Morris, 2006).

For Bronfenbrenner, a critical distinction is made between the concepts of environment and process, with the latter occupying a central position. “Process” encompasses particular forms of interaction between organism and environment, called proximal processes, that operate over time and are posited as the primary mechanisms producing human development. The definition of proximal processes includes the following points (Bronfenbrenner & Morris, 2006): 1) For development to occur, an individual must engage in an activity; 2) To be effective the activity must take place on a fairly regular basis, over extended periods of time; 3) To be developmentally effective activities must take place long enough to become increasingly more complex; 4) Developmentally effective proximal processes are initiated both from an individual and from the environment; 5) Proximal processes involve interpersonal interactions; and also interactions with objects and symbols. Importantly, for Bronfenbrenner, the proximal process has the general effect of reducing, or buffering against, environmental differences in developmental outcome.

For Bronfenbrenner the characteristics of the person function both as an indirect producer and as a product of development. From this ecological perspective, their effectiveness in the later role derives from their capacity to
influence the emergence and operation of proximal processes. Three types of person characteristics are distinguished as most influential in shaping the course of development and power of proximal processes through the life course. First, dispositions (or forces) can set proximal processes in motion in a particular developmental domain and continue to sustain their operation (“developmentally generative”), or conversely actively retard, or prevent their occurrence (“developmentally disruptive”). Second, resources are person characteristics that in themselves involve no selective disposition to action, but are barriers (e.g., morphological malfunction) and facilitators (e.g., ability, knowledge, skill, and experience) that influence the capacity of the individual to engage in proximal processes. Third, demand characteristics invite or discourage behaviours from others that can foster or disrupt the operation of proximal processes such as attractive vs. unattractive physical appearance. Thus it is important to know on what significant others focus their attention on the developing person.

In 1979, Bronfenbrenner conceptualized the environment in terms of nested systems ranging from micro to macro, and where the most important of these was the microsystem. It was defined as a pattern of activities, social roles, and interpersonal relations experienced by the developing person in a given setting with particular features that influence engagement in interaction with the immediate environment. Therefore effects of the physical environment such as the degree to which the physical set up of the home permits exploration influence development. Also social influences such as mother-infant interaction are essential aspects of the microsystem. Curiously, Bronfenbrenner and Morris (2006) adopted an internalist perspective by arguing that “the emotionally loaded patterns of interchange processes between the infant and the primary caregiver become internalized in the form of ‘internal working models’ (Bowlby, 1969,1973). Such working models are representations of the infant in relation to others and become the basis for development of the self” (pp.815-816). Beyond the microsystem, there is the mesosystem, defined as comprising the relationships existing between two or more settings (i.e., microsystems). The next level is that of the exosystem. It comprises the linkages and processes taking place between two or more settings, at least one of which does not contain the developing person, but in which events occur that indirectly influence processes within the immediate setting in which the developing person lives. The macrosystem is the broadest sociocultural context where the developing person is living (e.g., occidental world). Thus, the power of developmental forces operating at any one system level of the environment depends on the nature of the environmental structures existing at the same or higher levels of the system.
The dimension of time has three successive levels. Microtime refers to continuity versus discontinuity in ongoing episodes of proximal process. Mesotime is the periodicity of these episodes across broader time intervals, such as days and weeks. Finally, macrotime focuses on the changing expectations and events in the larger society, both within and across generations, as they affect and are affected by, processes and outcomes of human development over the life course. The primary emphasis is on the role of developmental processes and outcomes in producing large-scale changes over time in the state and structure of the broader society over time, and the implications of those changes for a society’s future. Environmental contexts influence proximal processes and developmental outcomes not only in terms of the resources that they make available but also in the degree to which they provide the stability and consistency over time that proximal processes require for their effective functioning.

Convergent and divergent points in these four schools

It is interesting to note that for Gibson, Brunswik and Bronfenbrenner, theory was a priority, but for Barker this was not the case. When he started collecting data in the Midwest of America, he saw himself as atheoretical, believing that more empirical data were needed in order to develop a theory in a new research area, such as psychology (Sommer, 1994). However, as his program developed, theoretical constructs started to emerge. From a methodological point of view, Gibson and Brunswik were both experimentalists, but Barker and to some extent Bronfenbrenner were naturalists. Curiously, Barker started doing research as an experimentalist, doing experiments about human motor learning (Barker, 1987). Overall, these are fundamentally different strategies for obtaining information about behaviour, although these scientists reflect an unusually high consideration of the environment, when compared with other psychologists.

Another point worth noting is that whereas both Brunswik and Gibson used and maintained the phrase ‘ecological psychology’ to identify their approach, Barker abandoned it in favour of the broader label ‘ecobehavioral science’, and in similar vein, Bronfenbrenner defined his approach as a ‘bioecological model’. Thus, the phrase “ecological psychology” has different meanings in these schools, and it is with no surprise that Mace (personal communication, 12th April, 2007) argued that Gibson adopted the term ‘ecological psychology’ “DESPITE their usages, not BECAUSE of them”.

Surprisingly, these four theorists did not influence each other very much. Bronfenbrenner (1979) explicitly discussed Brunswik’s concept of ‘ecologi-
cal validity’ and implicitly (and perhaps confusingly) ‘representative design’ (see Hammond, 1998). More concerned with social policy and development, Bronfenbrenner, was primarily focused on the study of children and their development at all levels of societal influence (Krebs, this issue). Barker, on the other hand was primarily interested in a comprehensive, precisely detailed, descriptive “psychological ecology” concerning a whole community (Kaminski, 1989), and children and their (social) development formed one component of the whole communal system (Kaminski, this issue). Barker shares with Brunswik the aspiration to include ecology in psychological theories and research. But his view of how ecology is “objectively organized” is different from the Brunswikian approach: “I stand with Brunswik so far as the breadth of psychology is concerned, and take the whole span from the environment to the environment, the $E-E$ unit, as the basic psychological entity… [But] I cannot accept his macro-probabilistic…treatment” (Barker, 1960), referring to the fact that Brunwik considered the environment to be always probabilistic. However, Barker (1966) criticized Lewin’s “encapsulation” in the “life space” concept, opposing it with Brunswick’s and his own attempts to integrate “psychological environment” and “ecological environment”. Also Barker (1968) made use of Brunswik’s “E-O-E-arc” (1952, 1956; ‘E’ for environment and ‘O’ for organism) in order to understand socially contextualized behaviour.

Moreover, Gibson and Brunswik were both experimentalists studying perception. Brunswik (1957) appreciated the work of Gibson (1950), but it seems that he was not much influenced by it. Gibson on the other hand, seems to have been influenced both positively and negatively (1950, 1957; see Lombardo, 1987 for an analysis of this influence). Importantly, several attempts continue to be made to integrate both approaches theoretically (e.g., Kirlik, 2001; Vicente, 2003) and methodologically (e.g., Araújo, Davids & Passos, 2007).

Gibson analysed further the organism-environment interrelations as they are effective and traceable in everyday life, taking the perceiver-environment relation as the main unit of analysis. Barker’s contribution is to have discovered an ecological structure that operates at an extra-individual level. However, Brunswik initiated a formal procedure for determining the meaning of terms like “extra-individual” or environmental. His methodology of representative design usefully clarifies ambiguous phrases used by psychologists such as ‘real-world’, ‘natural world’ or ‘typical world’. His insights revealed that a constructed or simulated environment is not unreal (for example laboratory experiments are ‘real’ experiences for participants and scientists).
Bronfenbrenner built on Barker’s framework, and his advances were particularly visible on the influence of conditions outside the boundaries of behaviour settings. Sensitivity to conditions that originate outside of “behaviour setting” boundaries highlights the fact that behaviour settings themselves are sociocultural phenomena (Heft, 2001). Bronfenbrenner provided an important contribution to these issues, by introducing the components of the environment designated by exosystems and macrosystems, as well as an emphasis on the role of the individuals (Krebs, this issue).

The influence of ecological psychology schools led by Barker, Bronfenbrenner, Brunswik and Gibson began to arrive in the sport psychology and performance literature two decades ago. Perhaps the major impact in this sub-discipline has been achieved by the Gibsonians (e.g., Lee et al, 1982, Salomon et al, 1984; Abernethy 1993; Oudejans et al., 1997, 2000), since in the sport sciences, the ecological approach will almost certainly be immediately identified with the insights of James Gibson. However, to a lesser extent, proponents of the other schools of thought have also expressed their interest in the human behavioural context of sport. The Barkerian school made early incursions (e.g., Kaminski, 1982) but with little acknowledgement, at least in the English language sport science literature. Both Bronfenbrenner (Spence & Lee, 2002, Bengoechea, & Johnson, 2000) and Brunswik (Araújo et al., 2005) have only recently influenced specific research programmes in sport psychology.

It is not the aim of this article to propose an integration of these approaches (but for discussion of this possibility see Kirlik, 2001, Vicente, 2003, Heft, 2001, Kaminski, 1989). Our aim in the next section of this overview paper is simply to comment on the target papers of this special issue to help orient the reader to the potential of these approaches for studying sport and exercise behaviours.

Person-environment interactions and the dynamics of sport performance

The ecological approach to cognition and action in sport and exercise ensures that physical and social constraints on individual behaviour are not ignored, while simultaneously ensuring that characteristics of individual performers are not overlooked. A key issue that is evident when reading the four leading papers of this special issue is the emphasis on the person-environment interrelationship, or simply on the environment. This is clearly a trend not shared with other theoretical approaches in mainstream (sport) psychology.
There are different types of complexity that can be found in a system such as sport competition (e.g., large problem spaces, distributed ‘situatedness’, hazards, coupled subsystems, uncertainty and perturbations; see Araújo et al., 2004; Lebed, 2006; McGarry et al., 2002; Schmidt et al., 1999). Whereas it is true that an individual or a team may have a “game plan”, that is only one constraint among many operating in performance and competition; and an individual or team that does not adjust to performance conditions as they unfold are unlikely to experience success. What makes each game unique is the way that performers adapt to changing circumstances over time. In such a dynamic environment, with so many particularities that makes each circumstance unique, it is relevant to question if decision making and action can actually be prescribed in advance by what is stored in memory representing the world, or whether behaviour is constantly adjusted to emerging circumstances through perception. Adaptive behaviours are task specific, mapping relevant perceptual variables to relevant action variables. Even though each of these four ecological approaches has privileged different phenomena in their focus, the process of how environment-organism interactions occur are said to vary. Next we will discuss some of these variations in each approach which are highlighted in each of the special issue target papers.

The title of Hammond and Bateman’s paper “sport psychology’s outer game” subtly captures the view that there has been an imbalance in the directional focus of sport psychologists’ work over the years. There has been a lack of psychological research which has used sports contexts as a basis for understanding psychological characteristics of behaviour. In the sport sciences, notational analysis of sport games\(^2\) (Hughes & Franks, 2004; Reilly & Gilbourne, 2003) tends to analyse some contextual characteristics of competitive performance. However, it has tended, until very recently, to be used as a methodology for recording data on patterns of behaviour (e.g., attacking of defensive plays) observed in competition. We are reminded in the paper by Hammond and Bateman that, although typically notational analysis has been conventionally used as a performance analysis tool, perhaps its greatest value is when it is used in conjunction with a theoretical rational. For example, this has occurred when notational analysis is allied to dynamical systems theory to discuss the emergence of patterns of behaviour in the complex system that is sport performance (see McGarry et al., 2002; Araújo et al., 2006). With respect to this point, Hammond and Bateman’s article raises an impor-

\(^2\) To interpret sporting events and performance by analysing statistical details of performance.
tant issue for sport and exercise psychologists. The idea of representative
design of experiments may need to be developed if one focused on the cor-
respondence between training sessions and competitions. Hammond and
Bateman’s paper facilitates a significant step in this regard, but simple simu-
lation of characteristics of match situations may not be enough. For example,
some evidence-based practices use more than one ball at the same time (and
even more than one goal to defend) in team handball games to develop
player awareness and a wider perception of the field. Also some basketball
coaches conduct training matches with imbalanced teams (e.g., five against
seven players), to prepare the players for the higher levels of space restriction
and temporal pressure that well-organised teams can effect during competi-
tion. These practice situations may not be strictly considered to be represen-
tative of competition, since they do not have the same sources of information,
or the same rules or game structure, but they effectively prepare players in a
certain stage of development for competitive performance. Perhaps represen-
tative design can go beyond statistical sampling towards a functional rep-
resentativeness (Araújo et al., 2007). By doing this, higher order strategical
aims, like when 5 play 7 in practice so that players learn to compress or cre-
ate space and time through their movements off the ball, can be addressed in
a straightforward manner.

The article from Kaminski situated very clearly the relevance of environ-
ment to study behaviour, highlighted by the use of Lewin’s concept of “psy-
chological ecology”. The description of behaviour settings in sport (Kamini-
ski, this issue) is in line with the arguments of Hammond and Bateman when
they point towards game analysis being grounded in a theoretical rational.
Moreover, this description can be so rich that it may go well beyond perfor-
man ce, and highlight social interactions between the main protagonists in
sport performance, including players, coaches, managers, audience, family,
as well as when the activity is directed to non-competitive goals such as
weight management or active life style. With this broader view, there is one
issue that may need further clarification: What is the influence of an experi-
ence in one specific behaviour setting (e.g., family) for performance in
another behaviour setting (e.g., sport competition)? For example what is the
influence of a family event or celebration (such as a dinner), on a training ses-
tion (or skipping the session!) the next day? The more general point is: how
should we conceive the influence of a behaviour setting beyond participation
in that setting? This issue should be addressed by an ecobehavioral science
interested in the dynamics of behavioural settings.

The theoretical rationale of Fajen et al.’s target paper not only provides
valuable insights into the control of action from a Gibsonian perspective, but
has significant implications for developing a broader ecological approach to motor learning and the substantiation of a nonlinear pedagogical framework in sport (e.g., Chow et al., 2006). The nature of agent-agent and agent-environment interactions (Guerin & Kunkle, 2004), are useful for understanding how the creation, maintenance and decay of key constraints affects the interactions of perceptual, cognitive and motor sub-systems during sport performance (Araújo et al., 2006; Chow et al., 2006, in press). In a study of the acquisition of coordination in a multi-articular lower limb interceptive action, Chow et al. (2006, 2008) produced convincing demonstrations of height and distance to target as emerging and decaying constraints over the duration of practice. They observed novice participants as they first attempted to satisfy height constraints before switching to distance to target constraints and back again over 12 practice sessions in a kicking task. In Fajen et al.’s target paper of this special issue, the example of changes in catchability of a ball as fatigue increases during a game illustrates neatly the dynamic nature of affordances’ perception as constraints on action.

There are clear implications of the dynamic nature of affordances as emerging and decaying constraints in a nonlinear pedagogy (Chow et al., 2006). One important implication is that affordances also shape motor learning. Additionally, practitioners need to understand the dynamic nature of affordances which will constrain the design and implementation of practice environments for each individual learner, recognising the temporary nature of many constraints, such as fatigue, injuries, emotional states and developmental status that might affect the perception of affordances. Clearly, the possibilities for action that a coach or teacher may view as ‘obvious’ for learners may not be those that are shaping the immediate decisions and actions of each unique individual during practice. The dynamic nature of affordances in sport are reflected by the fact that task and personal constraints change along different timescales, some more instantaneous, others over a longer term. Perceiving affordances can benefit the learner’s adaptation to immediate task constraints such as when learning to solve the difficulties raised by 1 v 1 situations formed by attackers and defenders in team sports such as football, hockey and basketball (Araújo et al., 2006). As argued by Fajen et al. (this issue), actors take the limits of their capabilities into account when organising their actions.

Fajen et al. (2009) also argued that affordances for controlling actions have a social dimension to them, an idea which is irresistible in its application to sport psychology, motor learning theory and for pedagogical practice in sport. Sport and physical activity is an inherently socio-cultural phenomenon with ample opportunities to perceive affordances for and of other people.
around the world, since global media coverage of sport in the digital age merely enhances these opportunities. The insights of Fajen et al. on affordances for action provide a sound theoretical framework for gaining a better understanding of some persistent issues in motor learning, such as observational learning. Further empirical work is needed to reveal how picking up an affordance for another person can benefit learning of a functional movement pattern in a specific performance context. It is likely that observational learning to pick up an affordance for another person would most benefit learners when body dimensions and action capabilities were co-calibrated (between model and learner) according to limb lengths and other relevant structural variables. The perception of affordances of other people and for combined actions could provide an integral aspect of learning tactical behaviours in conjunction with acquiring relevant coordination patterns. For example, in observing performance sub-phases of team games, perceiving affordances for actions of defensive and attacking players may enhance tactical awareness of learners.

This idea provides some support for pedagogical frameworks that emphasise the teaching of skills and tactics as inseparable, as espoused in a theory of nonlinear pedagogy by Chow et al. (2006). Although the idea of not separating the teaching of movement skills and tactical behaviours was originally proposed in the Teaching Games for Understanding pedagogical framework (Bunker & Thorpe, 1982), little in the way of theoretical rationale was provided for this contentious assertion. Observing actions for and of others in order to pick up affordances for learning in sports contexts would have the signal aim of perceiving the ‘functional semantics’ for a particular activity, unrelated to the process of verbally describing physical properties of sports contexts. These profound ideas indicate the importance of restricting the amount of verbal instructions and feedback provided during the learning process, sometimes used by coaches to describe a movement pattern and its effects on the environment in terms of distance, speed, height and force. Observing sports and physical activities to pick up affordances to control actions would provide a sound opportunity to enhance perceptual attunement to key invariants, which can be revealed through the realization of actions based on these informational constraints.

However for a deeper implementation of these Neo-Gibsonian ideas in sport psychology some mundane behaviours need some explanation. Even though, a direct perception theory may explain interceptive actions in sport, how can it contribute to the explanations of behaviours like when “a detective combines evidence with knowledge of the case to infer the events that led to a crime” (Fajen et al., 2009) This is exactly what happens
when a coach has to decide which player should be substituted (and by whom) to change (favourably!) the dynamics of a team game. The behaviours we are referring to are characterized by the fact that changes in current perception or action are insufficient to enable successful goal-achievement.

Krebs in this issue presents some interesting insights from Bronfenbrenner’s framework which could help in the creation of policies and programs for enhancing the development of youth through sport. The structure of environmental influences, particularly those influences beyond the microsystem, is unique among these ecological approaches. This structure helps in constraining and localising environmental influences in sport and exercise behaviour. For example, the promotion of physical activity for public health is a major concern in exercise psychology. To describe the breadth of intervention strategies available to fitness professionals, health professionals, and public health practitioners in promoting physical activity, the bioecological model may be useful. This is even more evident in: (i) interventions which are a function of their targets such as sedentary individuals, small groups like families, organizations like hospitals, communities and public policies; (ii) the relationship between targets (individuals and families), such as modifying a target, creating linkages between targets; and (iii), the delivery setting, such as workplaces, schools, communities or health care institutions (Gauvin, Lévesque & Richard, 2001; Sallis & Owen, 2002).

However, a major consideration in applying key ideas from Bronfenbrenner’s model is in making operational some of the key concepts: How can one operationally distinguish exosystem from mesosystem, and those levels from the macro system?; How can one distinguish the influence of proximal processes from those of the microsystem, the microtime, or the person? How can we trace these influences?; How can the characteristics of the person be measured? How do we know that these characteristics are generative or disruptive? Is this a judgment by the researcher?. If it is true that the core of these variables is possible to identify, their boundaries are far from clear, and far from having an independent measure. Clearly, the development of these concepts would enhance the impact of Bronfenbrenner’s ideas in sport and exercise psychology.

Next we will further discuss two major issues that arise from the papers of Hammond and Bateman, Kaminski, and Krebs: the dynamics of the environment-performer relation and the use of internal representations of the world by neurobiological systems.
As early as 1967 in the cognitive sciences, Neisser tried to avoid the idea of a homunculus to control the use of representations in humans: “If we do not postulate some agent who selects and uses stored information, we must think of every thought and every response as just the momentary result of an interacting system, governed essentially by laissez-faire economics” (p.293). But, influenced by computational theory, he thought that the explanation would come from an executive routine which would not be used by anything else: “Although there is a real sense in which it ‘uses’ the rest of the program and the stored information, this created no philosophical difficulties [the regress of control is not infinite]; It is not using itself” (1967, p.296). However, the executive routine of the programme still had to be established by the programmer, initiating the infinite regress. The problem in the approaches advocated by Hammon and Bateman, Kaminski and Krebs, we believe, resides in an over-reliance on representations as the meanings of symbols (the codifications stored in memory) used by neurobiological systems. The general idea shared by representationalist approaches, such as those advocated by Barker, Bronfenbrenner and Brunswik, is that representations might ‘stand for’ things in the world.

As Kaminski 2009 noted, Barker characterized the operations of a behaviour setting as being distributed across its participants and environment components. However, Barker placed the control of this environment-individual system in the individual by incorporating into Brunswik’ model, the TOTE concept proposed by Miller, Galanter, and Pribram (1960). In their turn, Bronfenbrenner and Morris (2006) explicitly referred to internalization of social interaction into mental representations. To be clear, Miller et al. (1960) proposed that all action is based on a process where an input stimulus is “processed”, creating grammar-like, rule-based structures for planning future responses. For them, cognitive processes were just specific rules that constrained behavioural inputs and outputs, much in line with behaviorism (Reed, 1997). This is why Gibson (1966; 1979; see also Fajen et al, this issue) rejected any sort of input-output model, constrained or not. Gibson’s contribution to psychology was to address the various processes of knowing without slipping into this representationalist viewpoint (Fajen et al, 2009).

One problem with representationalist approaches is that neurobiological systems can only operate with respect to that which is already established in memory. However, the Brunswikians Fiedler and Juslin (2006) have proposed that “processing” may also occur externally: “A considerable part of
environmental information encountered in the past is no longer out there as perceptual input but represented in memory, much like present environmental information may be represented in the sensory system.” (p.7). They clarified that “analysis of the stimulus environment impinging on the organism, and of its constraints on information processing, is of similar explanatory power as the analysis of memory constraints” (p.8). In line with this reasoning, Brunswik’s model, as well as all information processing models, extends the input-output model, viewing individuals as functioning as passive receptors of stimuli instead of active perceivers (i.e., not viewing perception and action as a coordinated ongoing process). During the act of perceiving, the hands, ears or eyes of an athlete can explore the available stimulation in a particular performance environment. Information is the basis for contact with the environment because it is specific to its sources in the environment. Unsurprisingly, knowing in advance the environmental circumstances to be encountered in a performance setting is incompatible with the idea that information detection should be the basis for adapting behaviour to novel situations. Even for the most experienced athletes, precise and comprehensive knowledge of the performance environment is rarely achieved, and adaptive behaviours support the successful negotiation of complex, dynamic contexts. In this respect, perception is the key to knowledge of the performance environment.

Indeed, Gibson argued that in all instances in which affordances are perceived, no matter how complex the property to be cognized, our awareness of it is necessarily rooted in perception (Fajen et al, 2009). The mechanisms typically proposed of associative memory, inference mechanisms, and knowledge structures are epistemic mediators. Their role is to provide the missing link between the performer and its environment. In order to fulfil this role, mental representations must be connected to the facts of the environment. But as Warren (2006, p.361) questioned, if perceptual and cognitive states are representations, how is it possible for the agent to know what they stand for without presuming some other direct access to the world? Similarly, invoking representations in action also runs the risk of an explanatory regress, accounting organization in behaviour by attributing it to prior organization in a representational area of the central nervous system.

We argue that the best way to solve the problem raised by a psychology of everyday, sport and exercise activities could be to move away from the “claustrophobic concept of cognition” (Lave, 1988). To achieve this aim, sport psychologists need to study cognition, perception and action in the context in which these processes actually occur, to establish how they are organized and adapted for use in different situations and how they
interact with different intentions of the performer. But this alone is not enough. Somehow the approaches adopted by Kaminki, Krebs, and Hammond and Bateman presume that the context enriches the mental representations of the performers. This focus contrasts sharply with how performers and contexts co-determine each other through ecological practice. Moreover, altering the notion of context from a mental space to the ‘outside’ world is helpful, but only insofar as one is seeking a valid description of cognitive phenomena. To explain the complex, contextually varying phenomena of cognition requires a theory that is accurate enough to explain how patterns of coherence can and do emerge from ranges of variation (Reed, 1993, Turvey, 1990). The merging of concepts and ideas from dynamical systems theory and ecological psychology promises to formalize the analysis of pattern formation and variability in cognitive processes at an ecological level (van Orden et al, 2003; Warren, 2006). As Beek et al. (2003) argued, Gibsonian ecological psychology and the dynamical systems approach share both a reluctance to invoke mediating constructs in the explanation of sporting actions, and the effectiveness of an analysis in terms of the recognition (perception) and formation (movement) of higher order invariants or collective variables.

The dynamics of person-environment interaction

From a Gibsonian point of view, behaviour (cognition, perception, action) can be understood in direct and deep connection with dynamic principles (Kugler et al., 1980; Barab et al., 1999; Turvey & Shaw, 1995; Warren, 2006). The dynamical systems perspective on movement behaviour captures action possibilities, lending itself neatly to the modelling of affordances as dynamic constraints on the behaviour of each individual performer. In the other ecological schools of thought, the influence of dynamical systems tools and concepts has been almost non-existent. However, Brunswikians, Barke- rians and students of Bronfenbrenner, as influenced by the systems approach, and with their stance on the complementary nature of organism and environment, would seem to be receptive to this link. We turn now to discuss how these links could be achieved and maintained.

The core ideas behind a dynamical systems perspective on coordinated human behaviour include: (i) the concept of state space (i.e., the hypothetical totality of all the possible states of order - i.e. states of coordination - which are achievable by an action system); (ii) the idea of a set of possible trajectories that a movement system can take through state space; and (iii), the
use of mathematics to describe the laws that determine the shapes of these system trajectories. Strictly speaking, dynamical systems theory is the branch of mathematics concerned with studying the evolution of numerical systems in the form of equations of motion. Applied to the study of human behaviour, dynamical systems theory provides a conceptual framework for identifying characteristic dynamical features of selected systems and for deriving equations of motion that can produce these features. These equations of motion constitute formal analogies of the phenomena of interest that describe, explain and predict the behaviour of a system under study, in this case processes of cognition, perception and action in neurobiological systems.

Applications of the dynamical systems perspective on human behaviour show how patterns of coordinated movement emerge, persist, and change (Haken, 1996; Kelso, 1995; Beek, Peper & Stegeman, 1995). These applications build on the insight that neurobiological systems consist of a large number of interacting parts, and that they are endowed with the capacity for spontaneous pattern formation or self-organization. They also allow the study of emerging macroscopic patterns in terms of the dynamics of one or a few collective variables, without having to know all the microscopic states of the individual parts. Conversely, when the dynamics of macroscopic phenomena have been identified, the contributions of relevant dynamical components to global system dynamics may be investigated in a top-down fashion. Based on the hypothesis that the morphology of human behaviour can be formalized in terms of low-dimensional dynamical systems (Kugler, Kelso, & Turvey, 1980), an ecological approach searches for the considered extension of nonlinear dynamics and the developing physics of self-organizing systems to psychological systems, and the application of both orthodox and novel strategies for uncovering the lawful regularities behind the behaviour of such systems (Turvey & Shaw, 1995). Undertaking this challenge by studying behaviour in multiple time slices, as often occurs in traditional psychology experiments on perception and decision making for example, is not enough because this approach freezes time by taking a series of snapshots (Vicente, 2006). The continuity in the dynamics that is clearly present in the environment is not fully exploited theoretically and methodologically.

Despite these challenges, there are a number of potential conceptual bridges for integrating ideas of dynamical systems theory and of the various ecological schools. For example, Hammond and Bateman argued that the probabilistic nature of a sport like tennis is foundational, and that not all events and behaviours have determined causes. These points suggest that behaviour can have a stochastic and a deterministic dimension which need to
be interpreted in every performance context. Indeed, another Brunswikian, Brehmer (1990) raised the problem of dynamic decision-making as “directing and maintaining the continuous flow of behaviour towards some set of goals rather than as a set of discrete episodes involving choice dilemmas” (p.263). Brehmer emphasised that the focus of research on human behaviour should be on understanding how people interact with their environment. This perspective signifies that the person involved in “stabilizing” (Brunswik, 1952) a dynamic situation, must be able to attend to his/her goal and vary his/her behaviour as local circumstances change (for a formalization see Kirlik, Miller & Jagacinski, 1993).

Barker was influenced by Ashby’s (1956) conceptions of cybernetics. It is unsurprising that he argued that the components of behaviour settings are connected by a complex network “which produces a self-governing entity” (1968, p.174). Indeed, as Heft (2001) noted, Barker characterized the operations of a behaviour setting as being distributed across its participants and environment components. As Heft aptly elaborated:

“Behavior settings are time-dependent phenomena, with their boundaries established and maintained by the coming together of particular behaviour-milieu components, and they subsequently dissolved when those relations no longer obtain. The “standing pattern of behaviour and milieu” is self-generated by the dynamic interaction of these components. It is not pre-programmed in any one component of the setting, but emerges from a confluence of multiple influences. Thus, no one individual controls the operation of a setting (although individuals may differ in power to control the setting). (…) Likewise, the functional identity of behaviour settings is distributed across a network of interdependent factors.” (Heft, 2001, p. 321)

Bronfenbrenner was also influenced by the systems approach in biology, emphasizing interaction, change and stability over the lifespan (long time scales), and he explicitly acknowledged the importance of time for understanding human development (Krebs, this issue).

We started this section by mentioning the complexity of sport environments. We think that these four ecological approaches have the capacity to develop our understanding of the nature of this complexity, and this endeavour is even more straightforward with the complementary influence of dynamical systems theory. Having stated this, we would like to conclude by raising some significant issues for the study of sport as a complex system. The points we raise represent key conceptual insights originally coupled with mathematical tools (Bar-Yam, 1997).
Sport as an ecological complex system

To understand sport, multi-scale descriptions are needed. Bronfenbrenner’s bioecological model is particularly rich in this respect, and it can be a starting point to comprehend the indirect influences that constrain sport and exercise behaviour. This approach may be a means to understand, among other things, what fine scale parameters are relevant on large time scales. This idea can be exemplified with reference to outstanding performers, such as Michael Schumacher in Formula One car racing, Muhammad Ali in boxing, Pelé in football, or Michael Jordan in basketball, who have all had a broad influence on society and on general sports practice across the globe. The analysis of the behaviour setting as Kaminski presented it may be a way to theoretically guide this analysis. For example it would be useful in describing and identifying the characteristics of competitions at different organizational levels, or in describing the behavioural units of a competition. Indeed the behaviour setting is a pattern, and its formation may be formalised, as well as the formation of other more macro patterns such as the meso-, the exo-, and the macrosystems of Bronfenbrenner. This is also the case for patterns of behaviour that emerge when realizing affordances, or the personal policies captured by Brunswik’s lens model, etc. At all scales of analysis we may find the formation of patterns, and by formalizing them from a mathematical point of view we may see the influence of the different scales in a precise way.

When analysing pattern formation, an interesting point concerns how one pattern changes to a new pattern, an idea with important implications for how changes in exercise behaviours can be managed or how skill acquisition in sport occurs. Indeed it has been observed in human behaviour (Warren, 2006, van Orden et al., 2003) that small displacements (perturbations) can lead to a recovery by the system to maintain an existing pattern. But larger perturbations can lead to radical changes in system properties, giving rise to new patterns of behaviour. Dynamics on such a landscape do not simply average over time. Moreover the maintenance of a pattern within a neurobiological system is self-organized, having no executive director organizing the pattern formation. This has been clearly demonstrated in the work of several Neo-Gibsonians (e.g., Kelso, 1995, Kugler & Turvey, 1987, Warren, 2006), who formalized experimental observations of transitions in human behaviour. To understand these transitions the concept of emergence is needed. This concept is related to the dependence of the whole on its parts, the interdependence of the system components, and the specialization of parts. This idea is directly relevant to questions about how we study systems both theo-
Theoretically and experimentally. Acknowledging the inter-dependence of the whole system and its parts signifies that the latter must be studied “in vivo”. Studying the parts of a complex system in sport in isolation does not work (e.g., to study the coordination of a single rower away from the other seven members of a rowing eight crew). However, the highly integrated nature of complex systems can be probed by investigating how changes in one part affect the others (e.g., how decision making in backs affects that process in forwards in the team sport of rugby union), and by studying the behaviour of the whole (e.g., how a volleyball team is performing in a particular game). Transitions in behavioural patterns, the coordination of teams, the relationships between team mates, etc, are manifestations of emergence. This concept challenges the concept of mental representations by indicating that the solution to a situational problem in sport is not in the head of a single performer, but emerges from ongoing individual-environment interactions.

In conclusion, the articles in this special issue signal how the juxtaposition of influential theoretical insights from different ecological psychology schools of thought and dynamical systems theory promises to yield valuable new insights into the dynamic and complex relationship between processes such as cognition, perception and action in neurobiological systems (Davids et al., 2001). Because a dynamical systems interpretation of human movement behaviour criss-crosses brain/body/environment boundaries, it is important to consider, not just stored knowledge about action as a constraint on the organization of behaviour as is popular amongst sport and exercise psychologists, but also actions performed by an individual in a specific context as part of a dynamic process in the performer-environment relationship. Such an explanatory framework is ‘embodied’ and is highly suitable for modelling parameters related to both the individual performer and the environment in a uniform vocabulary and conceptual framework, thus facilitating an understanding of the complex interactions between the two. These insights signal important avenues with potential for future research in many different areas of concern to sport and exercise psychologists.

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Sport Psychology as an instance of Ecological Psychology

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While the vast majority of publications in sport psychology look inward, in this paper we look outward to examine the relationship of the athlete to her environment. We describe the theoretical foundations and methodological implications of Egon Brunswik’s “probabilistic functionalism” and contrast that with the dominant theory and method of psychological research, namely the “rule of one variable”. We explain the importance of Brunswik’s concept of “representative design” if sport psychologists want to generalize their results from their studies to the competitive environment. We then use examples from the sport of tennis to show how probabilistic functionalism and representative design can be used in studying and training athletes.

KEY WORDS: Ecological Psychology, Sport Psychology.

Introduction

In this article we employ an approach to sport psychology called “ecological psychology” that focuses not on the “inner” game but on the “outer” game. Our emphasis is on the relationship of the athlete to her environment and on an analysis of that environment. We seek to analyze the competitive environment in terms which can be counted, measured, quantified. This approach has several advantages. By focusing on the environment and the outer factors we move away from inward looking, difficult (impossible) to measure variables of sport performance, and begin to build a body of literature that can demonstrably help athletes learn more effectively and perform better in competition(*).

Examination of the relevant literature suggests that there are two prominent biases in present research; first, as suggested above there is a strong
emphasis on the “inner” game. Sport psychology overwhelmingly concerns
the inner struggles of athletes, coaches, and parents. Mental toughness,
focus, goal setting, and motivation dominate the popular and academic sport
psychology media. Athletes from all sports now employ sport psychologists
to help them cope with the mental and emotional pressures of competition.
Sport psychologists employ imagery and visualization, standardized pre-per-
formance routines, and positive self-talk, among many other tools, to
enhance players’ performances. The second bias is “theory avoidance” and
“methodological conservatism”. We find very little — almost none — exposi-
tion of the theory that guides the empirical research on the outer game and
therefore offer what we believe to be an appropriate theory and compatible
method. For theory is never absent; if it is not made explicit, it is safe to
assume it is merely implicit. That appears to be the case with sport psychol-
ogy. Making the theory explicit, of course, has the advantage of making it
subject to criticism and improvement. Explicit theory and methodology fol-
 lows.

Theoretical/Methodological background

The theory that guides us is provided by the psychologist Egon
Brunswik (1903 - 1955), whose work can be seen in The Essential Brunswik:
Beginnings, Explications, Applications (K. R. Hammond and Thomas R.
Stewart, Eds. (2001)). Brunswik departed from conventional psychology that
emulates the physics of the 19th and early 20th century and that has been
generally depicted as “stimulus -response” psychology; it is accompanied by
the methodology known as “rule of one variable” (in any experiment vary
only one factor, control all others). Brunswik replaced this physicalistic
model by a more biologically oriented model that incorporated the goal-or-
ientation and flexibility inherent in organismic models, and presented the
methodological principles of what he called the “representative design of
experiments” to replace the “rule of one variable”. He referred to the bio-
logically-oriented theory as “probabilistic functionalism” to indicate that he
would incorporate uncertainty (and thus probability in his description of
both organism and the environment) — a critical feature that we will employ
in our empirical work — and would focus on behavior oriented toward the
distal objects in the organism’s environment, rather than proximal stimula-
tion. His rejection of the “rule of one variable” as the only means of
respectable research, and his introduction of representative design made him
a pariah among the academic psychologists of his day (and even this day).
Brunswik started from the proposition that if we are to understand behavior we must examine the circumstances in which behavior takes place, and then represent those circumstances in our experiment if we are to make useful generalizations. It is that theory and that methodological proposition that has guided our work from the start. That places us within the category of “ecological psychologists” and, therefore, brings us to the study of the ecology of the behavior of tennis players and other athletes. It is the application of knowledge generated from empirical study that interests sport psychologists, and application demands generalization based on the representation of circumstances of interest. Such circumstances are often described as the “real world” but, as we shall see, use of that term merely provides verbal escape from the logical demands of the representative design of experiments.

How implicit theory and method surreptitiously guides practice

When not attempting to absorb the mysteries of the “inner” game, tennis instructors and players have been unwitting slaves of stimulus-response psychology. Tennis instruction has centered on proximal stimuli — the proper grip, the proper swing, the proper angle of the racket face as it hits the ball and the like, thus making sure that the player’s attention is focused on these highly predictable, “close -to-the body” stimuli and responses. Instruction did so because “close -to-the-body” — the skin— is where psychology began, and because psychomotor skills remain in the domain of experimental psychology which has never quite liberated itself from stimulus-response psychology. In contrast, Brunswikian theory (“probabilistic functionalism”) centers on the distal (removed from the body), features of the player’s environment (his/her location on the court, the opponents’ location), and the uncertainties (and thus probabilistic) relations among these aspects of that environment. That is a shift that is slowly but surely taking hold generally in contemporary psychology in general and sport psychology in particular.

Along with implicit stimulus-response theory came an implicit attachment to methodology that prevents generalization from research to practice, and thus prevents application. And although stimulus-response theory is slowly — because implicitly — being set aside, the attendant methodological shift associated with the shift to distal focusing has not taken hold, and without this methodological shift research efforts will suffer deficiencies that will frustrate the research effort. The attendant methodological shift entails the representative design of experiments (in contrast to the conventional “rule of
The purpose and logic of representative design remain unknown to most of academic psychology; the “rule of one variable” reigns supreme under the guise of the “analysis of variance” method. The term “representative design” refers to the demand that the independent variable(s) of the experiment represent the circumstances toward which the results are intended to apply. That demand will come as no surprise to sport psychologists— or any other applied psychologist; they encounter it as a plea for attention to the features of the “real world”. The call for representative design, however, insists on making explicit the features of the situation toward which the results of the experiment are intended to apply, and eschews the meaningless term, “real world”. Making features “explicit” means analyzing one’s theory, and denoting those features of the environment that are theory-relevant. If the study is directed toward effectiveness on the court, then the theory must specify what effectiveness consists of, and the research method—the design of experiments, or studies—must include these features in the experiment, or study. That is, the study must represent the features of theoretical interest.

The study often is behavior and othersports may offer the best opportunities for liberation from psychology’s traditional conception of experimentation, for it is in the application of psychology that the limiting features of the rule one variable becomes readily apparent. Since application demands generalization from the laboratory to the work place, it demands that the results of the experiment should generalize to the conditions outside the laboratory. And the only way that can be brought about is by constructing the laboratory conditions in which the results of an experiment are obtained to represent the conditions for which the results are intended to apply. Thus, representative design does not require that an experiment be “realistic”, or that it somehow represent “real life”, or similar meaningless slogans. Representative design requires that the researcher justify how the conditions under which the results of an experiment are obtained represent the conditions to which the results will be applied. Because that is exactly the logic that is used to justify the sampling of subjects in an experiment, Brunswik accused conventional psychological researchers of employing a double standard, namely, demanding that the subjects of an experiment be shown to represent a population through sampling procedures, but remain arbitrary with respect to the objects in an experiment. The research we report in this article will reject that double standard.

In our research the conditions under which we obtain our data will represent the conditions in which we intend to apply them. Therefore we collect data from game conditions and generalize our results to game conditions. That
means that the data we show below were collected while observing players playing (not practicing strokes) and thus justify our application of our analysis to game conditions. (The reader will find examples of the application of this method in Hammond, 1996, 2000, 2007; Hammond & Stewart, 2001).

Theory: A cognitive continuum and judgments under stress

The reader will no doubt wonder how a study of external conditions can enlighten us about the stress-inducing features of tennis. No one doubts that tennis is a game that creates demanding conditions in many dimensions; the physical ones are obvious and even when the competition is modest, the demands of the game itself — getting to the ball, hitting the ball and moving back and forth — evoke considerable rapid physical activity. And when winning and losing become a significant part of the game, emotion clearly makes its appearance; the consequence of that is what we all want to know: what is the effect of stress on the quality of the player’s game?

It is generally assumed that stress lowers the quality of performance, although it is also generally accepted that under some circumstances (usually unexplained) that stress enhances the level of a person’s play. The fact is that the effect of this poorly defined term is unknown; we don’t know exactly when stress — whatever it is — makes us play better and when it makes us play worse. The reason for that is that “stress” is both a physiological (and physical) concept, about which a fair amount is known, and a psychological concept about which little is known. In what follows we offer a psychological account that differs from the usual; it focuses mainly on cognitive activity and has been explained in Judgments Under Stress (Hammond, 2000) and applied to a variety of fields. The approach is Brunswikian, of course, and ecological in nature, and here we show how it can be applied to tennis.

A Cognitive Continuum

We begin by differentiating the concept of cognition into two major (well-known) forms, intuition and analysis. Our premise is that there is a “cognitive continuum” defined by the poles of intuitive cognitive activity and analytical cognitive activity. When the player is behaving in a largely “thoughtless” manner, she is at the intuitive pole of the continuum, and when the player is thinking hard about each element of her game — grip, position of her feet, position of her body relative to the net — she is at the ana-
lytical pole of the continuum. Of course, most of the time the player is somewhere around the middle of this continuum, depending on her experience with the game — the expert is behaving largely intuitively because her experience makes thinking unnecessary, while the novice is thinking hard because of the unfamiliarity of the situation and the effort to remember what she has been taught. Even pros occasionally give the appearance of thinking, as they carefully and patiently examine and re-examine, again and again, the strings of their rackets between points. Indeed, it is highly probable that that is exactly what they are doing, because thinking takes time, and there is very little time to think during a point, particularly a point played at pro speed. And there is the key to the effect of stress in tennis.

The stress the reader is probably thinking about is essentially a general sense of discomfort brought on by the possibility of defeat brought on by the loss of a set or match or the loss of a game or even a point. The only chance even a pro can have to think during a point is when he or she is in the back court; at the net, points are played at such speed even intermediate players will have not have time to reflect on instruction, on strategy or anything else (time between shots is roughly 500 to 800 milliseconds). Thus most of the points at the net are played intuitively. As a result, stress — feelings of discomfort — can have little effect at the net. It is reflexes that count. It is different in the back court because there is more time. Because the ball travels a greater distance and by rule must bounce, the player has much more time to think when she is in the back court. In baseline rallies, professional players generally have between 1.0 and 2.0 seconds between shots. Lesser players have even more time. With more time to think, the player will have more time to analyze the circumstances (is the opponent moving to the net, will she get there, is this the time for a lob etc?). More time also means more opportunity for the choice of a stroke, and that means of course, the chance of the wrong choice. Thinking in the back court becomes dangerous, thus threatening, and thus stressful; on the other hand, thinking almost never occurs at the net because there is no time for it, and therefore there are almost never any choices. The player does what can be done at the time. Significantly for our theory of stress, the shots that present the most psychological stress to players at the net are the slowest; incoming shots that give them the most time (e.g. lobs and floating balls).

Our conclusion therefore, is that stress is a function of cognitive activity and location on the court, not the result of some mysterious state of mind.

Does this mean that the doubles player who retreats to the back court does so in a terrible state of stressful anxiety puzzling over what shot to use and where to hit it, while her partner at the net remains in a state of calm?
tranquility, knowing that everything remains in the reflex? Obviously not. Remember that we are discussing psychological stress. There will be physical stress at the net, but not psychological stress; there will be both physical stress — trying to cover considerable ground — and psychological stress of judgment and choice under time pressure in the back court. Training for net play thus requires practice, practice, practice until shot making becomes routine, as it will, because it must. Training for back court play, on the other hand, will require the development of physical fitness to cover the court, cognitive agility in observing the position of the opponents while watching the oncoming ball, development of skill in knowing which shots will most likely be demanded of you (the deep lob, the high velocity shot at the net player, the — possibly — passing shot), and — most important — how court location will affect the probability of success for each of these choices. Instruction, therefore, will depart from analysis of proximal data (the grip on the handle of the racket) and move to distal features (the player’s court location, the opponent’s court location, wind force and direction). In short, theory matters with regard to the aims of instruction; it also matters with regard to the design of instruction.

The unrepresentative design of Tennis lessons

Typically a tennis player will approach a coach seeking to improve her tennis game. That help will most often take the form of a lesson on a particular tennis stroke – the serve, the forehand, the backhand, volleys, etc. The coach will then schedule an hour lesson with the individual. What will that hour consist of and what will be the lesson environment?

The coach will most often arrive on court with a large basket of tennis balls. The coach will ask the player what stroke is giving her trouble. The backhand is a common problem so we’ll use that example briefly. The coach will examine the player’s grip on the racquet. The coach will “feed” a few balls to the player and have the player execute the backhand. The coach will observe the motion of the backhand in an attempt to see any stoking flaws that can be corrected during the lesson, or during subsequent follow-up lessons. Perhaps the student is having trouble hitting topspin backhands and the coach observes that the player is not swinging upwardly toward the ball and therefore cannot hit the ball with the desired spin. The coach will demonstrate to the player how to make a proper swing to hit a topspin backhand. Perhaps the coach will take the player’s arm and hand and help the player move through the proper swing path.
Match Versus Lesson Environment

The lesson environment is intended to improve the players’ ability to win matches. In order to do that, the lesson environment must in some way represent, or at least resemble, the match environment. Let’s ask ourselves how well the typical lesson environment does that.

The lesson environment focuses mainly on the motor skills and the kinesthetic awareness of the path of the arm, hand and racquet on a particular stroke. It is an environment set up to be stable, certain, comfortable for the player, thus predictable, cooperative, coach driven, and to a large extent focused on a closed skill.

In contrast, the match environment is nearly the exact opposite of all those characteristics. A tennis match is unstable, tending to large swings with small changes in any number of variables. A match environment is uncertain as regards the outcome, of course, but also as regards the behavior of the opponent, the incoming balls, the results of shots, both well-hit and not well-hit. A match is rarely a comfortable environment. A player must work hard physically, mentally, and emotionally in a match. Rather than knowing what sort of shots are coming and what sort of shot a player should hit, a match is very much an unpredictable environment.

During a lesson, both the player and the coach are striving for the same goal – improved play. Therefore the environment is one of cooperation. A tennis match, by contrast and by definition, is a competitive environment. Only one player (or team) wins a tennis match.

Unlike during a lesson, the player, not the coach, drives a tennis match. The player must make all the decisions on what shot to hit and where. The player must be self-motivated. The player will not receive feedback from the coach during a match. The player in a tennis match must learn to get feedback from his or her own body and from the environment rather than from a coach as is the case during a tennis lesson.

How can this situation be improved?

A representative design of a tennis lesson includes work on all the areas mentioned above, specifically the perceptual, cognitive, emotional, and physical demands of tennis. The coach can help the student’s perceptions and judgments of incoming balls by varying the speed, height, direction, and spin of her feeds. The coach can move around the court as she hits shots to her student. This will help the student judge incoming balls and help the student
see different openings on the court depending upon where the ball is coming from. By letting the student choose the targets and the type of shot she will use, a coach helps a student learn decision-making, the principle cognitive activity during a tennis point. A coach may introduce emotional stress into the lesson environment through creative scoring methods. By putting pressure on a student in the lesson a coach can help a student perform under the pressure of a match. A coach can also enhance the motor skill of a player beyond what happens in a typical lesson. Rather than having the player hit an isolated stroke from a single location on the court, the coach can stress the dynamic aspect of tennis by moving the player around the court. The coach can insist that the recovery for the next shot be an integral part of every stroke. By moving a player around and insisting on a recovery after each hit, the coach trains dynamic balance and tactical dimensions of tennis shot-making, all while helping a player improve a particular stroke.

**Representative design of Research**

In order to demonstrate the process of introducing representative design into tennis lessons, we’ll now offer up an example. In the winter and spring of 2004 one of us (Bateman) sought to improve an adult doubles clinic by making the clinic more closely represent the match environment. One goal was to train the players on the shots and situations that the players encountered most frequently. Another goal was to introduce uncertainty into the lessons. A final goal was to train decision-making under stress.

To learn about the match environment required the collection of match data. The data gathering consisted of charting the points played by adult subjects (thirty-four intermediate club players, both male and female, ranging in age from thirty to seventy years old). The charting method consisted of noting on a piece of paper 1) how long each point lasted (by total number of hits of the ball), 2) how the point ended (by error or by winner), and 3) where on the court the person hitting the final shot was located when they struck the last shot.

Analysis of this data revealed first that the points tended to be fairly short. Less than half the points played (roughly 45%) lasted beyond the third hit of the ball. Over seventy percent of the points lasted four hits or less. Second, data analysis revealed that the total errors greatly outnumbered the winners (60% more points ended with an error than with a winner).

For the third part of the analysis the court was divided into three areas as follows. The area of the court from the net to 4.9 meters from the net was
called the Finishing Zone. From the Finishing Zone to a line 11 meters from the net was called the Transition Zone. The area from the Finishing Zone to the back fence (18 meters from the net) was called the Back Zone. Video tape was used to capture every shot played to calculate error rates and winner rates from each zone. Data analysis from the video tapes showed that these players played most of their shots (excluding serves and returns) from the Transition Zone. Players in the videos hit 210 shots from the Finishing Zone, 460 shots from the Transition Zone, and 280 shots from the Back Zone. Video analysis revealed the following error and winner rates by zone:

- Finishing Zone: 20% error rate, 32% winner rate
- Transition Zone: 22% error rate, 11% winner rate
- Back Zone: 14% error rate, 3% winner rate

From this data it was clear that striking the ball from the Back Zone and Transition Zone were relatively poor ideas while striking the ball from the Finishing Zone was a good idea. The Back Zone was a particularly bad place from which to attempt to hit a winner, but had the lowest error rate.

**Inducing improvement through representative design**

The analysis of the match environment led directly to the following design of tennis lessons. The first design priority was to set up drills that put players in situations they would face in the first four hits of the ball. Those first four hits comprised 70% of all points played. Second, was to set up drills that emphasized consistency from the back court, drills that discouraged their urges to go for winners from that court position. Third was to set up drills that emphasized offensive skills from the front of the court. Players in the front part of the court were encouraged to identify and hit into open areas of the court with the goal of ending the point with a winner. Finally, practice sessions stressed tactical awareness as it related to positioning and shot selection. Players were discouraged from choosing to advance or retreat into the Transition Zone early in points. Players were encouraged to avoid hitting shots to opponents who were in the Finishing Zone on the opposite side of the net, but encouraged to hit the ball to any opponent who ventured into the Transition Zone. A simple rule that guided decision-making from the Back Zone was simply to hit the ball cross court, thus avoiding the opponent in the Finishing Zone. This simple rule helped alleviate the stress associated with the need to make decisions under time pressure.
With these distal goals in mind, practice was interrupted to work on specific shots. Players would work on specific shots in the context in which they were most likely to use those shots. For example, players were not simply drilled on hitting angle volleys from predictable feeds in isolation from the environment where they would be used. Instead, players were instructed on where to be when attempting an angle volley, when and why to aim an angle volley, how hard to hit an angle volley depending upon the competitive situation, and then fed a representative sample of balls on which to practice. Following some specific stroke practice, players would return to match-type situations where they had respond to random incoming shots, choose among the various options, and execute the best shot. Practice would always include using the shots in competitive game situations.

Summary

No sport psychologist — nor any other applied researcher — needs to be told that generalization from her study to the area of interest is essential; that the research is largely pointless otherwise — it can’t be applied. Then why did we take several pages to do just that? Because that topic — the logic of the generalization process — is rarely if ever examined. And as a result, applied psychologists must avoid the topic, or resort to merely asserting that their experiment, or study, resembles — or better — represents, the “real world” — or better, the area of interest. But proof of the representativeness of the study is apt to be absent for the reason that it never occurs to anyone to provide the necessary logical or empirical justification for it. Standard statistical procedures such as “rule of one variable” or analysis of variance and its many varieties of orthogonal arrangements are all silent on this question.

If these procedures and platitudes about the “real world” do not offer us guidance, where will guidance come from? Brunswik’s many treatises have offered it for over 50 years, thus; (1) our theory of behavior will tell us which variables to examine, (2) our study of the environment will inform us about the presence of these, and (3) if we have arranged our experiment so that the independent variables represent the environment toward which our results are intended to apply, we will have achieved our goal of generalization. Otherwise our goal will not be achieved, and our results will stand only until someone varies the experimental arrangement slightly, and then down will come the generalizability of the results, just what an applied psychologist does not want. The history of psychology is replete with examples.

The studies reported here are limited to tennis, but the procedure out-
lined above is general. The reader who is unacquainted with the representative design of research should find these studies instructive.

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Sport in the perspective of Barkerian Psychological ecology

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The first part of this paper gives an overview of (Barkerian) psychological ecology, its origin, its classical research tradition, and its further developments up to the present. Roger G. Barker aspired to complement (mainly) experimental psychology by establishing a psychological ecology modeled on biological ecology. In a field station (1947-1972) his research group applied two essentially different approaches of “naturalistic” methodology aimed at describing and analysing people’s everyday behaviour in a small rural town. – How could this research perspective and tradition be relevant to sport psychology? The second part of the paper tries to answer these questions, primarily by attempting to locate Barkerian psychological ecology within the network of sport sciences. Reflecting on one of sport psychology’s major tasks (producing “if-then-knowledge” aimed at improving sport performance) reveals that psychological ecology’s relevance has a fundamentally different emphasis. The analysis of various examples demonstrates how this peculiar kind of relevance can be utilised.

KEY WORDS: Behaviour setting, Ecological representativeness, Ecological validity, Psychological.

Why Psychological Ecology?

In 1947, the US-American psychologist Roger G. Barker founded, together with his colleague Herbert F. Wright, a research Field Station in Oskaloosa, Kansas (alias “Midwest”) which operated for 25 years (Barker and associates, 1978). He complained that psychology lacked a broad descriptive basis, as other disciplines like astronomy, chemistry, geology, biology had developed almost before beginning systematic detailed analysis through experimental research (Barker, 1968). Psychology, in contrast, had confined itself widely to research methods in which the investigators co-determine their results by their interventions through shaping and control-

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ling part of the situations and the processes to be analysed (e. g., in experiments, tests, interviews). Hence, Barker aspired to establishing a psychological ecology, arguing that it should, in principle, be modeled on biological ecology where the natural behaviour of organisms is observed and described within their natural habitats (e. g. gorillas’ social interactions as they happen in their wildlife habitat without any interventions of researchers). The term “natural”, then, has a primarily methodological meaning, contrasting with circumstances and behaviour that are arranged and provoked by the researcher in experiments. Such kind of “naturalistic” observations and descriptions lay the foundations of taxonomising activities and surrounding conditions. Thus, in analogy to biological ecology, Barker defined psychological ecology’s mission as observing, describing, taxonomising, and analysing people’s everyday behaviour within their everyday surroundings. What, exactly, should be understood here as people’s everyday behaviour and surroundings will become evident through the operationalisations described in the following sections.

How to describe and to analyse everyday behaviour psychologically?

Human everyday life encompasses a great many of varieties, many different types of environments, different sorts and compounds of people, different variants of activities. Moreover, most of what happens in everyday life appears as highly complex. So, Barker had to make a choice where to begin. He opted for a small rural town inhabited by about 700 people (Oskaloosa) where he focused his explorative ecological investigations primarily on the children of this community.

The Stream of Behaviour

The first concrete aim of the Barkerian research group was simply to find out what was really happening in a typical child’s everyday life from morning to evening. Once this information had been gathered it became possible to examine, e. g., how often particular sorts of situations and activities occurred (e.g., being frustrated; taking the initiative; being praised by an adult), under which conditions they happened etc.

To gain this kind of information, single children (mainly schoolchildren), out of a reasonably representative sample (n = 16), were continuously accompanied from getting up in the morning until going to sleep in the
evening by a team of six observers, one at any time, rotating every half hour. The observers had to watch the child’s activity and to describe it as minutely as possible, along with its surrounding conditions, in terms of everyday language (“specimen records”; cf. Barker & Wright, 1951, 1955). They had to focus on perceivable behaviour and avoid interpretations as far as possible.

Now, the child’s “stream of behaviour” recorded through a whole day is segmented into fundamental (theoretical) units called “episodes” that can be characterised as (goal directed) molar actions (“getting inside”; “taking off wraps”; “putting wraps away”; Wright, 1967, 70f.). Accordingly, we rather should speak of a “stream of actions” or, still better, of a “stream of transactions” (Altman & Rogoff, 1987) since the stream of actions is always viewed as embedded in a concrete stream of contextual conditions. The realisation of an episode appears to be organised in a more or less complicated hierarchy of subordinated actions (or transactions). Besides, two or even more episodes may be executed more or less in parallel, may overlap in time (Wright, 1967, 86ff.). The observational method does not yield introspective data representing cognitive and emotional processes. Thus, motivational and regulatory processes could, in principle, only be inferred through plausible interpretations of perceivable behaviour. Concerning the theoretical articulation of these internal processes, the Barkerians drew on Lewinian Topological Psychology (Lewin, 1938) with its central concept of life space, now called “psychological habitat” (Wright et al., 1950).

This first thematic, methodological, and theoretical approach within Barkerian psychological ecology has been termed “ecological psychology” (Barker and associates, 1978) although sometimes this term is also used for the undertaking in its entirety (Barker, 1968).

THE BEHAVIOUR SETTING

Evidently, merely a very small section of a community’s everyday life can be captured by specimen records. Hence, this approach could just be a beginning. Yet, while accumulating and analysing specimen records the investigators became aware that different children’s streams of behaviour strongly resembled each other during particular phases, e.g., while they participated in a school lesson or in a church service. So, it would almost suffice to observe merely one child from the school class during the school lesson in order to gain at least a stream of behaviour-period typical for transactions in school lessons. Why was this possible? Because all the children are used to behaving, roughly seen, much alike during a school lesson. We could say, a
school lesson is a concrete system of interactive social activities which is characterised by recurring sequences of school lesson-typical transactions. The Barkerians used the term “standing patterns of behaviour”. So, if we, e. g., pass by a schoolyard we would have no difficulties to identify what’s happening there as a “gym lesson”. We would, in this situation, ignore details, abstain from what we know about variabilities of gym lessons, and capture merely the most typical features.

Suprainsividual systems of this characteristic were termed “behaviour settings” (Barker, 1968). To be somewhat more precise, in the case of the school example, a behaviour setting encompasses all concrete school lessons of a particular class, e. g., in physical education, over a whole school year (which implies participating in sport), while each single school lesson is understood as one “occurrence” of the behaviour setting, as a particular realisation of it. Thus, a behaviour setting may have more or less numerous occurrences. Further examples of behaviour settings besides a school lesson and church service are: a birthday party; a family dinner; a baker’s shop; a court hearing; a baseball game (Barker, 1968, 166ff.).

This second approach of the Barkerian psychological ecology aims at describing, analysing, and taxonomising everyday life of a whole exemplary local community in terms of behaviour settings. The chief defining characteristic of a behaviour setting are,

- Typical standing patterns of behaviour (see above)
- A concrete spatiotemporal milieu within which they can be encountered (in the example, this concrete schoolyard and the time between the beginning and end of this gym lesson on this concrete day).
- A configurational fit between behaviour and milieu, called “synomorphy”-relation. (In the example, the students’ and the teacher’s transactions appear, in principle, adapted to the spatial, material, and semiotic qualities of the schoolyard environment and, on the other hand, the schoolyard and the equipment used in the gym lesson appear apt to meet the transactions to be carried out there).
- The milieu being “circumjacent” in relation to the behaviour (in the example, the transactions of the gym lesson are, in a topological view, surrounded by the milieu, i. e., by the schoolyard).

With this basic definition in mind the research group tried to locate and to identify all publicly accessible behaviour settings occurring in Midwest during a whole year.

While shifting their focus from the specimen record methodology to the behaviour setting approach, the researchers coarsened their view on everyday transactions. They contented themselves with identifying, describing,
and categorising typical transactional patterns. Therefore, they abandoned observing the stream of transactions within behaviour settings in detail. Instead, they merely traced the existence of behaviour settings by scrutinising pertinent announcements in the local newspaper and on posters, announcements of local authorities, school timetables, flyers disseminated within the community etc., and described most of them on the basis of participant observation, since most of the researchers were inhabitants of Midwest.

The immense variety of the behaviour settings identified demanded developing a set of descriptors apt to characterise all of them systematically. Only the most specifically relevant descriptors can be mentioned here (cf. Barker, 1968),

- **Population.** Number and composition of the participants.
- **Penetration.** Allocation of power and rights within the behaviour setting, the highest of six degrees ("zones") of responsibility to which a participant can "penetrate" being "single leadership". (In the gym lesson example, the teacher is, as a "single leader" ["zone" 6], solely responsible for the execution of the behaviour setting program. Two teachers sharing the responsibility are "joint leaders" ["zone" 5]. The students are "active functionaries" [4] while we, as passers-by, are "onlookers" [1]).
- **Action patterns.** (Eleven) categories of motivational orientation of the transactions practiced within a behaviour setting (e.g., business, nutrition, personal appearance, physical health, recreation, religion, social contact).
- **Behaviour mechanisms.** (Five) types of activity components (affective behaviour, gross motor activity, manipulation, talking, thinking).
- **Temporal locus.** Date and time of a behaviour setting’s and its occurrences’ begin and ending.
- **Milieu.** The concrete conditions which surround the behaviour setting’s happenings. (In our example, the schoolyard with all its equipment involved in the gym lesson)
- **Behaviour objects.** The equipment which is involved in the behaviour setting’s operation.
- **Pressure.** Degree of being obliged or being permitted (or even not) to participate.
- **Local autonomy.** Degree to which a behaviour setting is autonomous in coming to important own decisions.

Barker demonstrates the description of behaviour settings in the most minute details by two examples, one of them, remarkably, again being taken from the world of sport, a basketball game (1968, p. 94ff.) In this case, the behaviour setting “programme” corresponds to the Basketball rules. Major
components of the “milieu” are, high school gymnasium, playing court, seats for spectators. Examples of “behaviour objects” are, basketballs, goal baskets, referee’s whistle etc. Holders of “penetration zones” are, e. g., coaches (zone 5), referees (4), scorers (4), timer (4), players (4), cheerleaders (4), spectators (2).

Barker proposed also a theoretical framework, conceptualised in formal accord with the TOTE-model (Miller, Galanter, & Pribram, 1960). It aims at explaining the functioning of a behaviour setting as a dynamic interactive system (Barker, 1968). Hence, a behaviour setting is understood as a self-regulating, homeostatic, quasi-stationary system whose dynamic is determined and kept in balance essentially by three primary directing and regulating components, (a) its specific “program” whose execution usually being enforced by “leaders”; (b) particular intentions and goals pursued by the participating individuals (possibly being more or less in conflict with the program); (c) “maintenance operations” safeguarding the regular course of the behaviour setting’s functioning.

A behaviour setting may happen to get into a special kind of anomalous state inasmuch as it is operated by fewer inhabitants than would be needed for its regular working condition, i. e., it may be “undermanned” (later on revised to “understaffed”, or “underpopulated”). This type of condition appeared to Barker important enough to conceptualise its internal dynamic in a particular specification of the behaviour setting theory (“undermanning theory”; Barker, 1968; Barker & Gump, 1964). This theoretical specification has been introduced and illustrated with an example, again, from sport, “a baseball game played by eight-man teams on a regulation nine-man field according to the official rules” (Barker, 1968, p. 166f.). Presupposing the behaviour setting’s “constancy”, Barker predicts for undermanning conditions that the inhabitants “(a) are more active within the settings and (b) in a greater variety of actions”. Besides, he offers hypotheses on how these effects are mediated through the inhabitants’ cognitive-emotional functioning. Thus, the individual participants are supposed to have more or less limited latitude to modify the behaviour setting. How more extensive changes come about or can be brought about was described later, e. g., by Wicker (1979b) and by Stokols and Shumaker (1981) (see below, “the life cycle of behaviour settings”).

How these fundamental concepts of Barkerian psychological ecology may become specifically relevant to sport psychology will be made evident later in this paper using a couple of illustrating examples.
Barkerian Psychological Ecology Beyond the Behaviour Setting

Barker was aware that human everyday life may appear organised in still other functional units. Thus, he tried to reconstruct different higher order systems in terms of the basic unit behaviour setting.

A “multiple setting” (or “multi-setting synomorph”) is a special kind of higher-order system within a community. It encompasses more or less numerous behaviour settings that operate rather independently from each other, yet in loose coordination (e. g., a school encompassing lots of school lesson behaviour settings; or a fair; or a mall with more or less numerous shop behaviour settings).

An “authority system” is a hierarchical framework of behaviour settings wherein the superordinate ones are authorised to control, at least in part, the subordinate ones. Thus, the conference of the teaching staff, as a behaviour setting, is authorised to decide on regulations that are binding on all school lesson behaviour settings. Yet, all the teachers’ conferences are subordinate to pertinent behaviour settings of the supervisory school authority. Authority systems can be “grouped into five classes” (Barker, 1968, p. 90), (a) Business, (b) Churches, (c) Government, (d) Schools, (e) Voluntary associations (as, e. g., sports clubs).

A behaviour setting “genotype” can be understood as a conceptual superstructure (Barker, 1968, p. 80ff.). The most concrete realisation of a behaviour setting is a particular “occurrence”. While some behaviour settings consist merely of one unique occurrence (e. g., a particular chamber concert, or a particular friendly soccer match) others encompass more or less numerous occurrences (e. g., a weekly farmer’s market in Midwest; the training of a particular hockey team preparing for a particular competition; the almost daily operating of a particular baker’s shop or of a particular medical practice). Every behaviour setting is, in principle, a unique entity. Nevertheless, different behaviour settings may be more or less alike. The medical practice of internist A and that of internist B have very much in common. Thus, both are examples of the behaviour setting genotype “internist medical practice”. The most essential constituent of behaviour settings’ similarity is congruence in their programs, i. e., in the procedural structures that determine and regulate the course of all their activities (cf. Gump, 1987). The more behaviour settings’ programs accord, all the more they can be assigned to one genotype. However, behaviour setting genotypes can be constituted on different levels of increasing abstractness. All medical practices have a lot in common compared, e. g., with all lawyers’ offices. “Medical practice” can be viewed as a higher-order behaviour setting genotype. Or, the behaviour setting genotypes
“table-tennis match” and “lawn-tennis match” may be merged into a higher-order genotype which, then, could be opposed, e.g., to “boxing match” as a higher-order behaviour setting genotype. – Barker chose this “genotype” metaphor explicitly with regard to genetic conceptions (“coded programs in nuclei” vs. “coded programs” stored in the leaders of a behaviour setting). However, the illustrating examples make evident that the content of the metaphor complies with the standard of genetic knowledge at his time.

**Further Expansions by Other Researchers**

The traditional Barkerian approach has been kept alive and further expanded by scholars of rather different provenance, and there is no end in sight.

**Psychologising the Behaviour Setting**

Changing the research focus from the stream of behaviour to the behaviour setting entailed somewhat like a growing alienation from traditional psychology, as has been criticised many a time. But the stream of behaviour-approach itself had a certain share therein as well, since it concentrated, by its observational methodology, solely on the view from the outside. So, it missed liaising consequently enough with the growing trend towards cognitivism in traditional psychology.


**The Life Cycle of Behaviour Settings**

To understand the behaviour setting as a self-preserving, homeostatic system (Barker, 1968) appears plausible if one looks primarily on what happens
between beginning and end of a behaviour setting’s concrete occurrences. However, if one surveys sequences of occurrences it becomes evident that more or less extensive changes may come about. Following this lead, further results in inquiring into the whole history of a behaviour setting, its genesis and its “life cycle” (Stokols & Shumaker, 1981; Wicker, 1987, Wicker & King, 1988).

**PERSONOLOGICAL ASPECTS OF PSYCHOLOGICAL ECOLOGY**

The behaviour setting operates as a supraindividual system. The individual inhabitants conform, in principle, to its structural organisation and to its program. Behaviour settings exert “coerciveness” upon the participants (Barker, 1968, p. 29). Yet, they also grant participants more or less latitude in pursuing *individual goals* within their framework. Thus, frictions and conflicts can arise from this rather complicated dynamic relationship between participant and system. However, Barker did not yet view the *individual participant* in his/her wholeness, outlasting countless participations, making up a specific type of *systemic unit* with a *long-term permanence* and identity, and as such pursuing more or less long-term “personal projects” (Little, 1983), thereby making use of diverse behaviour settings. Followers began expanding their involvement towards an ecological personology (Bechtel, 1984; Fuhrer, 2004; Gump, 1984; Kaminski, 1992; Wicker, 1987, 2002, Wicker & August, 1999).

**SYSTEMS OF INTERPERSONAL RELATIONSHIPS, AND LOOSELY ORGANISED SUPRAINDIVIDUAL SYSTEMS**

Barker obviously concentrated too exclusively on the behaviour setting concept thereby undervaluing the specificity of social systems that superimpose, overlap, and outlast behaviour settings and thus may also exist and operate without being specifically embedded in specific surrounding conditions, as, e. g., friendship, team, crew, sports club (cf. Cranach et al., 1986; Forgas, 1979; Fuhrer, 1993, 2004; Georgiou et al., 1996; Gump, 1969, 1987; Kaminski, 1988, 1989, 1992; McGrath, 1984; Rapp, 1997; Wicker, 1987, Wicker & August, 1999).

Furthermore, while Barker granted behaviour settings such an outstanding importance he neglected widely the interspace regions between them (comparable with a cosmologist paying attention merely to luminous celestial bodies and ignoring the existence of interstellar dark matter). Thus, the behaviour setting approach needs to be complemented by taking into
account also less structured systems like a bunch of people waiting at a bus stop or crossing a lane at a pedestrian light (Rapp, 1997), or a crowd of spectators flocking to a stadium.

**Utilisation of Barkerian Psychological Ecology in Psychological Subdisciplines and Beyond Psychology**

The Barkerian approach has been employed with regard to numerous segments of societal life: Community as a socio-physical system, the education system, in particular the school system, welfare services, health care, administration, economy and working life, science as an institution, architecture and urban planning, leisure and tourism, sport, ontogenetic development and socialisation, variants of problematic behaviour (cf., e.g., Barker & Gump, 1964; Barker & Schoggen, 1973; Fuhrer, 2004; Georgiou et al., 1996; Gump, 1987; Kaminski, 1983, 1986b, 1989, 1994, 2000; Perkins & Baker, 1991; Schoggen, 1989; Wicker, 2002; Willems, 1976). Accordingly, a remarkable diversity of disciplines inside and also outside of psychology is involved.

**Sport and Psychological Ecology**

Whatever is usually called “sport” is an integral part of human everyday life. Since Barkerian psychological ecology is explicitly geared to analyse human everyday life in all kinds of manifestations, it therefore should, in principle, be optimally predestined to help exploring the world of sport.

**Sport as Everyday Life Reality in the Perspective of Various Sciences**

The ambiguity of the word “sport” becomes evident if we compare the various meanings it adopts within different sciences. *Social sciences* like sociology, political science, cultural anthropology, economics tend to define “sport” primarily as a sociocultural institution. *Medical science* may understand “sport” as a specific, although multifaceted kind of operational demand on the human organism. *Biomechanics* will view it as dynamic constellations of masses being more or less in motion. However, all would certainly presuppose that basically “sport” has to be understood as a particular type of *human activity* exerted, either collectively or individually, according to specific systems of rules. This corresponds well to how a (sport) psycholo-
gist would define “sport”. (S)he would probably explicate it somewhat further as sequences of more or less complex goal-oriented (trans)actions relying on specific somatic resources, performed in rule-guided interrelatedness with specifically shaped spatio-material surrounding conditions, and availing themselves of specific material equipment and sportswear.

Such kind of happenings are superimposed and co-determined by different contextual systems. One type of context systems is specific superordinate conditions being immediately and concurrently effective, like a particular workout session or a particular championship. Other contextual systems exert varied kind of influence, so to say, out of the backstage, a sport club, a sport federation, a community, the government of a country, mass media, the industry of sport goods etc. All these last-mentioned systems are, as such, primary research objects of different scientific disciplines. Even so, they are not out of (sport) psychology’s interest and responsibility since they are cognitively represented in individuals’ mind, and from there the representations exert influence on people’s thinking and acting. Thus, it depends on the “image” of a sport club or on the “attitude” towards it whether people are willing to join it or to sponsor it.

Barkerian Psychological Ecology within the Network of Sport Sciences

Although Barkerian psychological ecology aspires, in principle, to deal with human everyday life in its entirety it nevertheless intends to maintain always its psychological characteristic. This means that it draws on conceptualisations and makes use of empirical data that are typical of psychology. It follows that psychological ecology, in principle, concentrates on such manifestations of “sport” that have certain affinity with psychological perspectives. Therefore, it does not compete with traditional sport sciences, it rather complements them.

Undoubtedly, the most specific potential of Barkerian psychological ecology is the behaviour setting concept. Wherever it is discussed in interdisciplinary discourse it is characterised as an “interface”, as a “common meeting ground”, as exerting “mediating functions”, as “bridging a gap” (cf., e.g., Fuhrer, 1990b; Kaminski, 2006; Smith, 1974). Social sciences appreciate the behaviour setting’s capability to connect supraindividual conceptualisations with individual-based ones. Furthermore, it appears suitable for bridging the gap between sciences that specialise in analysing the spatio-material world and those concentrating on sociobehavioural reality. This conciliation is rendered possible by the transactional character of the Barkerian
approaches (cf. Altman & Rogoff, 1987) and facilitated in particular by the synomorphy concept (see above).

The first-mentioned mediating potential of the behaviour setting concept arises from its focusing on that particular type of context system whose specific conditions are immediately, continuously, and holistically effective within a concrete spatio-temporal frame, like a particular school lesson, a particular court hearing, a particular church service, etc. The range of these specific conditions, i.e., the boundaries of this particular type of context system, are defined through a dynamic gradient (Barker, 1968, pp. 22, 40ff.): Happenings within these boundaries appear rather densely interconnected (relatively high degree of “interdependence”) whereas the functional interconnections between this focus of happenings and its surroundings decrease with increasing distance, as evidenced by the three examples just mentioned.

- On the one hand, such kind of happening systems can be understood as manifestations of superordinate sociocultural structures. On the other hand, they are related to the individual participants in that they co-determine powerfully their concrete thinking and acting within this spatio-temporal frame. Interestingly enough, this type of context system is widespread just in the world of sport. This is due to the fact that sport is, generally and in its essence, a more or less strictly regulated activity, and the specific rules of the particular sports can be viewed as the core of the corresponding behaviour setting “programs” (cf. Barker, 1968, p. 166ff.).

Relevance of the Barkerian Approaches to Sport Sciences, especially to Sport Psychology

A scientific approach is relevant to other disciplines if it is suitable for supporting their knowledge production. The production of scientific knowledge encompasses different subtasks and subgoals. Hence, a particular novel approach may be relevant to different subtasks in different degrees.

Sport Psychology’s Focus of Interest

Sport psychology is often supposed to assist all kinds of efforts to improve any sort of sport through the application of psychological knowledge. What, then, has to be accomplished is, in principle, to optimise or to maximise specific states (achievement, health status, wellness, pleasure, public admiration, etc.) or processes. Sport psychology should help to find out under which conditions these goals can be attained. So, it has to produce
useful, well-founded “if-then-knowledge“. How does this production happen?

Let’s consider the typical case. At the outset, a problem arises somewhere, e.g., how could a teacher motivate teenagers to school sport? How could a tennis player anticipate the direction of his/her opponent’s next stroke? What kind of physical activity contributes most to elderly people’s wellbeing? Does flow experience enhance a marathon runner’s performance? In each example, the sport psychologist would design an empirical investigation aimed at generating (correlational or causal) “if-then-knowledge” suitable to answer those more or less specific questions through providing more or less safe predictions. (S)he either establishes specific (experimental) conditions under which the respective interrelations in question can show up, or (s)he selects pertinent (quasi-experimental) conditions and data from representative happenings in ordinary reality.

Now, to what extent can Barkerian psychological ecology assist sport psychology through contributing to its stock of such kind of knowledge? The answer is, perhaps surprisingly, rather little, indeed. Within the Barkerian research tradition, the production of customary if-then-knowledge has almost exclusively concentrated on the staffing (“manning”) problem. What kind of consequences can be predicted if a behaviour setting is not adequately “staffed” (“populated”), either understaffed (undermanned, underpopulated), or overstaffed (overmanned, overpopulated; cf. Perkins, 1982; Wicker, 1979a, b; Schoggen, 1989)? Barker himself, when introducing this problem, chose an example from team sport (baseball), as mentioned before. However, the repercussions of understaffing which he derived and predicted intuitively have been tested (and widely confirmed) empirically mainly within school settings (e.g., Barker & Gump, 1964) and not in sport settings. So, it remains open to which extent and in what way the results could be generalised to behaviour settings in the world of sports.

Why, then, has Barkerian psychological ecology such a poor share in supporting sport psychology in its primary task? Why and in which way should it nonetheless be relevant to sport psychology?

THE PECULIARITY OF PSYCHOLOGICAL ECOLoGY’S RELEVANCE

The peculiar mission of (Barkerian) psychological ecology consists in reminding tirelessly and constructively of human everyday life in all its naturalness, “completeness”, and complexity (cf. Kamiński, 1989). It aspires to be a critical corrective and a complement to customary modes of knowledge produc-
tion in psychology with their more or less inevitable specificity and selectivity (cf. McGrath, 1981). By specificity is meant here that any investigation includes merely a small subset of the entire qualitative diversity which the corresponding underlying reality comprises. Likewise, selectivity means here that from a corresponding underlying reality — viewed under quantitative aspects as a “universe” — merely few sampled subunits can enter an investigation. Psychological ecology, then, intends calling attention to selectivity in mainstream research methodologies, aims at making it transparent and reflecting on its risks (Willems, 1965). Psychological ecology raises questions like these: What is the background or the counterpart of specificity in (sport) psychological research? What is the proper, more general object of research in relation to which “specificity” and “selectivity” get their meaning? In which respects is a particular research paradigm or approach “specific” and “selective”? What kinds of risks do specificity and selectivity imply?

Usually, researchers try to avoid risks and disadvantages of specificity and selectivity by taking into consideration (implicitly or even explicitly) what we might call “ecological representativeness” and “ecological validity”. As concerns the first criterion, the researcher may, in furnishing an experimental setting (i.e., the “if”-components in the design), aspire to construct it in as many features as possible akin to the “real” conditions (s)he wants to “simulate” (e.g., presenting, in a lab, handball-video sequences to which the subject has to respond that resemble, i.e., “represent”, as much as possible typical “situations” in a real handball game). As concerns the second criterion, the researcher may try to provide for getting results (accruing from realising the “then”-components, i.e., the participant’s kind of responding) that are as “ecologically valid” as possible in that they can be generalised to responding in “real” handball games. Yet, what, exactly, does “ecological” mean in this context? How does the researcher interpret these standards and how does (s)he proceed in trying to approximate them in his/her design?

(Barkerian) psychological ecology can be viewed as intending to provide a systematic empirical and theoretical basis for answering that kind of questions so that they no longer have to be answered merely by virtue of intuition. However, if it claims to remind of the “proper” reality of human everyday life, emphasising its “naturalness”, psychological ecology has to realise that this reality is not seizable in its totality all at once, as we can learn from subjective experience. It seems as if human beings apply diverse “natural” strategies in order to capture and to handle this overwhelming complexity cognitively by decomposing it into diverse “compartments”. Consequently, psychological ecology has to adapt to these strategies and to incorporate their (cognitive) results which we could also call formats of viewing everyday real-
ity or partial perspectives. Thus, we can focus, e. g., on persons as potential or actual originators of special kinds of happenings. Or we can differentiate between the domain of activities and that of its surrounding conditions. Or we can pay attention to diverse temporal aspects of happenings, etc. Within these fundamental categorical domains (“persons”, “activities”, “surrounding conditions”, “temporal aspects”), psychological ecology tries to identify and to define respective “natural” entities which, then, allow constituting specific fields of ecological exploration.

This procedure needs a comment. Let’s further elaborate on the example mentioned in the beginning. Barker and Wright (1951) chose from the persons domain “one child”; from the activities domain “all kind of activities that can be watched by an observer”; from the surrounding conditions domain “all kind of surrounding conditions that can be observed in direct relation to the person’s activities”; from the temporal aspects domain “the duration of an ordinary day”. Thus, Barker and Wright constituted a special field of ecological exploration.

It belongs to the most essential peculiarities of psychological ecology that it always aspires to keep in view, as far as possible, the entirety of the respective “field” that has been defined as a target for ecological exploration. This means, in case of “one boy’s day” (and the other specimen records), that the single children’s daily activities had to be observed continously, without any gap. This fundamental pursuit of completeness and also the emphasis on a holistic view upon the natural functioning of systems in everyday life are strategic orientations characteristic of other operational tasks and procedures in psychological ecology as well. Thus, amongst others, this kind of basic strategic orientation implies also considering and analysing systematically the interrelations between the diverse “fields of ecological exploration” that have been constituted with respect to connectability and conceptual consistency — e. g., between the “stream of behaviour” approach and the “behaviour setting” approach within the Barkerian tradition, but also between these Barkerian ecological “fields” and those that have been constituted, e. g., by U. Bronfenbrenner and by J. J. Gibson (cf. Kaminski, 1989).

A field of exploration can be cognitively articulated on different conceptual levels. Let’s again take “one boy’s day” as an example. (a) The stream of transactions that has been observed can, on a first level, be described in terms of everyday language. – (b) On a second level, it can be interpreted as a sequence of basic transactional units, called “episodes” (or “actions”) and, in its entirety, be segmented accordingly. – (c) On a third level, the same stream of transactions can be further differentiated conceptually by partitioning it into hierarchically subordinate units. – (d) On a fourth level, we could still
further differentiate this stream of transactions conceptually (and also within exacting observation) by noticing that several transactional units are processed more or less simultaneously ("multiple acting"; cf. Wright, 1967; Kaminski, 1982; Fuhrer, 1984). – (e) On a fifth level, this stream of transactions can be conceptualised in a still more complicated way by virtue of a (trans)action model or theory in which we would hypothesise that the units of the observable transactional activity and their well-organised succession must be cognitive-emotionally prepared, concurrently regulated, and evaluated (Kaminski, 1982; Fuhrer, 1985; Wicker, 1992). On this theoretical level, we would try to make understandable the integrated functioning of transactional activity. – These five levels should be taken merely as exemplary manifestations of a rather general and flexible strategic principle which allows for wide variations in choosing the granularity of conceptualisations.

Description and conceptualisation on all these levels require the application of methods apt to provide the appropriate kind of data and methods yielding an adequate evaluation of these (primarily qualitative) data.

(Barkerian) psychological ecology makes use of yet another fundamental strategy of articulating the entirety of a "field of exploration" through taxonomising (and subtaxonomising) the field’s components in their complete range of variation. To take again "one boy’s day" as an example. The surrounding conditions which the child encounters during the course of a day may be partitioned in those including human beings ("social situations") and those without the presence of other humans. The former category may be (roughly) differentiated in those including adults and those without adults. The situations with adults may be completely subpartitioned according to the degree of latitude they grant the child for own decisions, etc. – Or, the universe of the child’s activities may be subdivided with respect to kinds of motivations supposedly satisfied.

How could all these peculiarities yield something like relevance to psychology in general and to sport psychology in particular? A sequence of some rather abstract answers may prepare for some more detailed explications and exemplifications in the concluding next paragraph.

- The (sport) psychologist may profit from psychological ecology through embedding a specific problem cognitively and conceptually in a wider ecological context. This could be rendered possible either by adopting descriptive and conceptual conventions and findings from psychological ecology’s tradition or by generating a particular ecological framework of one’s own, making use of the heuristic strategies developed especially in the Barkerian tradition (and thus contributing to psychological ecology’s further development). This kind of contextualisation could yield benefit in many ways.
Thus, the (sport) psychologist may be encouraged to consider a wider range of possibly effective variables and interrelations and hence accomplish a more “realistic” design of investigations avoiding detours and other inefficiencies in the research process.

The descriptive and conceptual ecological framework may mediate connections to other approaches whose assets could be utilised.

The ecological perspective may suggest scaling up the granularity in articulating a prospective object of research. This may lead to a further differentiation and specification of a problem and to disambiguating so far vague and ambiguous concepts. To exemplify, a tennis player giving an account of a match finished some hours before may state that he had been somewhat “demotivated” in a certain phase. This may appear as a rather coarse-grained view and rather vague and ambiguous description of what had happened “in reality”. Looking at a video playback of this phase he may recollect many details so that he can switch over to a much more fine-grained view and description. – This example should allow anticipating that the ecological perspective may also help transforming correlational designs and interpretations into more meaningful and productive causal approaches.

The ecological perspective may inspire the (sport) psychologist to greater flexibility in conceiving research strategies and designs, particularly in the choice and the application of data generating methods. It may also suggest extended analysis of data that have been gathered under more restrictive premises. - In a somewhat more specific view, the (sport) psychologist should, while developing and practicing a concrete research methodology, try to follow the principle, abandoning “naturalness” as late as possible (or saving it as long as possible). In other words, the application of methodologies that make use of any kind of simulation within experimental settings should, in principle, be prepared through the application of naturalistic methodologies. - That means, attempting first to exhaust all data sources that yield pertinent information without intervening in the natural functioning of the research object. This relates — in particular with respect to many sorts of typical sport activities — to observational methods and questioning methods that avoid, as far as possible, “distorting” the cognitions which the subjects are operating upon in their “usual”, “natural” mode of functioning (e. g., inviting spontaneous reports first before asking rather general, open questions and finally more and more specific ones). – In a next level, the questioning would be practiced spatio-temporally as close as possible to the natural functioning of the research object (cf. Ericsson & Simon, 1993), immediately after a pertinent transaction’s ending. – Furthermore, the moment of reporting could be brought forward into the transactional processes by asking for “thinking aloud” — if suit-
able — or by interrupting the transactional processes at any unexpected point and calling for immediate account (cf. Fuhrer, 1985). — In a next step, even stronger interventions could be introduced in the shape of systematic variations under relatively “natural” conditions (kind of field experiments). — What follows, finally, are customary formats of experimental research, quasi as a last resort, in order to produce kinds of knowledge that ecological methodologies would not be appropriate to contribute.

- Thus, the ecological perspective may sensitise (sport) psychologists to perceiving problematic “artifacts” in the design of their investigations and in the evaluation of their data (cf. Willems, 1965).

- It may help detecting and avoiding unjustified generalisations in the interpretation of empirical results, but also to discover reasonable possibilities for generalisation and application in danger to be overlooked (cf. Willems, 1965).

- It may facilitate paying attention to hitherto unnoticed interesting phenomena and problems and assist conceiving the direction of further research.

- The fundamental orientation of psychological ecology ensures not to lose sight of the heuristic maxim that it is lastly the (formidably complex and rapid) integrated “natural” functioning of human transactions and cooperations that have to be analysed and understood.

**HOW TO UTILISE ECOLOGICAL PSYCHOLOGY’S PARTICULAR KIND OF RELEVANCE. FURTHER EXAMPLES**

Analysing at least a few further problems more or less typical of sport psychology’s commitment may help clarifying the usability of ecological perspectives and strategies.

**Easing beginner skier’s trouble**

**Problem:** While participating in a (first) skiing course beginner skiers notoriously appear rather anxiously tense in their posture and their motor activities. They fall down frequently while executing the exercises. — How could this nuisance be remedied?

An empirical investigation would then aim at a better understanding of how those difficulties come about so that the evidence obtained allows a helpful revision of the skiing course (cf. Kaminski, 1982).

How could the “field of exploration” be defined in this case? Which components should be included in the definition? From which domains
should these components be recruited? – Our interest is primarily focused on the problematic transactions of the beginner skiers. So, they would take the centre of the “field”. For finding out which other components should be included at least two different strategies appear feasible. (a) We could ask people having pertinent experience (skiing instructors, former participants of skiing courses) in an explorative manner what kind of conditions they think could take influence on those difficulties. (b) We could adopt approved key concepts of (Barkerian) psychological ecology and make use of them in structuring the “field of exploration”. – Let’s follow the second lead.

We could consider interpreting the skiing course as a behaviour setting genotype. Although this appears, in principle, absolutely adequate we can realise, on the basis of our preliminary experience, that this would amount to an “over-instrumentation”. We can refrain from using the behaviour setting concept in its entirety and instead concentrate on those of its components that are particularly pertinent in this case. What is the behaviour setting concept’s share now? It reminds us of the “domains” that have to be taken into consideration in composing the “field of exploration”. These are, primarily, “population” (in particular the skiers and the skiing instructors), “activities” (in particular the skiers’ transactions in question), “program” (in particular the contents of the instructions that describe the tasks to be fulfilled by the skiers), “milieu” (e.g., weather conditions, topology of the terrain, quality of the snow), “behaviour objects” (in particular ski, ski sticks, skiing boots, skiing suit etc.), “spatio-temporal frame” (location, temporal parameters like time of day, duration of relevant process units).

Each of these domains encompasses a (more or less) multifaceted internal variability of constituents. These variabilities should be taken into consideration, in principle, each in the whole spectrum of its diversity. These variabilities can be captured and made manageable only by taxonomising them. However, the internal variabilities in all these domains (population, activities, milieu etc.) allow being taxonomised in different degree of granularity. So, the researcher has to decide – with respect to each domain — which degree of differentiation (s)he considers necessary or useful or adequate. Evidently, (s)he has to find a trade-off between keeping, in the granularity of the taxonomies, as close as possible to “real”, “natural” diversity and complexity on the one hand and pragmatic simplification on the other hand.

In the next step, we would try to estimate, drawing on our own experience and sufficiently approved knowledge, which variants in which of the domains can be expected to exert noticeable impact within the “field”. - Another reduction of complexity becomes unavoidable now in that we have to trade off the multitude of potentially influential variants in all the domains.
against the number of variables we could afford to include in the design of an explorative empirical investigation.

This kind of stepwise disciplined and transparent selection ends up with determining the components that will be introduced into the realisation of the investigation. It further generates a basis for appraising later on the possibilities and the limitations of generalising the findings to be obtained.

Especially with respect to the central component of the field of exploration, the skiers’ transactions, the question arises by which methods these processes should be captured. So, we have to choose an appropriate key concept or model which enables articulating these processes conceptually and allows determining what corresponding kind of data should be collected. Barkerian psychological ecology, in particular the “stream of behaviour”-approach, would suggest opting for “action” as a general conceptual frame. It implies the assumption that activities like those in question are — at least partially — prepared, concurrently regulated and evaluated by (more or less conscious) cognitive processes and that they are accompanied by emotions having a bearing on them. The specific knowledge basis for executing a concrete exercise is built up in perceiving and understanding the instruction. Thus, a skier’s transaction, as the central component of the field of exploration, begins with the presentation of the respective instruction by the skiing instructor and ends with the completion of the concrete exercise and the cognitive-emotional reaction upon it.

What follows for choosing adequate methods?

Recording the course of the events on video would allow subsequent observing and analysing the execution of the exercise, even in slow-motion. However, though the record may stimulate recollections of the skier’s experiences such kind of debriefing entails a time lag between the execution and the skier’s accounting. Besides, (s)he must switch over from the original (“natural”, internal) perspective into the view from outside and try to connect both perspectives. - In order to compensate for these insufficiencies we could have the skiers debriefed immediately after finishing the exercise and tape record their spontaneous accounts (cf. Kaminski, 1982). (The instruction procedure should also be recorded, of course.) – All this applies, in principle, to the entirety of the skiing course’s exercises.

The analysis of these relative “realistic” (qualitative) data makes evident that the conceptual framework with which we had started (“action”) needs to be expanded and differentiated towards a model of “multiple acting” (Fuhrer, 1984). This expanded model suggests a thorough revision of the instructions aiming at a more efficient and less stressful execution of the tasks.
Demonstrating how perspectives of psychological ecology can be utilised heuristically required discussing at least the first example, relatively, at length. Further exemplifications will have to get by with a truncated and more sketchy kind of presentation.

Modeling high speed cognitive processing of behaviour setting participation

Problem: How individual participating in a behaviour setting functions in detail, i.e., how the behaviour setting program is transformed into concrete sequences of transactions has never been modeled sufficiently “realistic” in the Barkerian tradition (cf. Barker, 1968). This fact strikes all the more in case of behaviour settings in which the program requires extremely rapid and complex responding. This insufficiency challenges attempts to overcome the deficit by advanced theory development (cf. Fuhrer, 1985).

An explorative empirical investigation should then aim at providing a data base that could substantiate the development of a more differentiated process theory.

How could the “field of exploration” be defined in this case? Which kind of behaviour setting genotype(s) would be appropriate for representing the problem and at the same time be suitable for investigating it empirically? Which components of the behaviour setting should be included in the definition of the field? – Let’s take a table tennis match as an example (Fuhrer, 1985). It appears reasonable to make, again, but differential use of the behaviour setting concept’s entire heuristic potential. This time, our interest is focused particularly on the cognitive-emotional processes that regulate the individual player’s high-speed transactions in executing program-guided rallies during the match. But which kind of model should be chosen now, helping to articulate these (internal) processes conceptually? To keep in accordance with the Barkerian view we would, again, opt for “action” as a general conceptual frame. However, since the structural and functional details of the process model have to be generated yet just in this explorative investigation we may start with only a minimum of presuppositions concerning the implications of the action concept.

Defining the corresponding part of the field of exploration requires in this case to find out beforehand a method suitable for affording access to the kind of phenomena in question, so that a fairly “realistic” definition of the field can be conceived. The following method, keeping relatively close to naturalness, proved to be satisfactorily effective (Fuhrer, 1985). Amidst a regular table tennis match, one of the players is interrupted quite suddenly at a
point in time unpredictable by him(her)self. The investigator asks for accounting whatever thoughts and feelings had been in mind right before the interruption. The players’ accounts are tape recorded immediately.

Accordingly, the central part of the field of exploration can be defined here as the (ideal) universe of conscious phenomena that accompany the player’s regulation of the transactional processes while participating in a table tennis match. Yet, this relates in this case in particular to a sort of extremely fine-grained phenomena that can be experienced within fractions of a second. This data specification appears absolutely necessary since, as observation makes evident, the regulation of this kind of transactions requires extreme high-speed processing, in the sense that the organism has to adapt continuously to very rapidly changing and relatively complex contextual conditions.

The complete corpus of the players’ accounts is analysed thoroughly with respect to possible conceptual candidates for taking a structural or functional position in a consistent process model.

**What follows from viewing a soccer match as a behaviour setting?**

Problem: Barker interprets a concrete boys high-school basketball game as a typical behaviour setting (1968, 94ff.), as mentioned before. Thus, it should, in principle, be possible to transfer this concept to a great many of other sporting events. Yet, a basketball game in a small rural town and, say, a modern soccer match in a huge urban sports stadium appear enormously different with respect to magnitude, duration, and structuring. Obviously, much effort has to be invested still in differentiating the behaviour setting concept in order to adapt it to modern living conditions. But even so, the traditional concept owns a heuristic potential that could be utilised multifariously. Let’s follow but one particular thread.

Like the previous examples’ protagonists (skiers, table tennis players), each of the football players, while participating actively in the match, has to perform rather complicated sequences of transactions. Here also, a sport psychologist could aspire to develop a process theory that conceptualises the genotypical functioning of these transactions. Again, (s)he would find but dissatisfying support in Barkers coarse-grained action theoretical conceptualisations. In trying to design a more differentiated, more “realistic” process model (s)he might primarily draw on the “program”, i. e., the rule system of soccer. What kind of regular “situations” could appear or be constituted in the player’s cognitive horizon (i. e., the cognitive representations activated at a specific moment as the basis of orientating and regulating his/her activity)?
What kind of regular transactions could the player plan and execute thereupon? How could all this be processed in adequate speed in his/her mind? Etc.

Yet, if we implement the behaviour setting concept in due completeness it compels us to take into account, among many other things, also the spectators of the match. In practice, everyone expects that the spectators’ cheers or boos (in whatever modern format they may appear) have an impact on the match, encouraging one party, demoralising the other one. But how, exactly, does this impressive specific acoustical and optical section of the behaviour setting’s total milieu intrude into the individual player’s cognitive horizon during the match? How, exactly, does it interact with all the other processes that playing soccer comprises? How, exactly, is boosting or impairing the player’s performance through cheers or booing effected?

Thus, if taking the behaviour setting concept seriously enough we may become aware of phenomena and questions that have been left more or less unnoticed hitherto. New aims for theory development may come into view, new kind of empirical investigations may be suggested.

Is the participation of children and youth in top-level sport precarious?

Problem: Is a child/youth having been involved long-term in top-level sport disadvantaged somehow, concurrently or in the long run, compared with a (“control”) child/youth burdened merely by customary sport practice? - If so, appropriate revisions in the organisation of high-performance sport would have to be conceived and initiated.

The structure of this problem is orders of magnitude more complicated than those of the previous examples. Hence, simplifying the discussion still more is unavoidable.

The present problem differs in at least three essential respects from the preceding ones. (a) Major aspects of the problem are emphasised in advance from outside in the name of public interest (cf. Kaminski, 2006, Kaminski, Mayer & Ruoff, 1984). So, the meaning of “disadvantaged” has to be determined in accordance with this public interest. This entails focusing attention primarily on those phenomena in everyday life that are possibly or presumably associated anyhow with a child’s/youth’s being or becoming “disadvantaged”. (b) The temporal range to be taken into account is enormously more extensive than in the examples before. (c) Our interest is focused primarily on the “individual system”, i.e., on the high performance athlete in his/her individual wholeness. So, this problem has to be assigned to ecological personology.

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If, again, we try to define a “field of exploration” it becomes evident that in this case we would not, as happened previously, come upon “domains” being approachable and manageable rather immediately. Sure, from the persons domain we would again choose “one child/youth” (basic minimum, one involved in high-performance sport and one with an ordinary burden). But what, e.g., about the activities domain, the surrounding conditions and the temporal aspects? - What needs to be taken into consideration here is much more extensive; it is in a sense superordinate to the “field of exploration”. So, it is appropriate to introduce a new term and call it the “field of interest”.

This much larger field of interest has, in its entirety, the character of a highly abstract cognitive construction which only partially becomes manifest and accessible. It comprises, in case of the present problem, much more than the person’s “activities”. It must include, in principle, not only all of the individual system’s states and processes that pertain particularly to the criterion “disadvantaged” but also all kind of states and processes that could possibly exert influence on the criterion in aggravating or in attenuating direction. These could be activities observable from outside or cognitive-emotional experiences or even states and processes that are but hypothesised to contribute to empirically accessible manifestations of the individual system’s taking part in everyday life. – As concerns the temporal aspects, especially the temporal range, the field of interest evidently extends from the individual system’s (the child’s/youth’s) entry into the world of competitive sport to a point in time after finishing the sporting career which allows assessing conclusively — in comparison with the ordinarily burdened child/youth — whether the involvement had caused any disadvantage or not. – Correspondingly, within this field of interest also all surrounding conditions, whether objectively assessable or subjectively coded, having been involved in the individual system’s transactions during all these years must, in principle, be taken into account. – As impracticable and futile as this perspective may appear at first sight, it represents the segment of everyday reality that, in fact, makes up the relevant background for composing a manageable “field of exploration” in problems of that sort.

It is this ideal background against which — in trying to define an appropriate field of exploration — we have to consider, as concerns temporal aspects, through how many and through how extensive periods we could try to represent the complete time lapse in question. So, we could, after all, decide choosing three periods of (longitudinal) data collection at intervals of, say, about four years (Kaminski, 2006, Kaminski et al., 1984). Furthermore, we could come to the conclusion that one ordinary week is a “natural” period representing with sufficient typicality and completeness what is going on in
the individual system’s everyday life and within a week the course of one ordinary day and additionally the course of the Sunday. These periods on different time scale provide, among others, a rather fixed amount of (weekly respectively daily) time resources that must be allocated by the individual system to various kind of behaviour setting participations. – In a similar way, all the remaining facets of the field of exploration could be decided upon, and this, of course, in due detail lastly.

The next step would be, once more, looking out for conceptual and theoretical structures appropriate to articulating the different facets of the field of exploration. Obviously, a problem of this sort would not require a granularity of conceptual articulation as fine as in the previous examples.

Guided by these conceptualisations, we then could, again, search for adequate — preferably “naturalistic” — data collecting methods or, if necessary, develop them specifically adapted to the particular problem context. Discussing further details as well as treating the procedures that follow would demand more space than is available here.

Conclusion

So, all in all, how could a sport psychologist take advantage from the Barkerian ecological approach and its further developments? First and foremost, this approach must be understood as a fundamental methodological orientation. In particular, it invites the researcher to reconsider his/her accustomed ways of observing, conceptualising, designing and realising research projects as well as to re-analyse and to re-evaluate traditional research. This approach suggests not to lose sight of the continuous stream of everyday life in all its multifariousness and vividness and it encourages the researcher not to surrender prematurely to its seemingly overwhelming complexity. It advises to describe pending problems and their background with sufficient precision and thoroughness before committing oneself to a quite special research design, whereby an inadequate narrowing of the problem horizon should be avoided. The general research strategy following from this methodological orientation has been described in more detail in the paragraph “the peculiarity of psychological ecology’s relevance” and in a sequence of illustrating examples.

There, it becomes evident that the sport psychologist may profit additionally in a more specific way through making use – in structuring his/her problem fields conceptually – from particular ecological conceptualisations offered by the Barkerian approach (e. g., the behaviour setting concept with
all its implications). However, this approach should, in its present state, not be regarded as a more or less closed and completed system. Instead, it should still be viewed as a rather early and provisional stage in the development of a psychological ecology whose progress needs much further creative efforts.

References


Information, affordances, and the control of action in sport

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The theory of affordances, a conceptual pillar of the ecological approach to perception and action, has the potential to become a guiding principle for research on perception and action in sport. Affordances are opportunities for action. They describe the environment in terms of behaviors that are possible at a given moment under a given set of conditions. Affordances capture the tight coupling between perception and action, and allow for the prospective and moment-to-moment control of activity that is characteristic of fluent, fast-paced behavior on the playing field. We begin with an overview of the ecological approach and the principle of direct perception, using past research on interceptive action to illustrate how this principle has been put to work to capture information-movement relations in perceptual-motor skill. We then review theory and research on body-scaled, action-scaled, and social affordances, highlighting outstanding questions that provide opportunities for new research on affordances in the context of sport. We conclude with consideration of affordances as providing a functional semantics for sports.

KEY WORDS: Affordances, Ecological Psychology, Interceptive actions, Perception-action coupling.

Introduction

Throughout the course of any game or match, athletes encounter numerous opportunities for action on the playing field. There are opportunities to avoid obstacles, intercept moving targets, violently collide with players on the opposing team, pass through gaps, jump over barriers, throw and kick balls through openings and to targets, and so on. Because of the fast pace of many sporting activities, opportunities for action on the playing field often
come and go in an instant. A gap between opposing players can open to afford passing through at one moment, and then collapse into an impenetrable barrier at the next moment. Opportunities for action can also materialize and dissolve in more subtle ways as a result of gradual changes in the player’s action capabilities or changes in playing conditions. A ball that was catchable at the beginning of the game may be uncatchable at some later point due to fatigue. A sharp bend on a racetrack may be possible to take at maximum speed when traction is good, but not after traction is compromised by weather. To perform well on the playing field and to achieve victory, athletes must be acutely aware of the ever-changing opportunities for action afforded by the situation.

What sort of theory of perception and action is needed to do justice to the kinds of skills that athletes exhibit on the playing field? One might say that such a theory should have the following five ingredients. First, it should place primary importance on explaining the success and reliability of perception; less importance should be placed on misperceptions and illusions, which are far less frequent. Second, it should acknowledge that movement plays a critical role in perception, just as perception plays a critical role in movement. Third, it should place more importance on how we perceive those properties of the world that are most directly relevant to how we move to achieve goals. Fourth, it should account for the tight coupling between perception and action that is characteristic of perceptual-motor skill in sports. Finally, it should include an account of learning that captures changes accompanying practice.

We argue that the fundamental starting point for such a theory is a commitment to the idea that actors can achieve direct epistemic contact with their environments; that is, that they can know their environments in a way that is unmediated by internal representations. In short, we are looking for a theory of direct perception (Gibson, 1986; Michaels & Carello, 1981). One of the most fundamental conceptual barriers that stands in the way of developing a theory of direct perception is the deeply rooted assumption, dating back in the era of modern sensory physiology to at least Müller (1843), that the informational support for perception is inherently ambiguous. This assumption says that patterns in the distributions of energy (e.g., light, sound) cannot uniquely specify properties of the world, meaning that the mapping from patterned energy distributions to properties of the world is one-to-many rather than one-to-one (whereas a one-to-one mapping would constitute unique specification of properties of the world by patterns in the distribution of stimulus energy). Such patterns merely correlate with and provide cues or clues about the world. Together with prior knowledge and
assumptions about the world, such cues can be used to infer properties of the world, much like a detective combines evidence with knowledge of the case to infer the events that led to a crime. Thus, what we perceive must be an interpretation of the world, not the world itself. Because according to this view perception of the world is mediated by an interpretation, the general term used to refer to such theories is indirect perception. Indirect perception theories maintain that perceivers are in contact with representations of the world, not with the world itself.

Theories of indirect perception are dominant, but they are more successful at explaining failures of perception than successes. Classic perceptual illusions such as the Ames Room1 (Ames, 1952) are often used to make the case for indirect perception because they appear to lend themselves to explanations in terms of prior knowledge, assumptions, and inferences (but see Runeson, 1988). We remind the reader that we are looking for a theory of perception that does justice to feats of perception and action that athletes exhibit on the playing field. Any theory that takes illusions as its starting point is not likely to provide an adequate account of the success and reliability of perception in fast-moving, high-pressure environments like sport.

Committed to the idea that a theory of perception should do justice to its success, James J. Gibson (1986) sought to develop a theory of direct perception. Direct perception—perception that is not mediated by internal representations—can be possible if properties of the world are specified in patterns of stimulus energy. If properties of the world are unambiguously specified, perception does not have to involve processes of interpreting ambiguous cues about the properties of the world. Gibson’s approach is an ecological approach because it stresses the reciprocity (Lombardo, 1987) or duality symmetry (Turvey & Shaw, 1999) of organisms and their environments. A first step toward meeting the challenge of a theory of direct perception is to reject the assumption that the input for perception is impoverished. In its place, Gibson and proponents of the ecological approach (Shaw, Turvey, & Mace, 1982) put forth the assumption that the distributions of energy surrounding an organism, when properly described, are rich with information that specifies action-relevant properties of the world. Justifying this assumption

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1 The Ames Room is a distorted room that is specially configured to project a retinal image that is identical to that of a normal, rectangular room when viewed from a particular vantage point (i.e., through a peephole). The room is not actually rectangular—one corner opposite the vantage point is much farther away than the other, leading to the appearance that a person or object located in the more distal corner is smaller than a same-sized person or object in the more proximal corner.
requires researchers to discover information in ambient energy arrays that specifies action-relevant properties and to show that movement is constrained by such information, which entails perhaps the even greater challenge of developing the conceptual and methodological tools for discovering how properties of the world are specified in patterns of stimulus energy (Turvey & Shaw, 1995, 1999). In the next section, we briefly illustrate how Gibson’s ideas have been put to work to understand a class of behaviors known as interceptive actions. This section is not intended to be a comprehensive review of research on interceptive actions. Rather, our goal is to give readers who are not already familiar with the ecological approach a sense of what it means to understand a perceptual-motor skill in terms of information-movement relations.

The main focus of this paper is on Gibson’s theory of affordances, and its application to sport. We feel that the theory of affordances is ideally suited to capture the behavior of athletes on the playing field, and has great potential to become a guiding principle for research on perception and action in sport. In the second part of this paper, we will introduce the concept of affordances, review some of the empirical research on affordances, and point out potential applications to sport that provide opportunities for future research.

An ecological approach to interceptive action

Ecological psychologists wishing to meet the challenge of developing a theory of direct perception seek an understanding of the perceptual control of action in terms of information-movement relations. To illustrate this approach, we will focus on a class of behaviors, all of which require actors to intercept fast-moving targets. Such behaviors are referred to as interceptive actions, and are among the most impressive things that athletes routinely do on the playing field. In baseball, for example, fielders reach out with gloved hands to catch balls that approach speeds of 100 mph (~45 m s\(^{-1}\)). When catching a fly ball, outfielders guide the movement of their bodies and hands to the right place at the right time so that the ball is within reach before it hits the ground. Before the ball can be caught, the glove must be oriented more or less orthogonal to the direction of motion of the ball, the muscles of the arm must be readied for the ball’s impact, and sometimes the entire body must be prepared so that the fielder can throw the ball in a particular direction as soon as possible after it is caught. Hitting a ball involves even more demanding spatiotemporal constraints because the batter should make contact when the bat is moving at its maximum speed while traveling in a particular direction.
A first step toward understanding interceptive actions is to identify and provide a formal description of the information that specifies action-relevant properties of the environment. In the 1970s, David Lee carried out extensive analyses of the changing optic array that revealed potentially important sources of information for a variety of activities, including catching and hitting (Lee, 1974, 1976; Lee & Lishman, 1977). It is difficult to overstate the lasting impact of Lee’s discoveries. Although subsequent research raised questions about whether actors actually use some of the specific variables that Lee identified, his work inspired generations of researchers to look for information in changing patterns of optic and acoustic arrays (e.g., see Hecht & Savelbergh, 2004).

INFORMATION ABOUT WHEN

Because interceptive actions require actors to satisfy demanding temporal constraints, it is widely accepted that an approaching object’s time-to-contact (TTC) must be accurately perceived in order to intercept the object. Lee (1976) demonstrated that TTC is optically specified by the ratio of an approaching object’s size in the optic array to its rate of optical expansion, which he dubbed $\tau$ (tau). The appeal of $\tau$ is that it explains how actors directly perceive TTC, without first estimating the object’s distance and approach speed. Furthermore, because $\tau$ is invariant over changes in the size of the approaching object, knowledge of the approaching object’s size is not necessary. Thus, $\tau$ explains how time-to-contact, a potentially action-relevant property of the environment, can be directly perceived by detecting information in optic flow. Because $\tau$ is specific to time-to-contact (i.e., values of the optical variable $\tau$ are lawfully determined by the physics of object motion), detecting $\tau$ allows the animal to perceive time-to-contact without making any inferences or performing any mental calculations.

Numerous empirical studies designed to test the role of $\tau$ in the visual control of action followed Lee’s early work. Most of the initial work was optimistic, claiming support for the use of $\tau$ by both humans (Lee, Young, Reddish, Lough, & Clayton, 1983; Savelbergh, Whiting, & Bootsma, 1991) and non-human animals (Lee, Davies, Green, & van der Weel, 1993; Lee, Reddish, & Rand, 1991; Lee, Simmons, Saillant, & Bouffard, 1995; Wagner, 1982). Other studies provided support for the hypothesis that $\tau$ is used to time interactions with objects that are moving under the influence of gravity (e.g., a falling ball), even though TTC specified by $\tau$ is greater than actual TTC for
accelerating objects\(^2\) (Lee & Reddish, 1981; Lee et al., 1983). Humans’ sensitivity to \(\tau\) was documented in an extensive series of psychophysical studies by Regan and colleagues (see Regan & Gray, 2000 for a review).

Despite the initial enthusiasm for \(\tau\), recent research has been more critical (Hecht & Savelsbergh, 2004; Tresilian, 1999). Several researchers have reported that performance differs under binocular viewing conditions (Rushton & Wann, 1999; van der Kamp, Savelsbergh, & Smeets, 1997), suggesting that actors do not rely exclusively on \(\tau\) (a monocular variable). Others have found effects of object size and approach speed that would not be expected if actors used \(\tau\) (DeLucia, 1991; DeLucia & Warren, 1994; Fajen & Devaney, 2006; Michaels, Zeinstra, & Oudejans, 2001; Smith, Flach, Dittman, & Stanard, 2001). The claim that actors use \(\tau\) to time interactions with accelerating objects has also been questioned (Michaels et al., 2001; Tresilian, 1997; Wann, 1996; Zago & Lacquaniti, 2005). Although this more recent work brings into question the role of \(\tau\) in timing interactions with moving objects, it has also led to the discovery of other informational variables, thereby reinforcing the importance of detailed analyses of the optic array.

**Information about Where**

Although a great deal of the research on interceptive actions has focused on information about TTC, catching and hitting also require actors to satisfy demanding spatial constraints. For instance, the passing distance – how closely an object will pass the actor – indicates how much (if at all) the actor needs to move to intercept a passing object. Both monocular and binocular information about passing distance has been identified (Bootsma, 1991; Regan & Kaushal, 1994) and tested (Bootsma & Peper, 1992; Gray & Siefvert, 2005; Jacobs & Michaels, 2006; Peper, Bootsma, Mestre, & Bakker, 1994). At least in principle, information about passing distance could be used together with information about TTC to move the hand into position at the right time to make a catch.

Catching also requires orienting the glove roughly orthogonal to the direction of motion of the ball, with little margin for error. If the catcher is using his or her hand rather than a glove, then the margin for error in hand orientation is even less. In certain sports, hitting also requires one to properly orient the

\(^2\) \(\tau\) specifies TTC assuming velocity is constant (i.e., first-order TTC). If velocity increases, as it does when objects fall under the influence of gravity, then actual TTC will be less than first-order TTC specified by \(\tau\).
bat, racket or paddle. For example, the ability of skilled tennis and table tennis players to hit balls to specific locations on the court or table would seem to depend on the pickup of information about the ball’s direction of motion at the moment that it is struck. Regan and colleagues have shown that direction of motion in depth is specified by both monocular and binocular sources of information (see Regan, 1997 for a review). There is some evidence that observers overestimate the angle of approach of objects moving in depth (Harris & Dean, 2003; Harris & Drga, 2005), but the role of these variables in controlling hand orientation during actual catching and hitting has not yet been tested.

THE ROLE OF PERCEPTUAL ATTUNEMENT

Stepping back to look at the vast body of research on the informational basis for interceptive action, one might get the impression that the goal is to identify the optical variable that is used by all actors all of the time. It is important to acknowledge that people are remarkably flexible in their ability to adapt to changes in task constraints, criteria for success, and the availability of information. Some degree of flexibility can be achieved by perceptual attunement to different informational variables as conditions change.

Perceptual attunement is particularly relevant to the study of perception and action in sport because most sports-related activities are skills that require extensive practice to master. The notion of perceptual attunement implies that differences between experts and novices reflect, in part, differences in the informational variables upon which experts and novices rely. Indeed, recent evidence from a range of perceptual (Jacobs, Runeson, & Michaels, 2001; Michaels & de Vries, 1998) and perceptual-motor (Jacobs & Michaels, 2006; Smith et al., 2001; van der Kamp et al., 1997) tasks suggests that novices rely on variables that do not specify the relevant property, but with practice converge toward specifying variables. For example, subjects in Smith et al. completed several sessions of practice on a ball hitting task with precise temporal demands. Because movement time was fixed, the task required subjects to learn the precise moment at which to initiate movement to hit the approaching ball. They found that novices relied on optical variables that were not invariant over changes in the size and speed of the approaching ball, leading to biases in performance when those factors were manipulated. With practice, however, subjects learned to rely on optical variables that allowed them to perform the task more successfully across variations in size and speed. Similar findings have been reported in studies of catching (Jacobs & Michaels, 2006; van der Kamp et al., 1997), helping to
establish perceptual attunement as a general principle that underlies learning and flexibility. This is important because it shifts the focus of research from finding the informational variable for a given task to understanding the factors that influence changes in the informational variables upon which actors rely. Knowledge of those factors could have important practical implications for sports, as training could focus on developing proper perceptual attunement to relevant variables under different performance conditions.

THE INFORMATION-BASED APPROACH: SUMMARY

To summarize, the ecological approach challenged researchers to identify information in changing patterns of optic flow that specifies action-relevant properties of the environment, and to show how this information is used in the control of action. Studies of the informational basis for interceptive actions such as catching and hitting have proven to be particularly fruitful in efforts to identify informational variables that support the control of action. Information about when the ball will pass within range, where it will be at that point in time, and its direction of motion has been identified and empirically tested. Although questions remain about which particular optical variables are used and how they are used, the ecological approach has led to a deeper understanding of how athletes satisfy demanding spatial and temporal constraints on the playing field. Further, the more fundamental claim that movements are guided by information in the changing optic array is now well established.

The information-based approach, more so than any other aspect of ecological psychology, has made its mark on the study of perception and action in sport. By comparison, other aspects of the ecological approach are perhaps underappreciated. In particular, we feel that the theory of affordances, which lies at the heart of the ecological approach, ought to be more seriously considered as a guiding principle for research in the sport sciences. In the next section, we explain the theory of affordances, review some of the empirical research on affordance perception, and point out its application to sport.

Affordances

THE CONCEPT OF AFFORDANCES

The concept of affordances was introduced by Gibson (1966, 1977, 1986) to describe the opportunities for action provided by the environment for an ani-
A given environment may afford a multitude of behaviors for an animal. Consider a soccer pitch (field) as an example environment. The pitch itself affords upright standing and locomotion, the ball affords kicking, and opposing players afford avoiding, to name a few of the many affordances of this environment. To perceive an affordance, in Gibson’s view, is to perceive how one can act when confronted with a particular set of environmental conditions. Gibson’s rather simple and modest claim, in the context of the soccer pitch example, is that a soccer pitch looks walk-on-able and a ball looks kick-able to a person who possesses the action capabilities necessary for walking and for kicking.

We believe the affordance concept is ripe for application in sport. In sport the outcome of a match can often hinge on an athlete’s ability to determine when a behavior is possible, and when it is not. For example, a basketball player must be able to determine whether it is possible to pass the ball around a defender to reach an open teammate, or whether the defender will be able to intercept the pass and deny an attempt at a game-winning basket. Compared to other developments in the ecological approach, such as the notion of continuous, information-based control (reviewed in the previous section), affordances have received less attention from the sport science community (see Williams, Davids, & Williams, 1999, for instance). In this section we highlight some key features of Gibson’s (1986) theory of affordances, and discuss some varied takes on the affordance concept in the perception-action literature. We then review a sample of the vast amount of empirical research on affordance perception as well as some more recent empirical and theoretical efforts to extend the theory of affordances to social contexts involving more than one actor. Along the way we highlight some of the many implications of affordances for sport.

**Key features of affordances**

*Affordances are Real.* In Gibson’s (1986) formulation affordances have a real existence—they are part of the ontology (Turvey, 1992). The real existence of affordances as ontological entities means that, in principle, affordances can be specified in patterns of stimulus energy (i.e., there is information about affordances available to the actor). If this is the case, affordances need not be conceived by the actor via some sort of constructive, cognitive processing, but rather they can be directly perceived.

*Affordances are Animal-Specific.* Affordances are not inherent in objects or environments themselves. However, they are animal-specific, meaning that
they are defined relative to the action capabilities of a given animal. A regulation-size soccer ball may afford kicking and dribbling for an adult, but may not afford kicking and dribbling for a toddler, for instance (cf. Araújo, Davids, Bennett, Button, & Chapman, 2004). Affordances thus refer to the relation between an animal and its environment. This feature of affordances is not incompatible with the claim that affordances are ontologically real. The fact that affordances are relational properties, and that the relation in question refers to a specific animal, does not make them unreal. A relation really does exist between the size and mass of a soccer ball and the size and mass of an infant’s body (see Huettel, Polger, & Riley, 2003, for a similar argument).

**Affordances Capture the Reciprocity of Perception and Action.** Affordances describe the environment in terms of how animals can act. By couching perception in the language of action, affordances capture the reciprocity of perception and action. Perception and action perpetually feed one another. Gibson (1966, 1986) recognized that any complete theory of perception must account for that fundamental fact and consider perception and action jointly rather than (as is the tendency in cognitively oriented approaches) treating them as separate problems that can be solved independently and afterwards connected. This is one of the reasons why we think the concept of affordances is so ideally suited for investigating perceptual-motor skill in sports.

**Affordances Allow for Prospective Control.** Perceiving affordances allows actors to prospectively control their behavior (Turvey, 1992; Turvey & Shaw, 1995). Recall from the previous section that the prospective control of catching implies that movements are guided on the basis of information about future states of affairs; e.g., information about whether or not the ball will be caught if current conditions (hand and ball velocity) persist. More generally, prospective control refers to the means by which actors adapt behavior in advance to the constraints and behavioral opportunities in the environment. Perception thus plays a preparatory role in action as well as an on-line role in tuning action as it unfolds. Prospective control is crucial for skilled behavior in everyday situations as well as in athletic performance (Kim & Turvey, 1998; Lee, 1980). In the absence of prospective control, action would be reduced to mere reaction, which would not suffice in many fast-paced sport environments.

**Affordances are Meaningful.** Gibson (1986) proposed that the environment is perceived fundamentally in terms of what it affords the perceiver, rather than in terms of animal- (and action-) neutral properties such as extent, shape, or color, per se. Such properties, Gibson noted, are devoid of any
meaning in and of themselves. If animals are perceptually sensitive only to those kinds of properties of the environment, as most other modern theories of perception have claimed since the work of Helmholtz (1867/1925), then the meaning of perception would have to be supplied by the perceiver through some sort of higher-order cognitive processing. In contrast, affordances are inherently meaningful in that they describe what an animal can or cannot do in a given environment. If affordances can be perceived directly—rather than perceived indirectly by first perceiving lower-order, animal-neutral, physical properties of the environment and then elaborating those sensory experiences by cognitive processing of some sort—then perception can be meaningful without the meaning being provided by constructive cognitive processes that mediate between sensation and perception. Gibson proposed that direct perception of affordances is possible because lawful processes dictate the relation between patterns of stimulus energy (i.e., the optic array) and the environmental properties that give rise to those patterns. If patterns of stimulus energy are specific (i.e., lawfully relate) to the environment, the environment can be perceived without the process requiring cognitive mediation.

**Affordances are Dynamic.** Opportunities for action come and go on a moment-to-moment basis. Affordances may arise and dissolve with movements of the actor even though the surfaces and substances in the actor’s environment remain static, or as changes occur in the actor’s environment while the actor remains static. The world of behavioral opportunities is dynamic (Kirsh, 1991; Turvey, 2004; Turvey & Shaw, 1995, 1999). This key feature of affordances is easily appreciated in the fluid sport environment. A fly ball in baseball may be catchable for a brief period after the ball is hit by the batter. But if the fielder gets off to a slow start, then at some point before it lands, the ball will become uncatchable. Thus, the situation can change from one that affords catching to one that does not afford catching in an instant. Similarly, changes in the actor’s environment can give rise to changes in what behaviors are possible. At one moment in a match, a teammate may be open, and a pass to that teammate afforded. Milliseconds later a defender may slip into the passing lane, and the pass is no longer possible. Action possibilities can evolve and devolve rapidly as in these examples, and also over longer time scales, as when a fatigued player late in a match cannot accelerate quickly enough to catch a pass would have been possible to catch earlier in the match, before the onset of fatigue. Although the “quicksilver” nature of affordances has perhaps been less well appreciated than the preceding features, it cannot be ignored if the affordance concept is to have utility for understanding perception-action in the dynamic context of sports.
VARIED TAKES ON THE AFFORDANCE CONCEPT

Since Gibson’s original writings on affordances there have been efforts to refine the affordance concept (see, e.g., Jones, 2003). One such effort led Turvey (1992) to define affordances as dispositional properties of the environment that are complemented by dispositional properties of animals termed effectivities. Alternatively, Stoffregen (2003) defined affordances as emergent properties of animal-environment systems, and claimed that affordances are not properties of the environment alone. Instead, according to Stoffregen’s perspective, affordances are undefined without jointly considering properties of both the animal and environment. Michaels (2003) defined affordances not as properties of the environment or of the animal-environment system, but instead as the possible actions themselves (e.g., walking is an affordance of a roughly horizontal, extended surface that is sufficiently dense relative to an animal’s mass; in contrast, defined in terms of the environment or the animal-environment system, the affordance would not be identified as walking, per se, but as walk-on-able). Other theorists have sought to situate affordances within more traditional cognitive and information-processing frameworks (e.g., Vera & Simon, 1993), treating affordances as if they are conceived rather than perceived (see Turvey, 1975; Turvey & Shaw, 1995, 1999). More recently, advocates of embodied cognition perspectives have invoked the affordance concept in efforts to understand how putatively “higher-order” forms of cognitive activity might be rooted in putatively more fundamental perceptual-motor exchanges between animals and their environments (e.g., Barsalou, 1999; Glenberg, 1997). It is not our goal in the present work to argue for one of those specific takes on the affordance concept to the exclusion of others, with the exception that (as can be intimated from the previous section) we do not endorse information-processing or representational accounts of affordance perception (see, e.g., Turvey, Shaw, Reed, & Mace, 1981). For our discussion of the importance of affordances for sport, it is sufficient to think of affordances as properties of animal-environment systems that can be specified in patterns of stimulus energy and that can therefore be directly perceived.

RESEARCH ON AFFORDANCES

Empirical research has demonstrated that people can perceive (by means of vision, hearing, touch, etc.) a variety of affordances with impressive accuracy, including affordances of step-on-ability (Warren, 1984; Wraga, 1999),
step-across-ability (Cornus, Montagne, & Laurent, 1999), sit-on-ability (Mark, 1987; Mark, Balliet, Craver, Douglas, & Fox, 1990), reachability in the horizontal (Carello, Grososky, Reichel, Solomon, & Turvey, 1989; Mark, Nemeth, Gardner, Dainoff, Paasche, Duffy, & Grandt, 1997; Rochat & Wraga, 1997) and vertical planes (Pepping & Li, 1997, 2000), pass-through-ability (Warren & Whang, 1987; Wraga, 1999), pass-under-ability (van der Meer, 1997; White & Shockley, 2005), and stand-on-ability of a slope (Fitzpatrick, Carello, Schmidt, & Corey, 1994). Many of these scenarios that have been investigated in the laboratory have analogues in sport. As an example of such an analogue, the situation that subjects encounter in studies of pass-ability is similar to that encountered in American football, where running backs must be able to perceive whether holes in the line of defenders afford passage. In the case of football, however, the gaps in the line are dynamic rather than static—the gaps’ locations and widths are constantly changing. No research has investigated the perception of affordances in such a scenario, although Gibson and Crooks’ (1938) work on fields of safe passage in driving (research that preceded Gibson’s development of the theory of affordances) anticipated such problems. The affordance of reach-ability is important in a number of sports, particularly in ball sports where an athlete must determine if a passing ball is reachable, such as a goalie in soccer. In softball, a fielder needs to be able to determine if a ball is reachable from her current location, or whether she will need to move to reach the ball, and the first baseman must determine whether the fielder’s throw is catchable without removing her foot from the base. Although more work on this topic is necessary, one study by Peper et al. (1994) found that seated subjects could accurately judge the catchability of balls that passed within or just outside of reach.

Two categories of affordances have been investigated extensively: Body-scaled affordances, in which the relation between some measurable dimension of the animal’s body in relation to a reciprocal property of the environment determines whether an action is possible (e.g., a person’s leg length relative to the height of a step), and action-scaled affordances, in which how the animal can behave relative to the environment (e.g., how fast the person can arrive at some location, or how much force they can produce with their muscles) determines whether an action is possible. Before reviewing the literature on body-scaled and action-scaled affordances, it is worth pointing out that not all affordances fit neatly in one of these two categories. For example, whether an object affords reaching by jumping is determined partly by body scale (i.e., the person’s height and arm length) but also by the actor’s force-generating capabilities (i.e., the amount of vertical force the person can produce). Affordances that are both body- and action-scaled may be preva-
lent in sports. Pepping and Li (1997), for instance, investigated perception of the maximum height to which volleyball players could jump in order to block an opponent’s shot. They found that even novice volleyball players could accurately perceive maximum block-able height. More research on these kinds of affordances is needed and may be highly relevant for analyses of sport. Since most research has focused on either body-scaled or action-scaled affordances, we will focus on research on each of those types of affordances in the next sections.

BODY-SCALED AFFORDANCES

A number of affordances can be described primarily in terms of the relation between some dimension of an animal’s body, such as leg length, and a complementary property of the environment, such as the height of a step. For instance, if the height of a step is less than or equal to 0.88 times a person’s leg length (Warren, 1984), then the step is climbable for that person. Affordances of this kind can be termed body-scaled affordances (though see Konczak, Meeuwsen, & Cress, 1992, for a discussion of factors other than body size that determine whether a step is climbable). Body-scaled affordances can be measured on a scale that is intrinsic to the perceiver (e.g., in units of leg length) rather than according to an extrinsic measurement system such as inches or centimeters. Perceiving the environment in body-scaled units thus relates the environment directly to the perceiver’s action capabilities. Warren (1984) found that perceivers were extremely accurate at perceiving the maximum climbable step height, as well as at perceiving the energetically optimum stair height, which corresponds to 0.26 times a person’s leg length.

Warren’s (1984) groundbreaking research demonstrated that people can perceive body-scaled affordances very accurately, but his study left open how exactly they went about doing so. In principle, Warren’s participants could have perceived step height in an extrinsic measurement frame and then used a cognitive strategy of dividing the extrinsically scaled step height by a stored representation of leg length, measured in the same extrinsic units. Affordance perception could thus be conceived as an indirect process, in line with more traditional theories of perception. Thinking of affordances in this way would fail to capture the richness of Gibson’s (1986) broader theoretical approach, however, and would amount to little more than an ad-hoc effort to revise traditional, constructivist theories in order to tie perception and action together. Theoretical arguments aside, the indirect, cognitive strategy seems
unlikely on the basis of empirical evidence. Mark (1987) found that after small amounts of practice participants could accurately judge their new maximum sitting height when wearing blocks attached to the feet (the blocks raised the maximum sitting height by making participants 10 cm taller), but the participants inaccurately estimated the height of the blocks. Accurate estimation of block size would be requisite for the sort of cognitive strategy just described.

Body-scaled affordances could be perceived directly by detecting optical information that delivers the environment in body-scaled terms to the perceiver’s perceptual systems. In that case, the perceiver does not have to perform a cognitive operation to relate the environment to his or her own body scale. One such source of information is eyeheight-scaled optical information (Lee, 1974, 1980; Sedgwick, 1973, 1980). A perceiver’s eyeheight can be optically specified, which in turn yields the dimensions of other objects in the optic array specified as ratios of object dimensions to eyeheight (see Warren & Whang, 1987). Because a perceiver’s eyeheight is related to other body dimensions, such as leg length, eyeheight-scaled information about surfaces and objects in the environment relates the environment to the perceiver’s body and thus provides a natural basis for perceiving body-scaled affordances. The results of several studies are consistent with the use of eyeheight-scaled optical information for perceiving a number of affordances (Carello et al., 1989; Mark, 1987; Warren & Whang, 1987; White & Shockley, 2005; Wraga, 1999). Warren and Whang had perceivers make judgments of pass-through-ability of an aperture. The aperture rested on a false floor that could be raised, thereby reducing specified eyeheight. Participants identified narrower apertures as pass-through-able when the false floor was raised (i.e., when specified eyeheight was reduced), but when aperture widths were scaled by effective eye height there was no difference in aperture width between the raised and normal floor conditions. Those results provide strong, direct evidence for the use of eyeheight-scaled information in affordance perception.

An avenue for future research concerns the use of implements that modify an athlete’s capabilities, such as by extending the athlete’s effective body dimensions (e.g., by extending reach). A number of such implements are used in different sports, such as gloves in baseball and softball or lacrosse sticks. Research on the haptic perceptual subsystem of dynamic touch (see review by Carello & Turvey, 2000) has shown that people can perceive distances reachable by means of a hand-held object (Solomon & Turvey, 1988). Physical properties of the object—namely the object’s spatial distribution of mass—play a determining role in perceiving what is reachable using the
object. In some cases, depending on an implement’s spatial distribution of mass, actual reachability using the implement and haptically specified reachability may be discrepant, requiring the user to adapt or calibrate to the implement in order to accurately perceive actions that are possible using the implement (we will discuss the issues of learning, adaptation, and calibration in a later section). The affordance concept has drawn considerable interest in the fields of human factors, ergonomics, and design (e.g., Norman, 1988; Warren, 1995; Zaff, 1995), and recent research suggests a role for considering affordances in the design of sporting equipment (Araújo et al., 2004; Hove, Riley, & Shockley, 2006).

**Action-scaled affordances**

Whereas some affordances are clearly constrained by actors’ body dimensions, others are constrained by their action capabilities. In baseball, for example, the catchableness of a fly ball depends less on fielders’ body dimensions, and more on their running (and perhaps even jumping) capabilities. Accordingly, such affordances are characterized as action-scaled rather than body-scaled.

The perception of action-scaled affordances is critical to successful performance on the playing field. Consider, for example, a weak fly ball hit in front of an outfielder, and suppose that the outfielder is too slow to reach the landing location on time. If the fielder runs as quickly as possible toward the landing location, and arrives a moment too late, then he may need to make a difficult play to keep the ball from skipping by. If the ball is uncatchable, the smarter play is to slow down and let the ball bounce far enough away that it can be easily caught after it hits the ground. In short, good outfielders reliably distinguish between two categories of action: catchable and uncatchable balls. Speaking in more general terms, good athletes know what they can and cannot do, and rarely attempt to do things that are beyond their limits.

The ability to perceive the catchableness of fly balls was demonstrated by Oudejans, Michaels, Bakker, and Dolné (1996) in one of the few studies of action-scaled affordances. They projected tennis balls into the air in front of and behind the subject, varying flight duration and landing location. Subjects were instructed to either judge whether or not the ball was catchable, or actually attempt to catch the ball. They found that judgments of catchableness closely corresponded to actual catchableness, provided that the fielders were allowed to move for a brief (1 s) period before making the judgment. These results demonstrate that actors can indeed perceive affordances that
are constrained by their action capabilities, just as they can perceive affordances that are constrained by their body dimensions.

The perception of action-scaled affordances is important, not only in making decisions about different categories of action (i.e., to try to catch the ball on a fly or let it bounce), but also in the ongoing guidance of action. This is because the limits on actors’ capabilities to run, turn, jump, stop, etc., place critical constraints on successful performance. Actors must be sensitive to those constraints. When outfielders pursue fly balls, they have some degree of flexibility in the trajectory that they can follow to the landing location. They can get off to a slow start, gradually speed up, and catch the ball while running, or they can run quickly to the landing location and wait for the ball. They can follow a straight path, or they can follow a curving path. Although some flexibility can be tolerated, fielders must move in such a way that the speed required to catch the ball never exceeds their maximum running speed. That is, they must move in such a way that catching is always afforded. Fajen (2007a) referred to this as affordance-based control.

Recent experiments on braking provide evidence that actors take the limits of their capabilities into account when guiding their movements on the basis of visual information (Fajen, 2005a, 2005c). In these experiments, subjects used a joystick as a hand brake to decelerate to a stop as close as possible to a row of stop signs. Fajen (2005a) found that when the deceleration required to stop was well below the maximum deceleration of the brake, then braking behavior was quite variable. However, when required deceleration approached maximum deceleration, subjects almost always increased brake pressure. Thus, deceleration is continuously adjusted in a way that takes into account the limits of one’s braking capabilities; that is, braking is controlled in such a way that safe stopping is always afforded. When three levels of brake strength (weak, medium, and strong) were used in another study (Fajen, 2005c), subjects in the weak and strong brake conditions initiated deceleration earlier and later, respectively, than subjects in the medium brake condition. However, when measures of braking behavior were scaled against maximum braking capabilities for each group, behavior was invariant across groups. Just as subjects in Warren’s (1984) study perceived riser height in intrinsic units related to the dimensions of the body, subjects in Fajen (2005c) perceive needed deceleration in intrinsic units related to their braking capabilities.

One issue concerning action-scaled affordances that warrants future research is the accuracy and precision with which action-scaled affordances can be perceived. This is an important issue because athletes often try to gain an advantage by pushing the limits of their capabilities. Not only are good ath-
letes stronger, faster, and quicker, but they also better perceive what they can and cannot do. Differences between athletes at different skill levels may reflect (at least, in part) differences in perceptual attunement. Recall from the first section of this paper that perceptual attunement refers to changes over a period of practice in the informational variables upon which actors rely. To the extent that novices rely on non-specifying variables or cues to perceive action-scaled affordances, their ability to reliably distinguish between possible and impossible actions across a range of conditions will be degraded (Fajen & Devaney, 2006). This issue could be investigated by studying highly skilled athletes when they are performing near the limits of their action capabilities.

Another outstanding question is how actors perceive affordances that are both body-scaled and action-scaled. One of the few studies to investigate the perception of such affordances is Cesari, Formenti, and Olivato (2003). They pointed out that the climbability of stairs depends not only on body dimensions (e.g., leg length) but also on action capabilities (e.g., strength and flexibility). They identified a new variable – the ratio of the height of the step to the distance (before movement was initiated) from the feet to the top of the step – that was invariant across participants with different body dimension and stair climbing abilities. This is remarkable because it provides a possible informational variable that could be used to guide action when climbing stairs in a way that takes into account differences in body dimensions and action capabilities.

THE NECESSITY OF CALIBRATION

Body dimensions and action capabilities are not fixed, but often change across both short and long time scales. The length of limbs increases during the normal growth period. In sport, players’ effective body dimensions are altered by implements such as gloves, bats, and sticks. Action capabilities change across short time scales as a result of factors such as fatigue, injury, and changes in load, and across longer time scales as a result of development and training. When body dimensions and action capabilities change, actions that were once possible may become impossible (or vice-versa). Some form of learning must be involved in the perception of affordances to allow actors to adapt to such changes. Such learning can be thought of in terms of perceptual-motor (re-)calibration. In measurement devices, calibration establishes a mapping between the units in which the measurement is taken and some known units, and recalibration updates the mapping if the characteristics of the device change. In perception and action, calibration and recalib-
bration are necessary to establish and update the mapping between the units in which the relevant properties of the world are perceived, and the units in which the action is executed.

To illustrate the role of (re-)calibration in the perception of body-scaled affordances, suppose that the ratio of maximum seat height to eye height for a particular actor is 0.40 (Mark, 1987). If the actor is calibrated, then she can use eye height scaled information about surface height to directly perceive the sit-on-ability of a surface. Now suppose that the actor’s leg length is suddenly increased by strapping 10 cm blocks to her feet, as in Mark’s study. Because both maximum seat height and eye height increase by the same amount (10 cm), the ratio also increases. Some surfaces that previously did not afford sitting (e.g., those that are slightly above 0.40) now do afford sitting. However, without the ability to recalibrate, the actor would incorrectly perceive that such surfaces are not sit-on-able. Thus, recalibration is necessary to learn a new mapping between eye height scaled information about seat height and the affordance of sitting. Mark found that subjects were able to relearn the maximum seat height that afforded sitting, confirming that such recalibration is possible. Further, he showed that recalibration does not require actual practice with the task of sitting. Even minimal activity (e.g., leaning) with 10 cm blocks on one’s feet leads to recalibration, although subjects who were completely restricted from moving did not recalibrate (Mark, Balliett, Craver, Douglas, & Fox, 1990).

Fajen (2005c; 2007b) investigated recalibration in the context of action-scaled affordances by modifying subjects’ braking capabilities in a simulated braking task. Subjects rapidly recalibrated, even when they were unaware that their braking capabilities suddenly changed, and even when the screen turned black one second after braking was initiated (well before reaching the intended stopping point). The latter result suggests that recalibration to changes in action capabilities does not require feedback about the outcome of the action, just as Mark (1987) showed that recalibration to changes in leg length (brought about by wearing blocks) does not require practice sitting.

Calibration makes it possible for actors to perceive the world in intrinsic units even after changes in body dimensions and action capabilities. For a properly calibrated actor, body-scaled and action-scaled affordances can be directly and reliably perceived by simply picking up the relevant information. Although recalibration occurs quite rapidly, it is likely that further experience leads to further improvements in calibration. One might say that top athletes are able to perform near the limits of the action capabilities because years of practice have left them so precisely calibrated. If so, then more
research on calibration in the context of sport should be conducted, with the goal of designing training sessions that facilitate proper calibration.

Research on learning to perceive affordances during perceptual-motor development (see review by Adolph & Berger, 2006) may have important additional implications for athletes and trainers. This body of research has revealed that learning and calibration to changing action capabilities may not transfer to nearly identical environmental conditions. An infant that has just learned to walk may, for example, try to traverse downhill slopes that were discovered to be safely traversable when crawling, but that are not safely traversable when walking (Adolph, 1997). After some amount of experience walking the infant comes to learn which layouts of surfaces afford locomotion by walking. The potential lesson for sports is that affordance learning may be quite specific to (i.e., may not transfer across) modes of action. As an athlete’s action capabilities change with training and experience, there may be a need to continually retune and re-calibrate in order to ensure successful control of action (cf. Campos, Anderson, Barbu-Roth, Hubbard, Hertenstein, & Witherington, 2000).

Finally, it is important to point out that calibration and attunement are not synonymous, although both play important roles in learning to perceive affordances. Recall that (re-)attunement refers to changes in the informational variables upon which one relies. An actor can be properly attuned, in the sense that she is relying on an informational variable that invariantly specifies the relevant property, but not properly calibrated. Thus, to reliably perceive affordances, both attunement and calibration are necessary.

**Affordances in a Social Context**

Social interactions are among the most fundamental of human behaviors, and other people are fundamental components of an individual’s environment. No account of perception-action is thus complete without consideration of the social aspects of perception-action (Marsh, Richardson, Baron, & Schmidt, 2006). This is especially true when considering perception-action in team sports, and possibly even in some “individual” sports, since individuals are usually competing against others who may afford certain behaviors. Early theoretical treatments of ecological social psychology and social affordances were offered by Baron and Boudreau (1987), Baron and Misovich (1993), and McArthur and Baron (1983). Three categories of social affordances can be described: Affordances for another person (i.e., what actions another person can perform under a given set of environmental conditions),
affordances for **joint action** (i.e., what actions can the perceiver and another agent or agents perform cooperatively), and affordances of another person (i.e., what actions another person afford the perceiver).

**Perceiving Affordances for Other People.** Although there is some debate regarding whether perceiving the actions possible for another person constitute cases of affordance perception or rather merely perception of relations (Michaels, 2003), evidence indicates that people can accurately perceive what actions are possible for another person (Ramenzoni, Riley, Davis, & Snyder, 2005; Rochat, 1995; Stoffregen, Gorday, Sheng, & Flynn, 1999; Zaff, 1995). The reported accuracy of perceptual reports of affordances for another actor has varied from ball-park accuracy ($\leq 10\%$ error or less; Stoffregen et al., 1999) to very high levels of accuracy ($< 1\%$ error; Ramenzoni et al., 2005). In some cases, however, affordance judgments for another actor have been less accurate than judgments for oneself. For instance, Zaff (1989; see also Zaff, 1995) reported that while people could perceive the affordance of overhead reachability for another actor, judgment errors increased as differences between the perceivers’ and the actors’ reaching heights increased (that error decreased with practice, however). Rochat (1995) found that children made errors in perceiving what is reachable for an adult, although children nevertheless clearly differentiated responses for adults and for themselves. In addition, adults in Rochat’s study were not prone to such errors when making judgments for children, suggesting a developmental basis for the children’s errors.

In all, evidence favors the idea that people can perceive affordances for another actor. What remains less thoroughly documented is the informational basis of this perceptual ability. Stoffregen et al. (1999) found using point-light displays of a walking actor that information contained in movement kinematics was sufficient to support the visual perception of affordances of maximum and preferred sitting heights for the actor, provided that the kinematic displays preserved information about the relation between the actor and the chair. Ramenzoni, Riley, Shockley, and Davis (2006) have shown that perception of affordances for overhead reaching is influenced by manipulating the perceiver’s eyeheight, suggesting that eyeheight-scaled optical information is used when perceiving at least one example of body-scaled affordances for another person.

Perceiving affordances for another person has significance for sport on a number of levels. Athletes need to be able to perceive affordances for their opponents, and tailor their actions to result in situations where certain actions are not possible for the opponent. For example, in tennis a player may need to know what shots afford returning by the opponent, and attempt
to deliver a shot that is not returnable. In basketball, a shooter must avoid attempting a shot when blocking the shot is afforded a defender. In other cases, an athlete needs to know what actions are afforded a teammate. In American football, a quarterback must know how high a receiver can jump to reach a pass that at the same time would not be reachable by a defender. Affordance analyses of these kinds of situations that occur in various sports may provide a useful theoretical framework for sport science research.

**Perceiving Affordances for Joint Action.** When two people come together with a common goal the action capabilities of the dyad in many cases will exceed (or at least differ from) the action capabilities of either individual (Marsh et al., 2006). There will thus be affordances of the dyad-environment system – affordances for joint action – that do not exist for either actor alone under the same environmental circumstances. Very little research has been conducted on perceiving affordances for joint action. In experiments by Isenhower, Marsh, Carello, Baron, and Richardson (2005) and Richardson, Marsh, and Baron (2007), pairs of participants were faced with the task of transferring planks of varying lengths from one table to another. Very short planks were grasped by one participant using one hand. At a critical ratio of plank length to hand size, participants spontaneously adopted a two-handed grasp of the planks. At another critical ratio of plank length to an actor dimension (in this case, arm span), participants exhibited a transition from one-person to two-person lifting. In experiments that only required perceptual judgments of intra- and inter-personal graspability perceivers exhibited prospective perceptual sensitivity to those action boundaries even though they did not have the opportunity to perform the actions in question. These results indicate that people are sensitive to affordance boundaries that span more than one actor, which may be critical for the prospective control of joint action (Sebanz, Bekkering, & Knoblich, 2006).

In sport, joint action may be an important factor related to teamwork. Affordances for joint action indicate what a group or team of athletes is capable of doing when coordinating their behavior as a team. In order to function effectively or optimally as a team it may be necessary that the individual members are capable of perceiving affordances for the team. On the other hand, it may be the case that team members only need to perceive affordances for other individual teammates, rather than perceiving affordances for joint action, and adjust their own actions accordingly so as to produce the desired, coordinated outcome for the team. Empirical studies that can differentiate among those two possible roles of affordance perception in relation to teamwork may provide useful data for improving performance in team sports.
**Perceiving Affordances of Other People.** Other people offer perceivers opportunities for action. For example, in basketball, a teammate may afford allowing me to separate myself from my defender by setting a pick for me, or an opponent may be defendable. As is the case with perceiving affordances for joint action, very little research has examined the perception of what other people afford. In an intriguing set of studies the affordance of whether a person affords mugging has been studied using point-light displays that depicted the person walking (Gunns, Johnston, & Hudson, 2002; Johnston, Hudson, Richardson, Gunns, & Garner, 2004). Those studies revealed that information contained in the kinematics of walking were informative of the walker’s vulnerability to a criminal attack.

**Conclusions**

Athletes are routinely confronted with enormously complex situations that they typically handle with seeming ease and grace. A viable theory of perception and action must explain how an actor performs successfully more often than not when confronted with complex tasks such as those encountered on the athletic field. Consider a forward in soccer dribbling the ball up the field. The forward is confronted with an almost innumerable array of possible actions. The forward could shoot, pass to an open teammate, pass to a less open teammate but one who is in a position to score, continue to dribble uphill (choosing a path based on the position, movement, and spacing of defenders, and the defenders’ ability to close the gap), etc. The forward must determine what actions are possible, determine from among those actions which are most likely to be successful given the existing constraints, and then select from among a dynamic flux of optical variables those invariant features of stimulation that will allow for the successful guidance of the desired behavior. All of that occurs within periods of time ranging from mere milliseconds to a few seconds, and while concurrently overcoming the incredibly challenging biomechanical and neuromuscular problems associated with maintaining an upright posture while locomoting at a relatively high rate of speed while dribbling the ball with the feet.

It is apparent when considering what an athlete accomplishes in even a routine play that perception-action at this level exemplifies a very sophisticated form of “knowing about” (Turvey & Shaw, 1995). In the language used by Turvey and Shaw in their discussion of the fundamentally cognitive nature of perception and action, affordances could be said to provide a functional semantics for sport. In other words, affordances are a way of describing the
meaning of the environment to the actor (i.e., semantics) in terms of how the actor can behave in the environment – the meaning of the environment is said to be functional because the meaning of the environment is with reference to how the actor can behave. An actor must orient and control activity with respect to behavioral possibilities of the environment, not merely to action-neutral physical properties of the environment. Physical descriptors of objects and surfaces in the environment, such as distance, speed, or height, each measured in conventional (and arbitrary) units, do not, in and of themselves, have any meaning for the actor. Affordances, in contrast, are meaningful and provide the athlete with information about how to control activity so as to achieve behavioral goals. Fleshing out the functional semantics provided by affordances will, we believe, provide insights into perception-action that are bound to have profound implications for sport. At the same time, research on affordances in sport is bound to have a profound impact on our fundamental understanding of perception and action.

Acknowledgement

Some of the ideas and empirical results presented in this paper are based on research that was supported by grants from the National Science Foundation (SBR 0423036 awarded to MTT, BCS 0236734 and BCS 0545141 awarded to BRF, and CMS 0432992 awarded to MAR).

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Bronfenbrenner’s Bioecological Theory of Human Development and the process of development of sports talent

RUJ JORNADA KREBS

Objective: The objective of this paper is to discuss the process of building the Bioecological Theory of Human Development, with emphasis on its four components: proximal processes, biopsychological characteristics of a developing person, the parameters of the ecological context, and the dimension of time. As a complementary objective this paper will propose a possible application of Bronfenbrenner’s theoretical structure to the field of sport.

Development: The paper was divided into three parts. The first one was dedicated to analyzing the building process of the bioecological theory. The analysis included brief comments of some of Bronfenbrenner’s assumptions and definitions, as well as the components of his model: proximal processes, which are determined by the interactions between characteristics of the person, the context and the time; biopsychological characteristics of a developing person, which are identified as disposition, resources and demands; the parameters of the ecological context, characterized as microsystem, mesosystem, exosystem and macrosystem; the dimension of time, presented as microtime, mesotime and macrot ime. The second part analyzed Bronfenbrenner’s effort to put theory into research designs. An original classification of research is commented: research on the discovery mode and research on the confirmatory mode. The third part discussed Bronfenbrenner’s theoretical structure applied in the field of sport. A theoretical model based on the Bioecological Theory of Human Development is discussed. The model proposes an analysis of the development of sport talents as a phenomenon of proximal processes and their interactions with personal attributes, ecological settings, and dimensions of time.

Conclusion: After the publication of Making Human Beings Human, in 2005, the great legacy of Urie Bronfenbrenner, his Bioecological Theory of Human Development, was concluded. Back in the seventies it is possible to see his first attempt to build an interface between developmental research and public policy. The phenomenon discussed in this paper, development of sports talent, has variables representing all the four components of the bioecological model, and perhaps it is time to use Bronfenbrenner’s model to follow the process of developing future athletes.

KEY WORDS: Bioecological model, Biopsychological attributes, Human ecology, Proximal processes, Sports talent;

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Introduction

The study of human development in the 1970s started to respond to a number of new trends. Investigators began looking for the origins of development in earliest infancy and in prenatal events and conditions. They started to view the infant as active, capable of initiating contact and influencing their surroundings from birth. They also started to distinguish between aspects of development that were relatively resistant to the environment and those that were responsive or vulnerable. Before 1970, the main concerns of many researchers in the field was to discover the extent of nature and nurture’s specific influences, with only a small number of studies designed to emphasize the interactions between nature and nurture, i.e., the child’s biologically based characteristics and abilities and the different contexts were the child lives. In the 1980s new perspectives in research and theory for the study of human development emerged. Among these new perspectives was the ecological approach, whose emphasis was on studying how people accommodate throughout their lives to the changing environments where they grow and live (Clarke-Steward et al., 1985).

In 1977, Bronfenbrenner had criticized the narrowness and artificiality of the research designs traditionally used in developmental psychology and stressed that: “much of the contemporary developmental psychology is the science of the strange behavior of children in strange situations with strange adults for the briefest possible period of time” (p.513) and in 1979 he published his classical book *The Ecology of Human Development, experiments by nature and design*, in which he defined ecology of human development as a scientific study of the interaction between all the characteristics of an active growing human being and the changing properties of all contexts in which the developing person lives. In 1992, Bronfenbrenner had complemented his definition for ecology of human development and made an important comment related to the imbalance of the number of studies whose focus was on the environment properties compared with those with the focus on person properties:

Yet an examination of the now substantial body of research conducted within an ecological perspective over the past decade reveals a striking imbalance. As I have documented in the series of articles and reviews, existing studies in the ecology of human development have provided more knowledge about the nature of developmentally relevant environments, near and far, than about the characteristic of developing individuals, then or now. (Bronfenbrenner, 2005, p. 107)
The concern with the future of research in human development motivated Bronfenbrenner and his colleagues to propose a research paradigm to be used as a theoretical framework to support investigations capable of reflecting developmental processes as much as, the forces of the context in which development occurs, in order to understand the results of that interaction. An analysis of the existing models and a formulation of two new ones were presented by Bronfenbrenner and Crouter (1983), named person-process-context and chronosystem paradigm. In 1995 Bronfenbrenner integrated those two models into the process-person-context-time model (PPCT), denominated as Bioecological Model. Among all these four components the process was considered by Bronfenbrenner the core of the model:

More specifically, this construct encompasses particular forms of interaction between organism and environment, called proximal processes, that operate over time and are posited as the primary mechanisms producing human development. However, the power of such processes to influence development is presumed, and shown, to vary substantially as a function of the characteristics of the developing Person, of the immediate and more remote environmental Contexts, and the Time periods, in which the proximal processes take place. (Bronfenbrenner & Morris, 2006, p.795)

When Bronfenbrenner (1995) proposed proximal processes as mechanisms of development, he emphasized their “substantive and theoretical significance as the mechanism of organism-environment behavioral interaction that drive development, and the profound ways in which these mechanisms are affected by characteristics of the developing person and the environmental context in which interaction takes place” (p626). He, also, commented that little was known about the operation of the proximal processes because, to date, they had seldom been used in research models that were required for their investigation.

For the next construct of the model – Person – Bronfenbrenner identified two characteristics. The first one was more related with ability, achievement, and the second was associated with dispositional orientation toward the environment:

I suggest that the proposed dichotomy between two general types of person characteristics, biopsychological resources versus directional dispositions, provides an initial strategy of choice for analyzing how differences in psychological makeup influence the effectiveness of proximal processes and their resultant outcomes. By introducing measures of both domains in the same PPCT design and then analyzing their joint, synergistic effect, we can obtain a more complete estimation of the contribution of the person to his or her own development. (Bronfenbrenner, 1995, p.635)
Another version of the *Bioecological Model* was developed (Bronfenbrenner & Morris, 1998, 2006) to include a third characteristic of the developing person, identified as “demand”. Regarding this third characteristic, Bronfenbrenner and Morris (1998) stated that demand “can invites or discourages reactions from the social environment of a kind that can foster or disrupt the operation of proximal processes (2006, p. 796).

According to Bronfenbrenner, “the bioecological theory of human development reached maturity ten years after the publication of *Ecological Systems Theory*” (2005, p.3). In his ultimate approach for the scientific study of human development over time, he wrote that:

> Development is defined as the phenomenon of continuity and change in the biopsychological characteristics of human beings both as individuals and groups. The phenomenon extends over the life course across successive generations and through historical time, both past and present. (2005, p.3)

The objective of this paper is to discuss the process of building the *Bioecological Theory of Human Development*, with emphasis on its four components: proximal processes, biopsychological characteristics of a developing person, the parameters of the ecological context, and the dimension of time. As a complementary objective this paper will propose a possible application of Bronfenbrenner’s theoretical structure to the field of sport psychology.

**Toward process of building the Bioecological Theory of Human Development**

When Thomas (1992) described the process of building a theory of human development as a sequence of steps, he explained that the theorists, in practice, frequently may not move systematically through the sequence, but “appear to shuttle back and forth among the phases revising their definitions, hypotheses and propositions, to produce a system they believe provides a convincing interpretation of the phenomenon” (p.15). Revising his writings published in the seventies, Bronfenbrenner probably followed the steps described by Thomas:

> “Ever since the publication of the *Ecology of Human Development*, now almost a decade ago, I have been engaged in a smuggling operation. In a series of articles written ostensibly for the other purposes, I have been pursuing a hidden agenda: that of reassessing, revising, extending, as well as regretting and even renouncing, some of the conceptions set forth in my 1979 monograph.” (2005, p 106)
When Bronfenbrenner made his first assumptions regarding an ecological paradigm for development in context he said that he was strongly influenced by Kurt Lewin’s classic equation: \( B = f(PE) \), which defines behavior as a joint function of person and environment. He changed Lewin’s equation to: \( D = f(PE) \). Bronfenbrenner emphasized that the “substitution is provocative because it focuses attention on the conceptual difference between behavior and development. The key distinction lies in the fact that development involves a parameter not present in Lewin’s original equation, the dimension of time” (2005, p.108). Bronfenbrenner’s definition for behavior can be inferred from his definition of activity, which is one of the three major elements of the microsystem (see figure 1). Behaviors which have the potential
to instigate proximal process were identified as *molar activities* and those without this potential were called as *molecular activities*:

A molar activity is an ongoing behavior possessing a momentum of its own and perceived as having meaning or intent by the participants in the setting. The terms molar and ongoing are used to emphasize that an activity is more than a momentary event, such as a movement or an utterance; rather, it is a continuing process that entails more than a beginning or an end. A molar activity is distinguished from an act, which is perceived as instantaneous and hence molecular in a character. Examples of act are a smile, a knock on the door, a single question, or an answer. The following are molar activities: building a tower of blocks, digging a ditch, reading a book, or carrying on a telephone conversation. (Bronfenbrenner, 1979, p. 45)

When Bronfenbrenner wrote *Ecology of Human Development: experiments by nature and design* (1979), the dimension of time was not mentioned in his definition of ecology of human development. In 1992 he included the expression *throughout the life course* in the definition to represent the dimension of time, but only in 1995 that dimension was explicitly discussed by Bronfenbrenner, when he explained two principles regarding life course perspectives. In the first one he stated that “the individual’s own developmental life course is seen as embedded and powerfully shaped by conditions and events occurring during the historical period through which the person lives” (p. 641), and in the second one he emphasized that “a major factor influencing the course and outcome of human development is the timing of biological and social transitions as they relate to the culturally defined age, role, expectations, and opportunities occurring throughout the life course” (p. 641). These two principles were taken into consideration when he proposed his *Ecological System Theory* (see Bronfenbrenner, 2005) and changed his definition for ecology of human development:

The ecology of human development is the scientific study of the progressive, mutual accommodation, throughout the life course, between an active, growing human being and the changing properties of the immediate settings in which the developing person lives, as this process is affected by the relations between these settings, and by the larger context in which the settings are embedded. (2005, p. 107)

**PROXIMAL PROCESSES AS MECHANISMS OF DEVELOPMENT**

When Bronfenbrenner revised his original model, some theoretical changes, both in form and contend were introduced, in order “to change the shift of the center of gravity of the model” (Bronfenbrenner & Morris, 1998,
p. 993), he recombined the features of the earlier version into a more complex and dynamic structure. In its revised structure, the bioecological model involves four principal components and the dynamic, integrative relationship among them. Those four components were described as: process, person, context and time, being the process the core of that new version of the bioecological model.

More specifically, this construct encompasses particular forms of interaction between organism and environment, called proximal processes, that operate over time, and are posited as the primary mechanism producing human development. However, the power of such process to influence development is presumed, and shown, toward substantially as 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. (Bronfenbrenner & Morris, 1998, p. 995)

The importance of proximal process as mechanisms of development was explained by Bronfenbrenner when he analyzed a study conducted by Drillien (1964, in Bronfenbrenner, 1995b) designed to assess factors affecting the development of children of low birth weight compared with those of normal birth weight (see Bronfenbrenner, 1995b). Without including proximal processes in the research design much information is lost, “not only with respect to the development power of proximal processes themselves, but also with regard to the ultimate effect of the characteristics both of the person and of the environment” (p.626). He commented that, “what is most revealing about proximal processes, however, is not the gains in predictive power that they provide, but their substantive and theoretical significance as the mechanisms of organism-environment behavior interaction” (p. 626). When Bronfenbrenner wrote these comments he also lamented that at that time little was known about the operation of those processes, because they had seldom been incorporated in the kinds of research models that were required for their investigation.

THE DEVELOPING PERSON

In 1992 when Bronfenbrenner wrote Ecological System Theory, he discussed the properties of the person from an ecological perspective. Specifically related to cognition in context he identified three kinds of concepts, and showed them in a progressive order: (1) competence as an achieved status, e.g., a coach of swimming is viewed as competent in aquatic activities (2) competence evaluated within the setting, e.g., the player who scored more
points in a basketball game is considered the most competent player, and (3) competence as the mastery of culturally defined, familiar activities in everyday, e.g., the athlete who can handle successfully not only the issues of his or her sport career but also those related to daily activities is viewed as the most competent. He also mentioned temperament and personality as properties of the person. Bronfenbrenner was not yet satisfied with his approach to describe the properties of a developing person, and in 1995 he described two types of person characteristics, namely biopsychological resources and directional dispositions.

In an invited address to the Jean Piaget Society (Bronfenbrenner, 1993), I drew a distinction between two broad types of person characteristics especially relevant in shaping the individual’s future development. On the one hand, there are the familiar measures of ability, achievement, temperament, and personality typically assessed by psychological tests. All such assessments can be thought of as indexing existing psychological resources and abilities. But there is another, more dynamic set of person attributes that also affect the course and character of psychological functioning and growth. These attributes share a feature incorporated in the first defining property of the bioecological paradigm: namely, they reflect a conception of the human organism as an active agent in, and on, its environment. This active orientation is manifested in strong dispositional propclivities to set in motion, sustain, and enhance processes of interaction between the organism and particular features of persons, objects, and symbols in its environment. (p. 634)

In an updated version of the model (Bronfenbrenner & Morris, 1998) a third characteristic was included – demands. The disposition may be viewed as a motivational force, negative or positive, that can activate proximal processes in a particular developmental. To explain positive or negative effects of the disposition the authors created the terms developmentally-generative (for the positive ones) and developmentally-disruptive (for the negative ones). In a sport setting a developmentally-generative disposition should be the athlete’s disposition to repeat a routine of exercises in order to improve his or her physical fitness, while a developmentally-disruptive disposition should be the athlete’s disagreement to repeat a routine of exercises which should improve his or her physical fitness. A comparison between the characteristics of these two types of disposition was made by Bronfenbrenner and Morris (2006):

Examples of the developmentally-disruptive disposition come more readily to mind. At one pole, they include characteristics as impulsiveness, explosiveness, distractibility, inability to defer gratification, or, in a more extreme form, ready resort to aggression and violence. At the opposite pole are such person attributes as apathy, inattentiveness, unresponsiveness, lack of interest in one’s surroundings, feelings of insecurity, shyness, or a
general tendency to avoid or withdraw from activity... By contrast, developmentally-generative characteristics involve such active orientations as curiosity, tendency to initiate and engage in activity alone or with others, and readiness to defer immediate gratification in order to pursue a long-term goals. (p. 810)

The second type of personal attributes, the resources, “constitute biopsychological liabilities and assets that influence the capacity of the organism to engage effectively in proximal processes” (Bronfenbrenner & Morris, 2006, p.812). Like these authors have done for the disposition characteristics of the person, the authors divided the resource according to their negative or positive characteristics. In the first category they identified the conditions that limit or disrupt the functional integrity of the organism and as examples they mentioned genetic defects, low birth weight, physical handicaps, severe and persistent illness, or damage to brain function through accident or degenerative processes (e.g., specifically in sports gymnastic and figure skating, obesity should be an example of negative resource). In the other category they mentioned abilities, knowledge, skills and experience that, (e.g., a tall volleyball player has his or her height as a positive resources to be selected for a team).

Most of the studies in the field of sport sciences that described personal characteristics of athletes have used analytical designs, in which one dependent variable (e.g., motivation, anxiety) is investigated at a time (Love, 1992, Seifriz, Duda & Chi, 1992, Kavussanu & Roberts, 1996, Vlachopoulos & Biddle, 1996, Papaiioannou, 1998, Dunn, 2000). The bioecological model offers a possibility to use new research designs to conduct better investigations to assess the athlete’s disposition, which Bronfenbrenner classified as developmentally-disruptive disposition or developmentally-generative. Within the sport context an athlete may experience at the same time both types of disposition, the positive ones and the negative ones. These opposite forces will generate an area of tension within the athlete’s feelings and emotions. If the disruptive disposition will prevail it is impossible to know because the dispositions are in constant interaction with the elements of the microsystem and with the forces of the mesosystem, exosystem and macrosystem, (micro-, meso-, exo-, and macro-system are the four level of the model designed by Bronfenbrenner in 1979, and will be described in the next section) as well as with the dimensions of time and with the other types of personal attributes. All the examples given by Bronfenbrenner and Morris (1998, 2006) to describe developmentally-disruptive disposition are present in any sport setting. The same is also true for the developmentally-generative disposition.

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The third type of personal attributes, demands, was included later in the model, and have to be understood as characteristics “that invite or discourage reactions from the social environment of a kind that can foster or disrupt the operation of proximal processes” (Bronfenbrenner & Morris, 2006, p. 796). Actually that third characteristic combines some properties of resources and disposition, and is evaluated according to its potential to make a person be accepted or rejected by the others in the immediate environment:

The distinguishing feature of this last Person characteristics affecting development is their capacity invite or discourage reactions from the social environment that can foster processes of psychological growth: for example, a fussy versus a happy baby, attractive versus unattractive physical appearance, or hyperactivity versus passivity. Half a century ago, Gordon Allport (1937) introduced by Mark A. May (1932), spoke of such characteristics as constituting “personality” defined in terms of its “social stimulus value”. Rephrasing this concept in terms of its analog in contemporary theories of perception, we refer to such Person qualities as demand characteristics.” (Bronfenbrenner & Morris, 2006, p.813)

The authors emphasized that the differentiation of these three forms leads to their combination of patterns of the developing person and can explain the individual’s differences within a group of persons. In order to demonstrate the dynamics between these three personal attributes, a hypothetical situation in the field of sport competition was created. When the athletes have to play in an important tournament, those that are more likely to act in an impulsive and explosive way and are unable to defer gratification but, at the same time, are striving to postpone immediate gratification in order to pursue a long-term goal will experience “a battle between dispositions”. In that case, an athlete that has positive resources and demands had planned his/her career in a macro-time dimension, and is encompassed by positive micro-, meso-, exo- and macrosystems, seems to have more chances to succeed. These elements of the setting are precisely what will be discussed next.

ELEMENTS OF THE SETTING

Bronfenbrenner changed the concerns of environment that were a consensus among many psychologists in the late decades of the last century. He stated that the environmental properties were not distinguished by reference to linear variables but analyzed in systems terms. That statement was emphasized when he defined the properties of the bioecological model and pointed that “the scientifically relevant features of an environment for human devel-
opment not only include its objectives properties but also the way in which the properties are subjectively experienced by the person living in that environment” (Bronfenbrenner & Morris, 2006, p.796).

He designed a structure of ecological environments with four levels: microsystem, where people can readily engage in face-to-face interaction; mesosystem, which comprises the interrelations among two or more settings in which the developing person actively participates; exosystem, which refers to one or more settings that do not involve the developing person as an active participant; and macrosystem, which encompasses the three other levels (see figure 1). Beginning at the innermost level of ecological schema, the microsystem, three elements were identified as important components of that level: activities (all the possible things that the developing person can do within the microsystem; e.g. long distance jump, goal kick, spike a volleyball), interpersonal relationships (all the possible ties that the developing person can establish with the other persons within the microsystem; e.g. the coach and the athletes planning a strategy to be used in the next game), and roles (involve both activities and relations expected of a person playing a particular position in society, and of others in relation to that person; e.g. what is expected from a gymnast who participates in a national competition).

He classified the activities into two types. He named as molar those activities perceived as having meaning or intent and in which the developing person persists until the activity is completed, and those without meaning and persistence were named as molecular. Bronfenbrenner explained the differences between molar and molecular activities:

All molar activities are forms of behavior, but not all behaviors are forms of molar activity. The reason for making the distinction lies in the belief that not all behaviors are equally significant as manifestations of or influences on development. Many are so short-lived as to have minimal importance; these are referred to as molecular behaviors. Others are more long-lasting but, because they lack meaning to the participants in the setting, have only negligible impact. The definition of molar activity thus emphasizes both some persistence through time and some salience in the phenomenological field of the developing person and of others present in the setting. (Bronfenbrenner, 1979, p. 45)

For an athlete it is possible to enumerate many different microsystems in which he/she actively participates, but maybe the most influent in a sport career are the athlete’s family home and the setting where the sport practice takes place. The second component of the microsystem, the interpersonal relationship, has its basic unit of analysis named as dyad, or a two-person system. “Although the literature of developmental psychology makes frequent reference to dyads as structures characterized by reciprocal relations, we shall see
that, in practice, this principle is often disregarded” (Bronfenbrenner, 1979, p.5). Actually Bronfenbrenner addressed that criticism to the way which data was collected and analyzed in most of the researches involving dyadic relationships. He commented that “with the traditional focus of the laboratory procedure on a single experimental subject, data are typically collected about only one person at a time” (1979, p.5). In the field of sport psychology any attempt to analyze a dyad between athlete and coach that uses separated measures of the athlete and coach interaction may fail to interpret the true dynamic possibilities for interaction provided by that dyad. When that interpersonal relationship within a microsystem includes more than two persons, the relationship becomes a triad, tetrads, etc. Bronfenbrenner explained the power of the presence and participation of third parties in the microsystem:

“In addition, a systems model of the immediate situation extends beyond the dyad and accords equal developmental importance to what are called N + 2 systems – triads, tetrads, and larger interpersonal structures. Several findings indicate that the capacity of a dyad to serve as an effective context for human development is crucially dependent on the presence and participation of the third parties, such as spouses, relatives, friends and neighbors. If such third parties are absent, or if they play a disruptive rather than a supportive role, the developmental process, considered as a system, breaks down; like a three-legged stool, it is more easily upset if one leg is broken, or shorter than the others.” (Bronfenbrenner, 1979, p.5)

The third element of the microsystem, the role, involves an integration of the previous two, the activities and the relationships in terms of societal expectations. Because these societal expectations are influenced by the culture as a whole, “the role, which functions as an element of the microsystem, actually has its roots in the higher-order macrosystem and its associated ideology and institutional structures” (Bronfenbrenner, 1979, p. 86).

A mesosystem comprises the linkages and processes taking place between two or more setting containing the developing person (e.g. the swimming pool where a swimmer have his or her training and the place where he or she attends to Physical Education classes), while the exosystem encompasses not only the settings in which the developing person participates but at least one more that does not ordinarily contain that person, and in which events occur that influence processes within the other settings that does not contain the developing person (e.g. the coach’s house environment where the swimmer does not participate. Some events within the coach’s family may affect processes involving coach and swimmer occurring in the swimming pool environment). Considering the mesosystem and the exosystem, Bronfenbrenner assumed that the same triadic principle (mentioned for the
microsystem) applies to relations between settings. In the sports field that triadic principle could be exemplified by the interdependence existing among the setting in which the athlete directly or indirectly participates (e.g. the athlete’s house, the athlete’s local of training, the athlete’s school or college, etc.). Thus the capacity of a setting to function effectively as a context for development “is seen to depend on the existence and nature of the social interconnections between settings, including joint participation, communications and the existence of information in each setting about the other” (Bronfenbrenner, 1979, p.6). When the athlete moves from one microsystem to another a mesosystem is created. Because the athlete transits between several microsystems, a very important social network is created. The linkage between these mesosystems and other microsystems where the athlete does not participate but have indirect ties with them builds several exosystems, which also have to be considered important component of the athlete’s social net. All the possible connections between microsystems, mesosystems and exosystems are the athlete’s macrosystem. In 1992 Bronfenbrenner updated his definition for macrosystem.

The macrosystem consists of the overarching pattern of micro, meso-, and exosystems characteristics of a given culture, subculture or other broader social context, with particular reference to the developmentally instigative belief systems, resources, hazards, lifestyles, opportunity structures, life course options, and pattern of social interchange that are embedded in each of this systems. The macrosystem may be thought of a societal blueprint for a particular culture, subculture, or other broader social context, (Bronfenbrenner, 2005, p.150).

In order to investigate microsystem as contexts of human development Bronfenbrenner wrote nineteen hypotheses to be tested. To analyze the forces of the mesosystem generated by the number of multisetting participation, indirect linkage, intersetting communication, and intersetting knowledge Bronfenbrenner formulated sixteen hypotheses. Two hypotheses were addressed to the exosystem. The five last hypotheses formulated by Bronfenbrenner included the macrosystem characteristics and the interconnections between all the systems (See Bronfenbrenner, 1979). Many situations experienced by one athlete during his or her career may be investigated using Bronfenbrenner’s hypotheses. For example, the ecological transition that athletes experience when they move from one context to another (e.g., when an athlete that plays in one soccer team moves to another team) may be inferred from the following hypotheses:

HYPOTHESIS 34. The developmental potential of a setting in a mesosystem is enhanced if the person’s initial transition into that setting is not made alone, that is, if he
enters the new setting in company of one or more persons with whom he has participated in prior settings. (Bronfenbrenner, 1979, p. 214)

HYPOTHESIS 38. The developmental potential of a setting in a mesosystem is enhanced to the extent that there exist indirect linkages between settings that encourage the growth of mutual trust, positive orientation, goal consensus, and a balance of power responsive to action in behalf of the developing person. (Bronfenbrenner, 1979, p.216)

HYPOTHESIS 41. Development is enhanced to the extent that, prior to each entry into a new setting (for instance, enrolling in day care or school, being promoted, going to camp, taking a job, moving, or retiring), the person and members of both settings involved with information, advice, and experience relevant to the impeding transition. (Bronfenbrenner, 1979, p.217)

HYPOTHESIS 43. The developmental potential of a mesosystem is enhanced when the persons involved in joint activity or primary dyads in different settings form a closed activity network, that is, when every member of the system engages in joint activities with every other member. This pattern becomes optimal if each party interacts with every other in each setting and is subject to the qualification that the balance of power gradually shift in favor of the developing person and those primarily responsible for his well-being. (Bronfenbrenner, 1979, p 223)

DIMENSIONS OF TIME

Time was the last factor included in the bioecological model. In the original model (1979), the properties of time were still missing. When Bronfenbrenner revised his definition for the ecology of human development, he discussed new approaches to investigate the “progressive, mutual accommodation between an active, growing human being and the changing properties of the immediate settings where the person lives” (1979, p. 21) he described two different research designs, the a person-process-context model and the chronosystem model (Bronfenbrenner & Crouter, 1983). Time was formally included as a component of Bronfenbrenner’s model in 1995. That new version of the model was formed by four elements - person-process-context-time (PPCT model), which was also named as bioecological model:

Considerations of time and timing as they relate to features of the environment, as opposed to characteristics of the person, have only recently begun to receive systematic attention in developmental research. The principal advances in this regard have been made by sociologists working in the life course perspective (1995, p.641)

Bronfenbrenner discussed time using two criteria, the historical period through which the person lives, and the “timing of biological and social tran-
sitions as they relate to the culturally defined age, role expectations, and opportunities occurring throughout the life course” (1995, p 641). Historical period and timing may be explained with the American boycott to the Olympic Games in Moscow. All the American athletes selected to participate in the games were affected by the political decision of the American government. Using the first criterion, it could be investigated the effects of the boycott within the entire setting of sport competition in that country. On the other hand, using the second criterion, the focus of a investigation could be on the comparison between those that were going to participate in the Olympic games for the first time and those that had already competed in the Olympic Games and had made plans to finish their sport careers after the Moscow Games. In 1998, Bronfenbrenner and Morris designed three successive levels to classify time: micro-time, meso-time and macro-time. Micro-time refers to continuity versus discontinuity within ongoing episodes of proximal process (e.g., one day of practice of a gymnastic routine). Meso-time is the periodicity of these episodes of proximal process (e.g., three weeks practicing a gymnastic routine). Finally, macro-time focuses on the changing expectations and events in a larger period (e.g., the entire season of sport, from the beginning of the gymnastic training to the final championship). In the chapter The Bioecological Model of Human Development (2006), Bronfenbrenner and Morris used the terms microchronological, mesochronological, and macrochronological systems as reference of time in the bioecological model. Although many studies in the sports science field had used the variable time in their research design, they were used merely in term of its chronological characteristics. Few studies however have used in their design the meaning for time proposed by Bronfenbrenner (Krebs & Copetti, 1987, Fiorese-Vieira et al., 1998; Vieira, 1999; Fiorese-Vieira 1999). Using Bronfenbrenner’s classification for time it is possible to formulate promising hypotheses to investigate problems related to an athlete’s sport career. It should be investigated the major factors influencing the course and outcomes of the athlete’s career. Another possibility should be an evaluation of the timing of the athlete’s biological and social transitions, as they relate to the culturally defined role expectations of the athlete, and opportunities occurring throughout his or her life course.

USING THE BIOECOLOGICAL MODEL AS A PARADIGM FOR SPORTS

Most of the studies in the field of sport sciences that described personal characteristics of athletes have used analytical designs (Love, 1992, Seifriz,
Duda & Chi, 1992, Kavussanu & Roberts, 1996, Vlachopoulos & Biddle, 1996, Papaioannou, 1998, Dunn, 2000) Bronfenbrenner’s bioecological model offers a possibility to use new research designs to conduct better investigations to assess the athlete’s personal attributes. The first biopsychological characteristic of the person is disposition, which Bronfenbrenner classified as developmentally-disruptive disposition or developmentally-generative. Within the sport context an athlete may experience at the same time both types of dispositions, the positive ones and the negative ones. These opposite forces will generate an area of tension within the athlete’s feelings and emotions. If the disruptive disposition will prevail it is impossible to know because the dispositions are in constant interaction with the elements of the microsystem and with the forces of the mesosystem, exosystem and macrosystem, as well as with the dimensions of time and with the other types of personal attributes. All the examples given by Bronfenbrenner and Morris (1998) to describe developmentally-disruptive disposition are present in any sport setting. The same is also true for the developmentally-generative disposition. In order to demonstrate the tension areas created when opposite dispositions are occurring concomitantly, a hypothetical situation will be described. If the coach has to select athletes to play in an important tournament, those that are more like to act in an impulsive and explosive way and are unable to defer gratification but, at the same time, are striving to postpone immediate gratification in order to pursue a long-term goal will experience “a battle between dispositions”. In that case, an athlete that has positive resources, had planned his/her career in a macro-time dimension, and is encompassed by positive micro-, meso-, exo- and macrosystems, seems to have more chances to succeed. Another hypothetical situation can illustrate the application of the bioecological model in sport situations can be shown when and athlete with negative dispositions of apathy, inattentiveness, unresponsiveness enters in a microsystem where he/she has an opportunity to experience molar activities, interpersonal structures sustained by reciprocity, balance of power and affective relations, his/her disposition may shift from the developmentally disruptive pole to the developmentally-generative pole. The second biopsychological characteristic of the person is resources. According to their nature these characteristics can be viewed as an active resource or as a passive resource. Those which are mainly genetic dependent (e.g., height) are the passives and those which are more like to be affected by environment and experiences are the active ones, and both can be identified by its positive or negative characteristics for a specific task or activity within a microsystem.

In the area of sport psychology the number of investigations regarding children and adolescents involvement in sport has increased in the last
decades. “This growth has been accompanied by a relative fragmentation of the field in multiple lines of work and research” (Bengoechea, 2002, p.1). Even though Bronfenbrenner’s *Bioecological Theory of Human Development* is not yet well known among the researchers of sport sciences, some studies have been designed to investigate topics in that field (Krebs, 1995, 1997, 2003; Fiorese-Vieira, Vieira & Krebs; 1998; Stefanello, 1999; Fiorese-Vieira, 1999; Vieira, 1999; Bengoechea & Johnson, 2001; Copetti, 2001; Krebs & Sartori, 2003; Burgos, 2006). All these studies centered the focus of the investigation on proximal processes and the dynamics between the athletes’ personal attributes, the structures of the environment, and the dimensions of time:

As I learned from Kurt Lewin more than six decades ago, there is nothing more practical than a good theory, and my hope is that the perspective I have developed will be seen as the most practical theory of all. I hope it will give all individuals greater understanding of what they can do to produce a better, more hopeful future for themselves, their children, and the people of the world. (Bronfenbrenner, 2005, p.xxix)

From theory to research design

In 1979, when he proposed the *ecology of human development*, Bronfenbrenner was offering a new theoretical perspective for research in human development. One of the most distinctive characteristics of his new approach was the requirement for the researchers to conduct their investigation beyond single settings and look to the relations between those settings (See parts three and four, “The analysis of settings” and “Beyond microsystem”, in Bronfenbrenner, 1979). In order to study the ecology of human development, Bronfenbrenner formulated a set of fifty hypotheses and discussed all of them using data reported by other investigators of the field of human development. His hypotheses were related to the four levels of his theoretical model (See Bronfenbrenner, 1979). Comparing his proposed model with the prevailing ones up to the seventies, he concluded that:

“A theoretical conception of the environment extending beyond the behavior of individuals to encompass functional systems that can also be modified and expanded, contrasts sharply with prevailing research models. These established models typically employ a scientific lens that restricts, darkens, and even blinds the researcher’s vision of environmental obstacles and opportunities and of the remarkable potential of human beings to respond constructively to an ecologically compatible milieu once it is made available. As a result, human capacities and strengths tent to be underestimated.” (p.7)
Bronfenbrenner’s first model (1979) was centered on the role of environment in shaping development. In 1983 he analyzed the evolution of environmental models in developmental research (See Bronfenbrenner & Crouler, 1983) and in 1988 he published *Interacting Systems in Human Development – Research Paradigms: Present and Future*. He had three main objectives in that article: (a) to describe systematically the nature and scope of the models currently employed, (b) to identify the strengths and shortcomings of each, and (c) to explore possibilities for improving on existing paradigms by combining their constructive elements in more comprehensive conceptual and operational designs. When he published *Developmental Ecology Through Space and Time: a Future Perspective* (1995 b), he made a very clever comment regarding the state of art of research in developmental sciences.

By and large, today’s developmental science is the science of average trends. We know very little about exceptions, and perhaps even less about the characteristics of those members of the sample to whom the findings in fact apply. Indeed, the ultimate paradox is that the more “scientific” the study, the less we are likely to discover which human beings are subject to its results. The reason for this paradox is that the psychological science took physics as its model, and physics seeks to discover universal principles: those that apply to all physical phenomena across time and space. But human beings, like all living creatures, are widely variable in their biopsychological characteristics and, as result, are differentially susceptible to the external conditions and forces to which they are exposed during their lifetime. Of course, this does not mean that such variation is unsystematic and, hence, not amenable to scientific investigations; what it does mean is that the research models we use must take such variation in account, and not simply in the form of random error. (p.632)

At the end of the past century the theoretical model proposed by Bronfenbrenner to investigate human development had a shift from the focus on environment to a focus on processes (See Bronfenbrenner 1995a, 1995b; Bronfenbrenner & Morris, 1998). When Bronfenbrenner defined properties of the bioecological model (2005), he explained that:

Another property of the bioecological model specifies that it deals with two closely related but nevertheless fundamentally different developmental processes, each taking place over time. The first defines the phenomenon under investigation: namely, that of continuity and change in the biopsychological characteristics of human beings. The second focuses on the development of scientific tools – the theoretical models and corresponding research designs required for assessing the continuity and change. (p.4)

In order to investigate continuities and changes of the person’s biopsychological characteristics in developmental researches, Bronfenbrenner defined two possibilities to elaborate the research design, the *discovery mode* and the
verification mode. The comparison between the two possibilities was made by Bronfenbrenner. “In the more familiar verification mode, the aim is to replicate previous findings in other settings to make sure that the findings still apply. By contrast, in the discovery mode, the aim is to fulfill to broader but interrelated objectives” (2005, p. 4). Actually, these two objectives can be considered essential to understand Bronfenbrenner efforts put the bioecological theory into research:

1 – Devising new alternative hypotheses and corresponding research that not only call existing results into question but also stand a chance of yielding new, more differentiated, more precise, replicable research findings and thereby producing more valid scientific knowledge.
2 – Providing scientific bases for the design of effective social policies and programs that can counteract newly emerging developmentally disruptive influences. This has been an explicit objective of the bioecological model from its earliest beginnings. (p. 4)

Bronbenbrenner studied the characteristics of the research designs that had been employed over the past several years to propose his formulations of the bioecological model and concluded that “an appropriate design strategy at this point in the discovery process could be one that involves a series of progressively more differentiated formulations and corresponding data analyses, with the results at each successive step setting the stage for the next round” (Bronfenbrenner & Morris, 2006, p. 802). Such a strategy could be used to design a research model to investigate a sport talent development. All data collected regarding the beginning stage should be used to reformulate the design to be used to investigate the next stage when the athlete is engaged in learning practice of specific sport skills According to Bronfenbrenner and Morris, (2006) the research designs employed in developmental sciences must be primarily generative rather than confirmatory versus disconfirming. “Of primary scientific interest are not those aspects of observed pattern already anticipated in the existing theoretical model, but those features that point to more differentiated and precise theoretical formulation” (p. 802).

Regarding the critical role in research design played by statistical analysis Bronfenbrenner and Morris commented that:

First in the discovery phase, Type I errors can entail an even greater risk than errors of Type II. To state the issue more broadly, dismissing as invalid a finding that points the way to a fuller and more precise explanation for the phenomenon under investigation may result in a greater loss than that produced by accepting a finding that is highly significant because of as yet undifferentiated and thereby confounded factors producing the phenomenon in question (e.g., the failure to distinguish Process from Context). The greater risk in the discovery process of dismissing findings as Type I errors is further compounded by the phenomenon of magnification of early environmental differences over time. (p.802)
When Bronfenbrenner explained for the first time what was an ecological experiment (1979) he said that if the researcher wished to understand the relation between the developing person and some aspects of his or her environment it is necessary to perturb the one, and see what happens to the other. “Implicit in this injunction is the recognition that the relation between person and environment has the properties of a system with a momentum of its own; the only way to discover the nature of this inertia is to try to disturb the existing equilibrium” (p.37). In the last revision of the bioecological model Bronfenbrenner and Morris (2006) stated that in ecological research, the principal main effects are likely to be interactions, and any research design based on a bioecological model must allow for the possibility of such interactions.

A Bioecological Model for the process of development of sports talent

When Bronfenbrenner wrote his Bioecological Theory of Human Development (2005), he presented nine new propositions to clarify the properties of the bioecological models. In the first proposition he emphasized that “experience”, as a critical element of the model. If this proposition is applied to analyze the development of a sport talent career it will be possible prevent possible negative effects of early sport specialization such as those related with burnout.

Experience pertains to the realm of subjective feelings: for example, anticipations, forebodings, hopes, doubts, or personal beliefs. These, too, emerge in early childhood, continue through life, and are characterized by both stability and change. They can relate to self or to others, and especially to family, friends, and other close associates. They can also apply to the activities in which one engages: for example, those that one most or least likes to do. But the most distinctive feature of such experiential qualities is that they are “emotionally and motivationally loaded”, encompassing both love and hate, joy and sorrow, curiosity and boredom, desire and revulsion, often with both polarities existing at the same time but usually in differing degrees. A significant body of research evidence indicates that such positive and negative subjective forces, evolving in the past, can also contribute in powerful ways to shaping the course of development in the future. (2005, p. 5)

Proposition II was entirely dedicated to explain the ways which proximal processes can affect human development. Among the examples he used to illustrate these processes were learning new skills, athletic activities, caring for others, performing complex tasks, and acquiring new knowledge and know-how. That proposition also has a great potential to be used as a “guideline” for programs designed to develop sports talent. He proposed that for development to occur, the person must engage in an activity (e.g., learning
sports). A good system to develop sports talent should offer a variety of sports activities in order to facilitate the inclusion of all children in these activities. Disregarding that proposition and putting young athletes in very intense training programs may raise the risk of failing a promising sport career. It is important to remember that Bronfenbrenner (1995) emphasized that “developmentally effective proximal processes are not unidirectional; there must be influence in both directions” (p. 28). Considering the case of the athlete-coach interpersonal interaction, that proposition means that initiatives do not come from one side only; there must be some degree of reciprocity in the exchange.

In Proposition III Bronfenbrenner emphasized the *process-person-context-time model* (PPCT) He stated that the form, content, and direction of the proximal process vary systematically as a joint function of the biopsychological characteristics of the developing person, the environment and time. Specifically regarding the importance of time in the PPCT model, he stated that to examine if development actually occurred, the research design “must demonstrate, or at least make plausible, that the elements in the design, and their dynamic relationship to each other, have influenced the biopsychological characteristics of the developing person over an extended period of time” (Bronfenbrenner, 2005, p. 7). That proposition could also be used to design a research to investigate development of sport talents.

The fourth proposition was previously discussed by Bronfenbrenner and Morris (1998), and by Bronfenbrenner and Evans (2000). It is related to changes and continuity of the person’s biopsychological characteristics and those of environment, over extended period of time.

In order to develop – intellectually, emotionally, socially and morally – a child requires, for all these, the same thing: participation in progressive more complex activities, on a regular basis over an extended period of time in the child’s life, with one or more persons with whom the child develops a strong, mutual emotional attachment, and who are committed to child’s well-being and development, preferably for life. (Bronfenbrenner, 2005, p.9)

That proposition must be taken into consideration by those responsible for sport programs for children (parents, coaches, sport administrators, etc.). Following what was proposed by Bronfenbrenner, all children should have the opportunity to participate in progressive more complex sport activities, under supervision of prepared adults, committed to children’s well-being rather than to their athletic characteristics. The remained propositions are related with the family environment and social policy, and also have a potential to be used as guidelines for development of sport talents (See Bronfenbrenner 2005).
Commenting on an article regarding innate talents from Howe et al. (1998), Bronfenbrenner argued that particular interactions serve to develop individual genetic potential for a particular skill. He called these interactions as proximal processes which, according to him, are primary engines of development. In order to apply Bronfenbrenner’s model to understand proximal processes in sport talent development it is necessary to consider his proposition which states that, “over the life course, human development takes place through process of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects, and symbols in its immediate external environment” (2005, p.5). Several studies have emphasized the influence of the parents in children’s engagement in organized sports programs (Copetti, 2001, Andrighetto & Krebs, 2006). They concluded that the first experiences of play activities of a child probably starts at home, and consequently the parents’ decisions and expectations regarding a sport career of their children will determine most of the characteristics of the proximal process of sport stimulation.

In his doctoral dissertation, Krebs (1987) reported that only a few scientific studies had investigated the physiological, biomechanical, psychological, and social implications of early sport specialization, described by him as a process of enrolling young children in intensive training programs of a specific sport, with the objective of having a gold medal athlete. During the last two decades the issue of detection and development of sport talent became a common topic of investigation in many studies reported in the sport literature. Most of the studies in the area of talent identification and development have used motor and physical tests as instruments to evaluate children capacities to be considered a sports talent. The main goal of these studies was related to descriptive variables such as height, weight, body composition, gross motor development and specific motor skills (Matsudo, 1996; Reilly et al., 2000; Bourgois et al., 2000; Silva, 2003; Falk et al., 2004; Elferink-Gemser et al., 2004; Jawis et al., 2005). Some other studies used psychological variables as indicators of sports talent among children and young athletes (Morris, 2000; Gould et al., 2002; Côté & Hay, 2002). The approach used in these studies was similar to what Bronfenbrenner and Crouter (1983) labeled as person-context model (the process and time were not included in those studies). Few studies related with sports talent have reported the use of Bronfenbrenner’s bioecological model. Vieira (1999) investigated elite athletes in track and field and used the PPCT model to analyze those athletes.
who abandoned the sport before they have reached the top of their career (e.g., an Olympic medal or a medal in Pan American Games). The results indicated different motives for each athlete. The combination of time duration of events occurred in the context, involving their biopsychological characteristics such as disposition to change the course of their lives (e.g., to get married, to have children, to have a college degree) were emphasized in the conclusions of the study. Another study with elite athletes in track and field was reported by Fiorese-Vieira. She investigated the engagement and permanence of those athletes in the sport. The criterion for inclusion in the study was to have participated successfully in international championship such as World Championship of Track and Field, Pan American games, Olympic Games, etc. The results showed an agreement of the athletes regarding the importance of the macrosystem (e.g., support from the government and private enterprises, the national and international media, public policies for the sport). For those top athletes the elements of the microsystem seemed to be less important than those of the macrosystem.

Theoretical models using the bioecological perspective in the field of sport sciences are still a novelty. Bronfenbrenner’s four dimensions of the ecological systems were used by Spence and Lee (2002) to develop an ecological model of physical activity. The authors identified high quality playgrounds facilities and verbal encouragement from teachers and friends as positive characteristics of the microsystem. Parental support for physical activities at home and child’s involvement in physical activities at school were viewed as good examples of positive characteristics of the mesosystem while workplace support for physical activities, regarding the child’s parents, and mass media were considered important features of the exosystem. Finally, they emphasized societal values about physical activities and safe neighborhoods as important characteristics of the macrosystem. Bengoechea (2002) wrote a paper whose main purpose was to use Bronfenbrenner’s bioecological perspective as a useful framework for integrating knowledge and for opening new pathways in sport psychology. These new pathways may be related with both guidelines for practice of sport and research designs emphasizing the discovery mode rather than the confirmatory mode.

When Bronfenbrenner and Morris (1998) designed the person-process-context-time model they spent some efforts to clarify the question of their how model was bioecological. One of the assumptions for the person-process-context-time model has to be considered, namely the influence of those biological based potential that a sports talent may express, and the environmental conditions and the needed experiences to unfold those potentials:
The present model rests on the assumption that biological factors and evolutionary processes not only set limits on human development but also impose imperatives regarding the environmental conditions and experiences that are required for the realization of the human potentials. The position is taken that, to the extent that the necessary conditions and experiences are not provided, such potentials will remain unactualized. (p. 1003).

The *Bioecological Model of Sports Talent Development* is an attempt to develop a theoretical framework based on Bronfenbrenner's *Bioecological Theory of Human Development*, to create new avenues for the investigation of the process of sports talent development. Because Bronfenbrenner stated that the proximal processes constitute the core of the model (See Bronfenbrenner & Morris, 2006), the phenomenon of development of sport talent is placed as proximal processes. A theoretical structure of proximal processes was proposed by Krebs (1992). It was constituted with four stages and the level of difficulty increases gradually from stage to stage. The two variables responsible for changes in the level of difficulty are organization, which is related with the interdependency of the elements of the setting and the complexity of the activities experienced by the persons participating in that setting. The first proximal process was named as *stage of sport stimulation*. Its structure has a low organization and low complexity, which means that all the elements that constitute the activities in that setting have little relationship among them and the tasks are very simple (e.g., tag games).

The main feature at that stage is to create a strong network with all the contexts in which the developing person actively participates and to create favorable conditions to assure inclusion in play activities for all participants of that microsystem. The second proximal process was called a *stage of sport skills learning*. Its structure is more organized than the previous one and the tasks are also more complex. It was assumed that in this stage learning of different sport skills will occur. The third proximal process was identified as *stage of sport practice*, which setting is highly organized and the tasks involved are also highly complex. The condition to starts in this stage is the developing person have reached autonomous phase of the learning process. Finally, the fourth proximal process, named the *stage of sport specialization*, which is oriented to deal with perfection in sports performance. The arrows in the figure 2 represent the progressively more complex reciprocal interaction between all the four elements of the model (See Bronfenbrenner, 2005). This model was oriented to support research designs with emphasis on interactions rather than in the main effect, and it should be viewed as a design for researches on the discovery mode (See Bronfenbrenner & Morris, 2006)
Conclusion

After the publication of *Making Human Beings Human*, in 2005, the great legacy of Urie Bronfenbrenner, his *Bioecological Theory of Human Development*, was concluded. Back to the seventies it is possible to see his first attempt to build an interface between developmental research and public policy. His first theoretical model, designed as a set of nested structures, each inside the next, resembling a set Russian dolls, was a reaction to those studies of human development which did not include variables from context in the research design. The inclusion of the three properties of the person, biopsychological resources, directional disposition, and demands; the dimensions of time; and the characteristics of proximal processes, may be viewed as a turning point in his theoretical framework. In that first decade of twenty-first century, Bronfenbrenner’s theory reached the status of one of the
most powerful toll to generate new avenues for researches on developmental sciences.

The strategy design with the emphasis on the discovery process, proposed by Bronfenbrenner, has not yet been tested in the field of the sport sciences. The phenomenon discussed in this paper, development of sports talent, has variables representing all the four components of the bioecological model, and maybe it is time to use Bronfenbrenner’s model to follow the process of developing future athletes. In order to implement the bioecological model to investigate in the sport science, the design must be generative rather than confirmatory. There is not a better way to conclude this paper than using Bronfenbrenner’s own words. “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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Some brickbats and bouquets for ecological approaches to cognition in Sport

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The articles by Brett Fajen, Michael Riley and Michael Turvey, Kenneth Hammond and Robert Bateman, Ruy Jornada Krebs, and Gerhard Kaminski on different ecological approaches to sport cognition present a unique compilation of thought-provoking essays that should be of both interest and challenge to all sport psychologists. Each article presents a position on the study of the psychology of sport (and other facets of skilled human movement) that is directly influenced by one of the giants of ecological approaches – James J. Gibson (in the case of Fajen et al.), Egon Brunswik (in the case of Hammond & Bateman), Urie Bronfenbrenner (in the case of Krebs), and Roger G. Barker (in the case of Kaminski). In this commentary I make some necessarily brief observations on the strengths and issues associated with these ecological approaches, treated first individually and then collectively. My perspective in examining the papers is that of someone with a particular interest in skill learning and expert performance. My interest in ecological psychology is largely from the context of a researcher intrigued by the contribution that ecological psychology, in its various forms, might make to understanding movement expertise (e.g., Abernethy, Burgess-Limerick & Parks, 1994) and as an interested observer of the paradigmatic tussles between cognitive psychology and ecological psychology for dominance of motor control and learning research (Abernethy & Sparrow, 1992).

The Gibsonian, Brunswikian, Bronfenbrennerian, and Barkerian schools of ecological psychology share in common a central focus on the environment and on the individual’s reciprocal interactions with the environment. The approaches reject, to varying extents, the predominant traditional approach of cognitive psychology with its conceptual emphasis on

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symbolic, mental processes, cognitive representations, and computational metaphors and its methodological emphasis upon controlled laboratory studies in which a minimal set of cognitive variables are manipulated, simple responses are measured, and task configurations are used which are generally both novel and atypical of the requirements of perception and action in the natural world. All four articles refer to inadequacies in prevailing cognitive models of psychology (Fajen et al. refer to indirect models of perception being better at explaining misperceptions and illusions rather than successful perceptions of the type that characterise athletic performance; Hammond and Bateman refer to the problems associated with experiments from conventional psychology that artificially vary only one factor at a time; Krebs, quoting Bronfenbrenner (1977, p. 513), notes “much of the contemporary developmental psychology is the science of the strange behaviour of children in strange situations with strange adults for the briefest possible period of time”; and Kaminski refers to the problems identified by Barker of a traditional focus that fails to first understand, through naturalistic observations, the essential context in which cognitions and behaviours occur.) As a general observation, many of the contrasts that are drawn within the articles are with older and largely superseded cognitive models and there could be some legitimate arguments from cognitivists that the caricatures of cognitive psychology that are used are more convenient “straw men” for creating contrast than necessarily indicative of contemporary approaches. A number of more recent cognitive models of human performance, such as those from situated cognition and situated learning (e.g., Greeno, 1998; Norman, 1993), place much greater emphasis upon understanding environmental and contextual effects than do the traditional information-processing models. Consequently, these contemporary cognitive models are less striking in their differences to the ecological approaches than are the more conventional cognitive models.

While the papers, and the various schools of ecological psychology, share some commonalities the stand-out feature is the diversity of views that exist within and between the different schools. Both the underlying theoretical premises and the practical inferences on what type of research is likely to be most informative demonstrate remarkable heterogeneity rather than homogeneity. Hammond and Bateman, influenced by the theories of Brunswik, emphasise the importance of focusing on the environment (the ‘distal stimulus’ or ‘outer game’) rather than the athlete (the ‘proximal stimulus’ or ‘inner game’) whereas the bioecological theory of Bronfenbrenner, advocated by Krebs, gives the characteristics of the person equal importance to those of environmental context. The Bakerian perspective, as described by Kaminski, permits explicit consideration of cognitive representations.
whereas the Gibsonian perspective, as described by Fajen et al., makes the
denial of the necessity for representations a central pillar to the understand-
ing of perception and action (see also Carello et al., 1984; Turvey & Carello,
1981). [The issue of mental representations has been a controversial one for
many years and undoubtedly a barrier to more widespread acceptance of the
Gibsonian version of ecological psychology (Summers, 1998).] Brunswik’s
representative design suggests that the key consideration in research design
should be the extent to which the study represents the circumstances to
which the observations/findings are intended to be applied and the extent to
which they represent the factors of theoretical interest. In contrast, Barker
places emphasis on the extent to which the study environment is ‘natural’
and captures the full array of factors and circumstances that can usually
influence behaviour and cognition. It is as yet unclear whether diversity of
approaches and assumptions within the different schools of ecological psy-
chology is a strength or an impediment to the greater adoption of the
approach(es) (Michaels & Beek, 1995; Summers, 1998).

In their article Fajen et al. provide a strong case for the understanding of
sport performance being advanced by the use of Gibsonian approaches to
ecological psychology. At a general level such justification is barely necessary
given the quantum of studies of perception and action in sport tasks from
this perspective that have already been published and made significant con-
tributions (e.g., Bardy & Laurent, 1998; Bootsma & van Wieringen, 1990).
A more contentious issue is the authors’ advocacy of affordances, a key con-
cept of Gibsonian ecological psychology, as offering un(der)exploited poten-
tial as a contributor to the understanding of perception and action in sport.
A major challenge to the wider usefulness of the affordance concept would
appear to arise from the long-standing issue of the lack of uniformity in how
affordances are defined and positioned within broader theory (e.g., see
Fodor, 1980). Further, from a skill learning perspective, the observations
Fajen et al. report, from Pepping and Li (1997), that the use of affordances,
at least as currently operationally defined within sport tasks, do not appear to
differentiate expert from novice players and, from Mark (1987), that adjust-
ments in affordance judgements can be made from only small amounts of
practice, suggest that affordance measures are not in synchrony with the
(over?) factors known to be associated with skill learning. The concept that
skill learning involves both a progressive (re)attunement from non-informa-
tional to informational variables and a proper calibration to the informa-
tional variable is a valuable one and, importantly, one that can be tested
empirically. Studies from our own laboratory on anticipation skills in fast
ball sports suggest, counter to this concept, that the transition from novice to
expert is not one of a fundamental shift from reliance on non-informative to informative sources but rather one in which experts develop the capacity not only to exploit the informational variables used by novices but also to utilise additional, earlier information sources to which the less skilled are not attuned (Abernethy & Zawi, in press; Müller, Abernethy & Farrow, 2006). There appears to be some contradiction in Fajen et al.’s view as to the role that exploration of boundary conditions may play in the acquisition of expertise as they note in the section on action-scaled affordances that ‘good athletes…rarely attempt to do things that are beyond their limits’ and soon thereafter that ‘…athletes often try to gain an advantage by pushing the limits of their capabilities’. These statements clearly need to be reconciled in developing a consistent position on how skill learning may be achieved.

Hammond and Bateman use some examples from tennis to illustrate how the theories and methods of Brunswik can be applied to issues related to the understanding and enhancement of athletic performance. Their paper provides a timely reminder of the fundamental principle of research design – that the design must capture the features of central theoretical interest and adequately represent the conditions to which inferences are to be made – and provides an important cautionary note regarding how meaningless and overused the descriptor “real world” has become. Hammond and Bateman also advocate the importance of making theory explicit, to make it open to scrutiny, criticism and improvement – a view that is consistent with our own regarding the importance of making explicit the assumptions underpinning research positions (Burgess-Limerick, Abernethy, & Limerick, 1994). The sample application to tennis of the Brunswikian approach uses observations from match data on stroke frequencies to advocate a ‘new’ approach to tennis practice that makes greater use of match-like situations and has benefits over the ‘typical’ tennis lesson in which the emphasis is on technique instruction. From a practitioner’s standpoint the characterisation of the ‘typical’ tennis lesson provided by Hammond and Bateman is rather simplistic and not really reflective of contemporary approaches to coaching; modern approaches do, indeed, already make great use of match analysis information (e.g., King & Baker, 1979) and practice and learning strategies that involve tactical decision-making (e.g., Griffin & Butler, 2005). While the addition of the theoretical underpinning from Brunswik is valuable, as is the reminder to researchers about the fundamental importance of the representative design, there are grounds to question whether the perspective provided by Hammond and Bateman offers practitioners new ways of doing things that they either haven’t discovered themselves or have been derived from other, more traditional, theories of cognition and learning.
In his paper, Krebs provides an extensive overview of Bronfenbrenner’s bioecological theory of human development and illustrates how this approach, with its focus on development, has the potential to inform research and understanding into sport talent development and associated issues surrounding early specialisation. The emphasis within the Bronfenbrennerian school, in contrast to the other schools of ecological psychology, is with the need to account for individual differences and the changes that occur over time with the interplay between maturation and experience. The position that ‘…biological factors and evolutionary processes not only set limits on human development but also impose imperatives regarding the environmental conditions and experiences that are required for the realization of the human potentials (Bronfenbrenner & Morris, 1998, p. 1003) is especially significant given the recent discussions in this journal on the roles of nature and nurture in sport expertise (Baker & Davids, 2007). The model, based on Brofenbrenner’s, presented by Krebs to conceptualise talent development in sport has clear potential – it would be valuable, nevertheless, as a next step to see engagement with other conceptualisations of this issue (e.g., Bailey & Morley, 2006; Côté, Baker, & Abernethy, 2007) that are not specifically motivated by the same theoretical framework but which nevertheless share much in common.

Kaminski, in his article, offers a refreshingly frank assessment of the potential impact that the Bakerian school of ecological psychology may have in the sport domain and explicitly acknowledges the limitations arising from psychological ecology being a concept still very much in development. The Bakerian school of ecological psychology emphasises the importance of understanding the ‘entirety’ of the situation in which cognition, behaviour and/or skilled performance occur and seeks to progress initial description of phenomena by forming taxonomies that encapsulate the complete set of conditions that influence any natural event of interest. Kaminski notes that while the principal benefit of a Bakerian approach is to remind researchers of the importance of embedding research issues within their wider natural context, there is an inevitable tension between the Bakerian drive for completeness and the pragmatic concerns of researchers needing to decompose cognition and performance into manageable ‘bite-size’ chunks. The strategic pathway proposed by Kaminski of (i) first attempting to describe and understand the contextual entirety of the skill or behaviour of interest before committing to ‘narrower’ research designs, (ii) preserving naturalness for as long as possible when finalising operational research designs, and (iii) encouraging flexibility rather than rigidity in the selection of research designs and methods, are all logical and laudable ones. It is noteworthy that the final
strategy of encouraging methodological pluralism is one already gaining considerable momentum within contemporary sport psychology (Biddle et al., 2001; Gould, 2002).

While each of the papers separately provokes thoughts of somewhat different issues, two common observations and issues arise from each of the papers. The first of these relates to the general tendency of researchers, of all theoretical bents, to engage primarily with research that has a similar theoretical/conceptual background or motive to their own and to be far less fully engaged with research motivated by a different theoretical perspective. This is, of course, not a complaint that can or should be levelled selectively at proponents of ecological psychology but one that is nevertheless pertinent and, for me, limiting, in relation to this particular set of papers. As an interested reader it would be instructive to see, for example, how Fajen et al. might position the evidence from cognitive psychology proposing a common coding for movement perception and production (e.g., Knoblich & Flach, 2001; Prinz, 1997) and demonstrating some transfer of pattern recall and recognition expertise (e.g., Abernethy, Baker, & Côté, 2005; Smeeton, Ward, & Williams, 2004) in relation to Gibsonian views on the essential reciprocity of perception and action and the putative specificity of affordances. Equally it would be beneficial to see Hammond and Bateman’s views on ‘thoughtless’ behaviour in tennis players either contrasted or reconciled with the growing body of literature, with traditional cognitive psychology origins, that deals with implicit motor learning (e.g., Masters, 1992; Masters & Maxwell, 2004) and, as noted previously, it would be valuable to see Krebs’ conceptualisation of sports talent development considered in parallel with other models, not explicitly ecologically motivated.

The second, more pragmatic, concern relates to the ‘bottom line’ of ecological approaches to sport psychology for athletes and coaches. While the papers make useful attempts to demonstrate how the different schools of ecological psychology may be applied to issues in sport, it is not immediately clear that these, in fact, lead to new ways of thinking about the teaching and practice of skills – or at least lead to practical implications fundamentally different from those already in place either through tradition, trial-and-error, or educated inferences from perspectives other than ecological psychology. [For some exceptions in which ecological perspectives do suggest alternatives to current practice see Handford et al., 1997]. While the papers provide great assistance for sport psychology researchers in understanding the context and design/methodological aspects of their work, the implications for practising sport psychologists and coaches are not yet as readily apparent. If Kurt Lewin is indeed correct and there is ‘…nothing so practical as a good
theory’ then further theory development in sport psychology is clearly still needed. The various schools of ecological psychology, so well represented in this collection of papers, will have an important role to play in this endeavour.

References


Ecological approaches to sport psychology: prospects and challenges

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The four ecological perspectives on sport psychology that are brought to the reader’s attention in the present issue share much in common. They all aspire to study and understand sports behavior in terms of the actual environment and the broader context in which it appears and evolves – this is what renders them “ecological”. In addition, each one of them is based on the intellectual legacy of a single creative scholar – Brunswik, Barker, Gibson, and Bronfenbrenner – each dissatisfied with mainstream psychology and its emphasis on “inner” processes and reductionist methodologies. Finally, and important in view of the present issue’s theme, the four approaches were all developed in contexts other than that of sport psychology, implying that their relevance for sport psychology still remains to be demonstrated and can only be estimated from the penetrating character of their constituent concepts and corresponding methodologies. Inevitably, this requires a judgment call on the part of the reader, which in turn will depend on the reader’s personal background and research interests. It is therefore useful to state right away that I am interested in the control and learning of movement in the context of skilled actions, and that I have read and evaluated the four target articles from this background. At the same time, however, I do believe that most of my criticisms have broader validity and bearing as well, but that is of course for others to decide. Here is what I have to say in response to the four target articles.

In underscoring the relevance of Brunswik’s notions of “probabilistic functionalism” and “representative design” for the study of training of athletes, Hammond and Bateman make a sharp distinction, which they then
capitalize upon, between studies in sport psychology that are concerned with processes and aspects that are internal to the athlete, such as mental toughness, focus, goal setting and motivation, and studies of the relationship between athlete and environment, such as theirs. They claim that the former make up the bulk of sport psychology and that the latter are few and far between. However, this is clearly an overstatement as much of the literature in sport psychology is specifically concerned with the relation between athlete and environment. For example, there is an extensive body of work on the visual guidance of a variety of sport actions including long-jumping (Lee, Lishman, & Thomson, 1982), somersaulting (e.g., Lee, Young, & Rewt, 1992), basketball shooting (e.g., de Oliveira, Oudejans, & Beek, 2006), hitting (e.g., Bootsma & van Wieringen, 1991), and catching (e.g., Dienes & McLeod, 1993; Peper, Bootsma, Mestre, & Bakker, 1994), to name but a few, as well as the visual anticipation of upcoming shots and throws in ball sports (e.g., Abernethy, 1990; Müller, Abernethy, & Farrow, 2006; Williams, Ward, Knowles, & Smeeton, 2002). Likewise, there is a sizeable and growing literature on the perception of situational probabilities in sports (Abernethy, Gill, Parks, & Packer, 2001; Williams, 2000), as well as on match analyses (e.g., Lago & Martin, 2007). In light of this literature, Hammond and Bateman’s plea for an environmental perspective on sport behavior is rather vacuous – such studies are already thriving in sport psychology for quite some time.

Also at other instances, the contribution of Hammond and Bateman is hampered by the absence of appropriate references and an adequate positioning of the proposed approach within the pertinent literature. For instance, according to Hammond and Bateman, a representative design of a tennis lesson includes variations in the characteristics of the balls that are fed to the student by the coach, as well as variations in the position from where the balls are played and received by the student. This feature is reminiscent of the “variability of practice” hypothesis that spawned from Schmidt’s (1975) schema theory, even though the authors would probably qualify this theory as an example of an “inner” rather than an “outer” theory. Surely, an appropriate discussion of the differences between schema theory and Brunswik’s probabilistic functionalism would have allowed a better delineation of the distinguishing features and potential merits of the proposed approach vis-à-vis more conventional and established theoretical approaches.

On a more positive note, the scope and limitations of the notions of probabilistic functionalism and representative design become reasonably clear in their application to the study of tennis and the training of tennis players. The analysis of match data in terms of the probabilities of success and failure of particular shot types is rather straightforward and illustrates that
such an analysis may indeed usefully inform the design of tennis lessons aimed at improving shot selection in actual tennis matches. However, it is not at all evident why tennis training should be restricted to such “distal” effects at the neglect of more “proximal” aspects like the manner in which a tennis player positions one’s legs, rotates one’s trunk and shoulders, holds one’s racket, and so on. Surely, to be successful in competitive sports like tennis, those more “proximal” aspects are of critical importance too, not only in order to optimize performance, but also to prevent injuries, as has been amply demonstrated by many biomechanical studies, particularly of the golf swing, which is known to be very sensitive to variations in execution technique (e.g., Hsu, Chen, & Oware, 2005; Hume, Keogh, & Reid, 2005; Murray, & Cooney, 1996). Although it is an issue of current debate and research how such “proximal” aspects are best trained, that is, by means of implicit rather than explicit instructions (Liao & Masters, 2001; Masters, 1992), or by inducing either an internal (“proximal”) or an external (“distal”) focus of attention (Wulf & Prinz, 2001), it appears unfruitful, if not dangerous, to deny that both technical and tactical training is required to improve performance, as indeed has been recently demonstrated for expert table tennis players (Raab, Masters, & Maxwell, 2005). In all likelihood, the design of such optimal training is served best by incorporating knowledge of both “proximal” and “distal” aspects of sports performance, gathered within a theoretical approach that accommodates both types of aspects rather than one at the expense of the other. Irrespective of what theory one adopts, it is crucial that its concepts are sufficiently clear and incisive to design and conduct experiments that will yield meaningful and useful conclusions. Unfortunately, however, judging from the authors’ concluding remarks that “(1) our theory of behavior will tell us which variables to examine”, and that “(2) our study of the environment will inform us about the presence of these”, this requirement does not appear to have been met in the first contribution. At least this reader fails to see which “theory of behavior” and “variables” are alluded to, nor what is meant by the “presence of variables”.

The second contribution to the theme of this special issue is that of Kaminski, who proposes to study sport and sport behavior from the perspective of Barker’s “psychological ecology”, which purports to observe, describe, taxonomize and analyze people’s everyday behavior within their everyday surroundings. The approach in question encompasses multiple concepts, such as “behavior settings”, “standing patterns of behaviour”, “spatiotemporal milieu”, “synomorphy”, as well as various descriptors, including “population”, “penetration”, “action patterns”, “behavioral mechanisms”, “temporal locus”, and so on. A cursory overview of those concepts
and descriptors is followed by an attempt to apply Barkerian psychological ecology to sport science, in particular the concept of “behavior setting”. Unfortunately, however, this attempt never really gets off the ground. The discussion remains abstract and is nowhere made concrete through specific demonstrations of the potential of the approach in addressing the kind of problems that are confronted by sport psychologists. An arbitrary selection of such problems is listed, but from the discussion that follows it becomes evident that Barkerian psychological ecology has little to offer in terms of their treatment, something that the author appears to sense as well.

There is no doubt in my assessment that the third target article by Fajen, Riley, and Turvey is the best of the quartet, not only in terms of writing and scholarship (i.e., coverage of relevant literature), but also in terms of its potential for sport psychology and the study of perception and action in sport. It provides a succinct introduction to the ecological approach to perception and action as formulated by Gibson (1979) and elaborated by others, including the principle of direct perception on which it is based, followed by an in-depth overview of the theory of affordances and pertinent research on body-scaled, action-scaled, and social affordances. In the course of the article, various opportunities and directions for new research on affordances in the context of sport are identified, which convincingly support the article’s general claim that the theory of affordances has the potential to become a guiding principle for research on perception and action in sport. I believe so too, but I see at least two issues that, down the road, will have to be confronted to appropriate the twin notions of information and affordance to the study of the control of action in sport.

The first issue that will have to be addressed is that of the selection of affordances. In virtually all research on affordances the goal of the performed action, and thus the actor’s intention, is either explicitly given or unambiguously implicit in the experimental set-up. For example, in Warren’s (1984) research on stair climbing, the intention of the actor is to ascend a staircase and he or she may employ different behavioral modes to realize this intention (e.g., bipedal climbing versus quadrupedal “clambering”), depending on the riser height of the stair relative to the leg length of the climber. Likewise, in research on the development of ball catching, the intention to manually intercept the ball is given by instruction and task constraints, and the infant may intercept an approaching ball by means of either a one-handed or two-handed catch, depending on the size of the ball relative to that of the infant’s hands or arms. In contrast, in the complex sport situations referred to in the target article, such as a forward in soccer dribbling the ball up the field, the forward is confronted with an almost
“innumerable array of possible actions” (e.g., dribbling on, passing forward, sideward or backward, firing a shot at goal) and must indeed select one of those possible actions. Put differently, the actor must select an affordance to act upon. The question is how this selection comes about, and this should be made explicit by extending the theory of affordances. Fajen and colleagues suggest that the forward must determine which actions of all possible actions are most likely to be successful given the existing constraints and then select “those invariant features of stimulation that will allow for the successful guidance of the desired behavior”. Thus, the first question to be addressed is how the athlete knows which actions are most likely to be successful, and how this knowledge comes about. Although, the selection of the most successful actions involves awareness of the existing constraints, it will also be based on past experiences and acquired knowledge of situational probabilities and the success rate of particular actions under similar conditions. Cutting (1982, p. 216) already argued that “the concept of affordance does not constrain perception and behavior nearly enough”, and the selection problem highlighted here is just another version of what he meant at the time, albeit perhaps an exacerbated one.

A second, related issue is the need to address the theoretical implications of evidence from perceptual (Jacobs, Michaels, & Runeson, 2000; Jacobs, Runeson, & Michaels, 2001; Michaels & de Vries, 1998) and perceptual-motor studies (Jacobs & Michaels, 2006) showing that novices, as well as more experienced observers and actors, do not rely on variables that specify the relevant property but on (combinations of) lower order, non-specifying variables. Although it is true that during training with appropriate feedback most (but not all) participants attune (or converge) to specifying variables, allowing them to perform the task more successfully, the significance of the findings in question is not limited to the shift in research focus that they brought about “from the informational variable for a given task to understanding the factors that influence changes in the informational variables upon which actors rely”, as the authors emphasize. I believe that the implications are more profound and reflect back on the concepts of direct perception and affordances itself. After all, the findings in question do imply that perception is not simply the pick-up of higher-order invariants that unambiguously specify properties of the actor-environment system: apparently, only after extensive, dedicated learning does this assumption imply. In complex perceptual-motor tasks of the kind encountered in sports, which are bound to be indeterminate and not seldom ambiguous, it may well be that individual differences in perception and reliance on non-specifying cues is the rule rather than the exception, even in experienced athletes. If so, the
notion of affordances will have to be re-evaluated and redefined in terms of non-specifying information, perhaps in the form of a combination of multiple variables. It is interesting to note in this context that Gibson (1952) himself recognized earlier in his career that several possibilities for perception are open when stimulus conditions are indeterminate or ambiguous. “The practical problem here” he wrote (p. 375), “is that of learning to use the reliable cues and to neglect the unreliable and irrelevant cues”. A less attractive alternative (but one that can not and should not be dismissed out of hand) is that the information for perception and action does not always take the form of higher-order invariants specifying properties (i.e., affordances) of the environment but may also be derived from cues or cue combinations that are sufficiently reliable to guide the successful execution of actions. In other words, some perceptual heuristics may continue to play a role, also in expert performers, who often will (try to) introduce ambiguity in order to deceive their opponents.

The fourth and final contribution to the special issue by Krebs largely consists of a discussion of the evolution of Bronfenbrenner’s bioecological theory of human development and its conceptual constituents – proximal processes, biophysical characteristics of a developing person, the parameters of the ecological context and the dimension of time – supplemented with some relevant methodological considerations. As in the contribution of Kaminski, the discussion remains rather abstract and the alleged merits of Bronfenbrenner’s conceptual framework for studying and addressing concrete problems in sport psychology do not really become apparent. Although the theory may indeed have some potential for sport psychology in that it recognizes the multifaceted, dynamic character of “proximal processes” like the development of sport skills, talents and experiences, the proposed analysis contains few concrete guidelines as to how the approach may be applied in sport psychology. Aspects of the development of sports talent are linked to all components of Bronfenbrenner’s bioecological model on a general semantic level, and a generative rather than confirmatory design of research is advocated, but how such a design should be implemented, and what kind of insights are to be gained from such an implementation, remains largely opaque.

In conclusion, in my judgment, the potential for penetrating applications of the ecological approaches presented here to the domain of sport psychology is rather limited, with the exception of Gibson’s notion of affordance, which, in spite of its theoretical and methodological limitations, holds a definite promise. Although it is not impossible that meaningful sport-psychological studies could be conducted from the other three theoretical
approaches as well, it appears evident that, in order to accomplish this, those approaches have to be appropriated first to the domain of interest by deriving carefully crafted hypotheses and research questions, based on rigorously operationalized concepts and variables. Also, where appropriate, connections and critical interactions with existing methodologies and insights should be sought.

Acknowledgment

The author is grateful to Piet van Wieringen for the inspired and lively discussions we had about the four target articles.

References


Ecological approaches to Sport Activity: A commentary from an action-theoretical point of view

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The objective of this paper is to comment on four ecological approaches to sport activity which are based on the conceptions of Urie Bronfenbrenner, Roger G. Barker, Egon Brunswik and James J. Gibson. Their consensual general message is that to sufficiently explain, predict and improve some behaviour it is necessary to study the objective properties of the environmental context in which this behaviour takes place. Concerning their peculiarities, it is shown that each of these approaches provides particular contributions to an extended theoretical understanding of sport activity. However, the most profit will be gained when focusing on their complementarities within an integrative frame of reference. In this sense, a promising perspective is provided by action theory. Action theory is designed as a systems approach to the person-environment interrelation, assuming that the human-specific core of this interrelation is the intentional organisation of behaviour within a meaningful situational context, i.e., action. It is shown that this perspective is capable to embody and interconnect central aspects of different ecological approaches according to their particular significance within the dynamics of situated action. The main focus, however, is on further differentiation of the organisation of action with regard to a comprehensive understanding of the psychological nature of the person-environment interrelation. The essentials of this conception are briefly outlined with special reference to the structure of action situations and the functional architecture of actions.

Introduction

The general intention of sport-psychological intervention may be considered as optimising performance, health and quality of life of sport participants. Attaining this goal in a systematic and responsible way with a sufficiently high probability of success and an amount of resources, effort and time as low as possible fundamentally depends on a sound theoretical basis.

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It is the merit of this IJSP-Special Issue and its editors doing justice to this fact by presenting ecological concepts which undoubtedly contribute to an extended theoretical understanding of sport activity which is urgently needed.

However, taking into account environmental properties and their inter-relation to the characteristics of the acting person and his or her development and behaviour is not a new insight as such. Beyond the long-standing controversy over the ‘heredity-environment problem’, all of the ‘great theories’ in psychology – e.g., phenomenological psychology, psychoanalysis, behaviourism, gestalt theory, cognitive psychology, humanistic psychology – principally refer to this aspect. What is comparably new is shifting the focus of theorising, empirical investigation and intervention from person to environment.

This is exemplary shown by the contributions to this Special Issue by Krebs related to Urie Bronfenbrenner’s “bioecological model” (e.g., Bronfenbrenner, 1979, 2005), Kaminski related to Roger G. Barker’s concept of “behaviour setting” (e.g., Barker, 1968), Hammond and Bateman related to Egon Brunswik’s “probabilistic functionalism” (e.g., Brunswik, 1955; Hammond & Steward, 2001), and Fajen, Riley and Turvey related to James J. Gibson’s concept of “affordances” (e.g., Gibson, 1979).

To say it in advance: While looking for applications to research and intervention in the field of sport, these authors more or less modify the background concept they refer to while emphasising particular aspects. Additionally, we have to take into account the fact of a relatively brief presentation of highly complex conceptions. Thus, it sometimes might be difficult to decide whether a missed aspect of potential relevance has been ignored on the whole or merely not reported.

In spite of great differences concerning details, all of the four presented conceptions are labelled “ecological”. Supposing all of them were well-founded, the question would arise: What are the common features, and how far are the peculiarities to be considered as complementary parts of a more comprehensive picture?

To answer this question requires an appropriate frame of reference to evaluate and compare the conceptions at stake from the same point of view. The frame of reference applied here is threefold with regard to (1) the constitutive components of these conceptions; (2) their particular contribution to the solution of theoretical, methodological and practical problems in the field of sport; (3) their relation to a comprehensive understanding of human action, in particular provided by action theory.
Constitutive Components of the Ecological Approaches

GENERAL ASPECTS

As a guiding principle, psycho-ecological approaches share the basic assumption that to sufficiently explain, predict and improve some behaviour it is necessary to study the environment in which this behaviour takes place.¹ This has important consequences on all constitutive components of scientific investigation (see Figure 1) resulting in the following common features of these approaches.

¹ This idea is borrowed from evolutionary biology emphasising the “ecological world” instead of the “world of physics” (cf. Gibson, 1979, Introduction and chap. 1; Lewin, 1942, p. 217): Unlike biological (animate) systems, non-biological (inanimate) objects have no “environment” to cope with and adapt to. Methodologically, this perspective goes along with a shift from classic physics to modern physics, e.g., increasingly applying formal models from field theory and synergetics/dynamic systems theory. By expressing this orientation, these conceptions are labelled “ecological physics” (e.g., Shaw & Kinsella-Shaw, 1988).
The general *phenomenon* (subject matter) is best characterised by what Kurt Lewin told us already about 70 years ago (e.g., Lewin, 1936): Behaviour (B) is to be understood as function of *life space* which is constituted by person (P) and environment (E), expressed in the well-known formula: \( B = f(P, E) \). Some decades later, Urie Bronfenbrenner extended this equation by including the time perspective of development throughout the life course (see Krebs, in this issue).

There is also consensus concerning the general attributes of person, environment and behaviour. According to the wording of Bronfenbrenner (cit. by Krebs, in this issue), *person* is considered “as an active agent in, and on, its environment” involving changes in his or her properties depending on growth, learning and alterations in psychobiological state. Concerning the *environment*, it is not the physical world itself which is of primary interest, but – in analogy to the bio-ecological concepts of ‘biotopes’ and ‘habitats’ – “the way in which it exists for that person at that time” (Lewin, 1942, p. 217). Thus, the focus is not on elementary physical properties themselves but on dynamic “higher order” structures (Mace, 1977, p. 44) which are potentially relevant for the organisation of behaviour (and development), i.e., the “behavioural environment”, a conception which can be traced back to Koffka (1935). Consequently, *behaviour* is – beyond a single molecular act or merely a reaction to external conditions – concurrently conceptualised as an adaptive molar and meaningful activity, i.e., action.

Corresponding to this understanding of the phenomenon as ‘a dynamic person acting in and on a dynamic behavioural environment’, the common features of *theoretical conceptualisations* can be summarised as follows. Instead of an elementaristic approach priority is given to a holistic or system perspective in more or less explicit reference to gestalt theory and field theory. In particular, this perspective involves emphasising dynamic functional *structures*. Thus, the intended scientific explanations do not refer to single causal relations between isolated variables but to functional interdependencies within and between complex systems.

The implication for *methodology* is applying a “naturalistic” research strategy (see Kaminski, in this issue). However, this does not mean that experiments are to be abandoned in favour of field studies, or that the setting of an experiment should somehow represent “real life”. The guiding principle is what Brunswik (1955) called “representative design”. As Hammond and Bateman (in this issue) pointed out, the conditions under which the results of an investigation are obtained should “represent the circumstances toward which the results are intended to apply”. This requires “making explicit the features” of the real situation the investigation refers to, i.e., to
describe precisely those environmental properties which are actually relevant for displaying the investigated behaviour under field conditions. At a first glance, this appears to be a basic requirement for experiments only (and in fact this was Brunswik’s primary intention). However, it is also valid for field studies taking into account the problem of generalisation: Even in field studies the results are necessarily obtained from more or less selected persons and selected circumstances. Generalisation of observations then depends on what is actually considered as a ‘prototypical person-environment interrelation’ (e.g., catching an approaching ball under experimental conditions; a return shot in a tennis match, or a school lesson).

Finally, the understanding of the basic phenomenon and the general characteristics of theoretical conceptualisation and methodological strategy correspond to the overarching research intention of psycho-ecological approaches, namely to analyse the behaviourally relevant person-environment interrelation in order to optimise the person-environment fit as a general adaptive goal of any behaviour and behaviour modification as well. This involves three directions of investigation and intervention: (a) describing the given structures of environmental conditions and identifying and modifying the unfavourable ones; (b) analysing the behaviours which occur under these conditions; (c) making the person for him- or herself, if necessary, more sensible and adapted to those conditions by learning and training.

**SPECIFICATIONS**

Despite these common features of psycho-ecological approaches mentioned above, some important differences in specification concerning each element of Lewin’s equation — person, environment, behaviour — as well as their interrelations still remain (including differences to Lewin’s special understanding of these elements as well). Accordingly, each of the ecological approaches under discussion can be characterised by its particular profile in specifying and balancing the four constitute components of scientific investigation shown in Figure 1. I cannot go into all of the details here but will only take up some of the most relevant ones in focusing on theoretical aspects.

The critical questions are: (1) Which kind of behaviour is considered in its relation to which kind of environmental conditions? (2) What is the assumed nature of this interrelation? (3) What follows from this concerning the properties of the acting person? Answering these questions may help to clarify, how far the obvious differences between the conceptions are due to
(a) differences in terminology; (b) different sections of the general phenomenon under study, or (c) alternative (competitive) explanations of the identical phenomenon. To say it in advance: All of these options come into play.

* Bronfenbrenner's bioecological theory of development (Krebs, *in this issue*). Undoubtedly, the conception with the comparably broadest scope – concerning the range of environmental conditions, person’s properties, person-environment interactions and time perspective – is provided by Bronfenbrenner’s “bioecological theory of human development” (e.g., Bronfenbrenner, 2005). The leading idea behind this conception is to provide an appropriate scientific basis for effective social policies and programs which are urgently needed to promote, in particular, the development of disadvantaged children (see, for a well-known example, the US-national “Head Start” program, created in 1965). Applying a shell metaphor, person’s environment is considered as a nested structure of four interconnected surrounding systems – formally denominated as “microsystem”, “mesosystem” “exosystem”, “macrosystem” – which are primarily defined in sociological terms. Individual development of the person as a whole is considered as to be dependent on (a) both objective and subjectively perceived properties of these systems, the systems’ interplay, and transitions from one setting to another; (b) the properties of the person, including “biopsychological resources” (genetic potential and actual capabilities) as well as “directional dispositions”, in particular, psychological characteristics of the developing person called “developmentally-disruptive” vs. “developmentally-generative”. Beyond changes throughout the life course, special attention is also paid to a very important point concerning the developmental effectiveness of external influences, namely the “timing of biological and social transitions”. With regard to theory, methodology and intervention, the main focus is (but not exclusively) on social interrelationships.

In summary, this conception is what it ought to be: a very fruitful frame of reference for developmental research and intervention. It offers a systematic description of the areas and factors influencing human development. Thus, it is primary a classification model but not a process theory, although emphasising organism-environment interactions by “proximal processes” as “primary engines of development” (Krebs, 2009). However, there is no precise information available, at least in Krebs’ presentation, on how proximal processes operate in detail. Furthermore, the time perspective is mainly related to the present and past, the future orientation appears to be too neglected.

* Barker’s behavior setting concept (Kaminski, *in this issue*). While Bronfenbrenner’s conception is focused on the conditions of development,
Barker’s “ecological psychology” (cf. Barker, 1968) is narrower in scope emphasising the socially determined spatio-temporal context of in situ behaviour (see for details, criticisms and several extensions Kaminski, in this issue). Based on extensive observations of children’s every-day behaviour and implicitly applying a casting mould metaphor, the essential point is that this context, called “behaviour setting”, implies “programs” for “standing patterns of behaviour” irrespective of the concrete inhabitant of the setting. That is, the focus is on molar, individual-unspecific behaviours which are typical for particular settings (e.g., classroom). It is worth mentioning that this is also of high importance to explain characteristic alterations of an individual’s behaviour across different settings.

The specific impact of a behaviour setting is investigated from an outside perspective of an external observer. Thus, the intentions of an individual and its active contribution to the modification of a setting or the constitution of new ones are not explicitly and systematically taken into consideration. Socially deviant or destructive behaviours are out of the scope as well.

Beyond nuances in meaning, there are some obvious correspondences between Barker’s and Bronfenbrenner’s conception: Both of them are no process theories in a narrow sense. Barker’s “behaviour setting” may be considered as a specification and differentiation of Bronfenbrenner’s “microsystem” extended by the behaviour setting “genotype” which refers to common properties of a class of behaviour settings. Barker’s “multiple setting” is similar to Bronfenbrenner’s “mesosystem”. However, the socio-cultural context (“macrosystem”) as well as Bronfenbrenner’s historical perspective (applicable to the genesis of behaviour settings) remains neglected. Barker’s “stream of behaviour” corresponds to Bronfenbrenner’s “ongoing behaviour”. Bronfenbrenner’s concept of “role” as a set of social behaviour expectations may be considered as a specific aspect of Barker’s behaviour setting “program”. Thus, both approaches prove to be compatible and complementary with regard to their particular aspects.

Brunswick’s probabilistic functionalism (Hammond & Bateman, in this issue). Compared to the conceptions of Bronfenbrenner and Barker, Brunswick’s “probabilistic functionalism” is another step narrower in scope: The emphasis lies mainly on the problem of perception organisation, thus primarily providing a process theory of perception but not a more general theory of human behaviour. In dissent from Lewin, the focus is on the objective environmental properties. The basic assumptions are: (a) Environment is ambiguous (uncertain) in nature. (b) The (distal) environmental objects are not perceivable per se but mediated by a set of (proximal) cues which are considered to be in a probabilistic relation to these objects. (c) Then, what
the organism has to manage with regard to adaptive goals, is to infer reliable judgments by utilising uncertain, probabilistic evidence about the world. (d) In particular, this requires evaluating the functional validity of the cues and the ecological validity of the resulting judgments on an experiential basis in a process of probability learning. Incidentally, the terms „proximal“ and „distal“, as used by Brunswik and Bronfenbrenner, are quite different in meaning: Brunswik refers to the relation of the organism to cues (proximal) and objects indicated by these cues (distal), while Bronfenbrenner has in mind the individual’s relation to the microsystem (proximal) and the more general environmental contexts (distal).

Applying the metaphor of a convex lens which bundles the various incoming cues to the resulting judgment, these assumptions were condensed in Brunswik’s “lens model” (e.g., Brunswik, 1955), a conceptual idea borrowed from Fritz Heider (e.g., Heider, 1930). (Taking an applied sport-specific perspective, Hammond & Bateman, in this issue, did not explicitly allude to this concept.) This conception proved to be of high influence on the probabilistic learning theory, decision making, social judgment theory, interpersonal perception of emotions, etc. Furthermore, some basic ideas of fuzzy logic and modern connectionism’s concepts of neuronal network structures in cognitive science are anticipated. Despite the very stimulating impact on psychological research from an ecological perspective (see also the concept of “representative design” emphasised by Hammond & Bateman, in this issue), processes within the organism as well as the implications of the fact that the objective environment is to a large extent created by mankind and by the individual itself, appear to be largely disregarded.

**Affordances in Gibsonian tradition (Fajen, Riley & Turvey, in this issue).** Similar to Brunswik’s conception, Gibson’s “ecological approach to visual perception” (Gibson, 1979; cf. Fajen et al, in this issue) started from the problem of functional perception organisation, based on his groundbreaking studies on pilot training during World War II (in particular, landing airplanes according to the optical ground surface). Both conceptions refer to the objective environment, sharing the assumption – to a certain degree – that environmental objects (source of stimulation) are indicated by explicit higher order structures within the perceptual field containing relevant information about these objects for the perceiver. However, there is at least one remarkable difference between these conceptions: While Brunswik emphasises the probabilistic nature (uncertainty) of the environment, Gibson and his associates hold the more radical position that the “properties of the world are unambiguously specified” (Fajen et al, in this issue). This can be considered as the core of Gibson’s concept of “direct perception”.

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The assumption of direct perception is based on two essentials with regard to the phenomenon and its explanation: (a) As known from every-day observation, the perception-action coupling often appears to operate so fast that it does not allow for any time-consuming mediation processes. (b) If it is true that the properties of the world are unambiguously specified in the pattern of ambient energy arrays, then “perception does not have to involve processes of interpreting ambiguous cues about the properties of the world” (Fajen et al, in this issue). Thus, “actors can achieve direct epistemic contact with their environments”, “unmediated” by cognitive inference processes or internal representations (Fajen et al, in this issue). As a consequence, both the classic sensualistic understanding of perception and the representational view in cognitive theories are strictly rejected; furthermore, it opposes representational concepts in motor control research (e.g., Schmidt, 1988). This position appears to be very close to the gestalt theoretical statements by Köhler on “The Characteristics of Organized Entities” and “Behavior” (Köhler, 1947, chap. 6, 7).

According to Fajen et al. (2009), perception and action are “tightly coupled” by “affordances”. They are defined “as dispositional properties of the environment that are complemented by dispositional properties of animals termed effectivities”. Implicitly applying a key-and-keyhole metaphor, affordances are considered to be “specified in patterns of stimulus energy” which are “inherently meaningful” in the sense of “opportunities for action”: “they describe what an animal can or cannot do in a given environment” (Fajen et al, 2009). For example, a step may look “climb-able”, a gap “pass-through-able”, a ball “kick-able”. Thus, the focus lies on the potential relation between environmental properties and the person’s capabilities. This is in contrast to Lewin’s preceding concept of environmental “valence” which emphasises the perceived motivational qualities of the environment, inviting the person to perform an action to satisfy “quasi-needs” (e.g., Lewin, 1926; see also Koffka, 1935).

The affordance concept shows remarkable correspondences to some aspects of the ecological approaches discussed above. In particular, Barker’s “synomorphy”-relation between behaviour and milieu (cf. Kaminisky, in this issue), the “intuitive” character of this relation assumed by Hammond and Bateman (2009) and Barker’s behaviour setting “program” seem to be ideas on the same line. Although Gibsonians would probably reject this ‘representational’ interpretation, “social affordances” described by Fajen et al. (in

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2 See also the understanding of objects as “frozen actions” proposed by Rombach (1987).
this issue), in particular “perceived affordances for joint action”, may be considered as functional related to Bronfenbrenner’s role expectations (cf. Krebs, in this issue): Joint action implies the expectation that the other person will perceive, accept and play the complementary role. “Perceptual attunement” and “(re-)calibration” on the basis of learning and practice (Fajen et al., in this issue) appear to be – in the core of the matter – implicitly (although not in theoretical notion) very close to Brunswik’s concept of cue utilisation: In both cases, the novice should learn to “rely” on the “informational variables or cues” that “specify the relevant properties” (Fajen et al.). If this notion makes any sense, then it implies (a) distinguishing between relevant and irrelevant information, and (b) referring to the functional and ecological validity of these variables (Brunswik). Hence, the Gibsonian idea of “detecting” specifying information seems functionally equivalent to Brunswik’s idea of changing the weights of the available information variables appropriately.

Concerning learning in general, the following problems arise: Neither Gibson (1979) nor Fajen et al. (in this issue) provided an elaborated process theory of learning with regard to the underlying learning mechanisms (more or less they refer to the result of learning in the sense of “better than before”). Concepts like “attunement” and “calibration” emphasise specific tasks and effects of learning; they tell nothing about how attunement and calibration are achieved (except “by practice”). Notions like “learning to detect” or “to rely on” the right information are descriptive at the best; they are no explanatory terms: When a person learns to perceive something which he or she did not perceive before, why and how does this happen? What processes within the person result in this change? Furthermore, the set of assumptions by Fajen et al. (in this issues) is not stringently conclusive: If environmental properties are “unambiguously” specified and perception is “direct”, and if perception and action are “tightly” coupled, then novices cannot perceive (“rely on”) “non-specifying variables or cues” and perform an inappropriate action (except the – explicitly excluded – case of misperception) – or what they perceive and do is not considered as “perception” and “action”. If novices have to learn to “rely” on “specifying variables”, then the ambient array cannot be “unambiguously” specified for the actor in the sense of direct perception – or direct perception is not a general principle that, e.g., “capture information-movement relations in perceptual-motor skill”, but a more or less approximated ideal, at the best an end-product of preceding processes. However, if some kind of misperception does occur (relying on non-relevant information variables, that is, variables with low ecological validity), then learning to “rely” on specifying variables means to alter the weights of the
perceivable “information variables” (including 0- and 1-values): this is what Brunswik tells us.

In summary, the affordance concept, particularly in the extended version proposed by Fajen et al. (in this issue), provides very stimulating insight into fundamental aspects of perception-based human actions. However, it should not be mistaken as a comprehensive conception either with respect to perception and action or with regard to the perception-action relation. This needs some further comment.

In the tradition of Gibson, the environment is designed as a structured perceptual field which is investigated with regard to its potential relevance to the immediate shaping of corresponding behaviours by “simply picking up the relevant information” (Fajen et al., in this issue). However, as Ullman (1980, p. 375) conclusively pointed out, rejecting the combination of sensations assumed by the classic sensory-based theory of perception does not justify by itself the conclusion that other alternatives to “direct perception” are also refuted, and mediation processes such as categorization, interpretation, inference, etc. have no place in the theory of perception. Furthermore, it is “nothing but a tautology”, if only “stimuli that give rise unambiguously to unique perceptions are considered” (e.g., excluding the conditions of misperceptions and illusions), “then stimuli and percepts are related by a one-to-one mapping” (Ullman, 1980, p. 379). Moreover, the focus is on the what-and how-question of spontaneous perception while neglecting the why- or wherefore-question of intentional observation. The latter would involve applying heuristic strategies which actively guide goal-directed perceptual searching, selection and restructuring procedures based on internal representations. Aside from perceptual conditions of behaviour organisation, other important aspects of perception remain unnoticed: particularly the perceptual basis of intention formation and of developing realistic representations of the actual properties of one-self (“self-concept”) and environment (“world view”), which in turn are of perceptual and behavioural relevance. The time perspective is restricted to the present situation, thus the possible priming effects on perception resulting from past experiences and future expectations are not taken sufficiently into account. In general, there is no explicit notion on different basic functions of perception in action which would provide a systematic distinction of functional properties of affordances with regard to orientation, selection, initialisation and control of an action.

Concerning the notion on perception without mediating cognitive processes, a fundamental problem has to be solved: If the existence of cognitive processes is not principally denied, and if cognitive processes have an evolution-based adaptive function in the interaction of person and environment,
and the person acts as a system as a whole, then it is highly questionable maintaining the *general* assumption in spite of these facts that “the environment can be perceived without the process requiring cognitive mediation” (Fajen et al., in this issue). If perception operates without internal representation, how then should it be possible to identify objects in the perceptual field which are partly covert or blurred?3 (We should also keep in mind that perceptual ambiguity is the basis of projective testing in psycho-diagnostics.)

My impression is that Fajen et al. (in this issue) let in through the back door what was kicked out through the front door. Several statements refer explicitly to the inner perspective of the acting person and its knowledge, for example: “In American football, a quarterback must know [!] how high a receiver can jump to reach a pass …. ” The terms “social” and “sport” are extensively used within the frame of reference of direct perception and affordance in spite of the fact that there is no way to directly extract the social or sportive character of something out of the ambient energy array *per se* without additional internal representations. Even experiments on catching or hitting a ball can only be conducted, when we assume that the subjects cognitively represent and intent the task they are asked to fulfill.

Although the term “action” is used, its meaning is reduced to the performance of relatively simple and isolated perceptual-motor skills, emphasising the ‘ability aspect’ without any explicit reference to intention, motivation, emotion, or cognitive anticipation, planning and evaluation. Fajen et al. (in this issue) are right in paying special attention to learning processes concerning novice-expert differences, “perceptual attunement” and “(re-)calibration”. However, they made no point on their understanding of learning, thus avoiding to have to deal with a critical problem: learning without developing corresponding internal representations. In my opinion, the essential point is not to reject or endorse the role of cognitions and internal representations, but to specify the conditions under which they are or are not necessary and useful (see also Ullman, 1980, p. 375).

This leads to an essential requirement concerning theory construction, namely to pay careful attention to the epistemological status of the if-then relations in our explanations with regard to the kind and directness of the relation between conditions and consequences. It makes a great difference to consider the “direct” relation between stimulus information and perception as well as the “tight coupling between perception and action” (Fajen et al., in

3 Gibson’s (1979) explanation of perception under the condition of partly occluded surfaces provides some basic insight into this phenomenon. However, it does not refer to the fact that we can perceive and identify, for example, a *certain* person that is partly visible.
this issue) as (a) a phenomenological relation in the sense of being not aware of the underlying processes; (b) an implication of a molar theoretical perspective excluding the underlying ‘micro’-processes as non-psychological, or (c) a causal relation in the sense of unmediated determination.

Especially, there are two aspects that seem to be relevant for a differentiated understanding of the perception-action relation. First should be taken into account the following distinction: (a) condition of possibility (see Gibson’s affordances; “real affordances” according to Norman, 1999), e.g., a ground may be ‘walk-on-able’; (b) condition of occurrence in the sense of Norman’s “perceived affordances”; e.g., a ground surface may afford ‘walking’; (c) condition of appearance according to Lewin’s environmental valences, e.g., ‘walk!’. Neglecting these distinctions would lead to an inconsistent use of the term “affordance” and result in terminological confusion. Second, we have to distinguish between necessary and sufficient conditions. If, and only if, the environmental properties determine completely some behaviour, they are necessary and sufficient conditions of that behaviour, thus allowing its prediction. This is not valid for affordances as opportunities for action in the sense of Gibson. In some cases however, the visual properties of environment may be sufficient conditions of perception and behaviour as well (e.g., optical delusions), but not always necessary (e.g., moving with closed eyes), or reference to the ambient energy array may be a necessary but no sufficient condition of behaviour (e.g., traffic signs). The latter give reasons for further important differentiations.

Starting from the generally accepted fact that behaviour is related to the meaning of environmental objects, the perception-behaviour coupling can be established at least on three different levels:

(1) animal-specific on the basis of biological evolution (cf. Holzkamp, 1973, p. 320 f.; Mausfeld, 2001, p. 441): Perception and action are a priori interrelated in the sense of a ‘natural correspondence’. This seems to be the primary focus of Gibson’s original affordance concept.

(2) individual-specific in the sense of ‘personal correspondence’: The perception-behaviour relation depends on (a) the individual’s properties according to ontogenetic development and/or (b) experiences made by the individual him- or herself or acquired in observational learning processes. Particularly the first point is in the focus of Fajen et al. (in this issue) with regard to the relation of “affordances” and “effectivities”, additionally including actual states like “fatigue”.

(3) culture-specific in the sense of a ‘conventional correspondence’ (cf. Norman, 1999): The meaning of perceptual structures is – beyond the characteristics of the perceptual surface – based on social conventions adopted in
the process of socialisation, e.g., flags, tricots, traffic signals, bank-notes, letters in writings, play grounds in sport, gestures of referees, handling of sports kits, perception of persons as team members or opponents, etc. Even a chair may be more than a ‘sit-on-able’ object, namely a social status symbol. In basketball the basket offers itself to have the ball thrown into it, but hopefully into the basket of the opponent team. Outside the laboratory, we do not live in a world of ‘walk-on-able’, ‘step-on-able’, ‘grasp-able’, ‘catch-able’ or ‘hit-able’ things. Beyond that, we live in a world of social symbols and conventions. Last but not least, it is not a world of objects only, but a world of conceptual denominated objects, which needs explicit reference to language while investigating the person-environment relation. At the best, Fajen et al. (2009) refer only implicitly and partially to this aspect.

Now, the essential point is that on all of the three levels the phenomenon of “direct perception” can be observed, i.e., the meaning of environmental properties can be perceived without time-consuming mediation processes. However, perception of affordances may prove to be only one of possible explanations of this fact (or a valid explanation of a special case): The perceptual field provides by itself the informational basis of behaviour, and the transformation of perception into behaviour is so fast, because mediating cognitive processes are principally excluded. A possible alternative explanation would start from the distinction between perceptual learning and actual perception on the one hand, and motor learning and motor control on the other: What happens during the learning process is quite different to what happens during the application process: During the learning process, the perception-behaviour relation is cognitively (pre-)structured (high degree of awareness and explicit cognitive control of action at the beginner level; development of internal representations) and stabilised by practice (automatic processing at the expert level). Then, the actual perception-behaviour coupling at the expert level can operate so fast because of preceding automatisation which makes time-consuming cognitive mediation processes in situ more or less unnecessary. Furthermore, it may also be worth paying additional attention to a specified representational view on the issue of “tight coupling between perception and action”, which is quite different from the position held by Fajen et al. (in this issue), namely the principle of “common coding of perception and action” within a recent representational framework (see Hommel, Müßeler, Aschersleben & Prinz, 2001; Prinz, 1990)⁴.

⁴ The basic assumption of this approach is that representations of stimulus information (“event code”) and action (“action code”) are directly interrelated within a common representational system.
Applications to the Field of Sport

General Aspects

All authors of the conceptions under discussion argue that the conception they relate to is of high theoretical, methodological and practical relevance to the field of sport. I agree with them. However, we should be aware of the fact that these conceptions do not cover the whole range of sport activities. They are – at least in the presented versions – primarily related to skill-based motor behaviour of athletes, thus making no point either to other persons involved in sport (e.g., referees, spectators) or to other intentions of sport activity than competition (e.g., health sport, adventure sport), or applying sport as a means of psychological intervention. Tactical aspects of sport behaviour are also widely neglected (except by Hammond & Bateman: their “match lesson” of tennis implies some tactical elements).

Because the components of these conceptions are already thought to be transferred to sport, well-illustrated with respect to sport and commented above, it is not necessary to go back to them once more. Thus, it may be sufficient to add a few comments and ideas on practical aspects which go beyond the common message: “Be aware of the properties of the objective environmental context while intending to improve the behaviour which takes place within this context.”

Specifications

Krebs (in this issue) demonstrated the applicability of Bronfenbrenner’s ecological model to the development of sports talents. Although several propositions seem to be very close to what we already know from literature on motor learning and training in sport as well as on career counselling (cf. Hackfort & Schlattmann, 1994), the systematic ecological approach, including a great variety of variables, remains impressing. The proposed “stage model” intends to stimulate sport participation, enlarge and tighten the environmental network, and increase task complexity and the athlete’s specialisation by a step-by-step procedure. Of special interest are the statements on optimal conditions for transitions from one context to another (e.g., moving to another team), and on “developmentally-disruptive” and “developmentally generative” dispositions of athletes. Beyond this, it is recommendable to pay more attention to the ‘harmonious’ interconnection of different environmental systems on the meso- and exosystem level, the impact of cultural and
social ideologies (macrosystem), and the athletes’ future perspective after finishing their sport career.

Kaminski (in this issue) illustrated the usefulness of the Barkerian approach particularly by analysing the behaviour settings of beginner skiers, table tennis and soccer. Remarkably, he extended Barker’s original approach by involving the inner perspective of the athlete, i.e., theoretically with explicit reference to cognitions and emotions, opting for “action” as a general conceptual frame, as well as methodologically (questioning methods). Additionally, the behaviour setting perspective may be stimulating with regard to the following aspects: (a) development of taxonomy of sport-specific behaviour setting “genotypes”; (b) analysis of behavioural implications of inconsistent, ambiguous, conflicting or even paradoxical behaviour setting “programs” (see, for example, violence and doping in sport); (c) treatment of adaptive problems and decreasing achievement of athletes and coaches resulting from an imperfect person-setting fit (e.g., integration of foreign players into a new team).

Hammond and Bateman (2009) exemplarily illustrated Brunswik’s concepts of “probabilistic functionalism” and “representative design” with regard to tennis. They showed that different locations of the player on the court produce different kinds of stress, thus demanding different kinds of training. Favouring the “outer game” versus the “inner game” perspective, they developed a training procedure (“match lesson”) according to the empirical probability of success of shots from different court regions. This is a very fruitful application of Brunswik’s ideas. To further improve the proposed match training, specifying its conditions may be recommendable with regard to (a) the reference group according to gender, age, constitution and skill level of the player; (b) the actual situation of the match (e.g., stage of the game; own service); (c) the individual ‘style’ of playing the game (e.g., offensive-oriented); (d) the actual state of the player (e.g., fatigue); (e) the detection of relevant cues for optimal tactical decisions (see Brunswik’s “lens model”). Above all, the probably most interesting question is: How the player’s effectiveness might be enhanced by creating new variants of behaviour derived from the Brunswik model?

The conception of Fajen et al. (in this issue) in tradition of the Gibsonian approach was already discussed at length. Only few points should be added. Fajen et al. focused on the visual control of “interceptive actions” in sport which they consider as a typical case of affordance-based direct perception related to the athletes’ “effectivities”. The essential practical message which can be drawn from this conception is learning to ‘read’ the objective environmental properties. It has to be added that learning to ignore (not to rely on) perceived affordances and/or block the corresponding behaviour is
equally important, if the perceived affordance provides an opportunity for action with harmful secondary consequences (so-called ‘action traps’, e.g., feinting movements of an opponent in sport; water or ground surfaces hiding high risks for the actor). Finally, there is no distinction made between ‘what is possible to do’ and ‘what is important to do’. Completely neglected is what may be called ‘emotional affordances’ (cf. Norman, 2004).

The Action-Theoretical Frame of Reference

GENERAL ASPECTS

Action theory in our understanding is not a ‘closed’ theory but conceptualised as a meta-theoretical perspective in continuous progress. Several of the comments above on ecological approaches are already implicitly made from this perspective.

The action-theoretical paradigm is characterised by three fundamental assumptions: (1) The basic nature of human behaviour is expressed by the intentional organisation of behaviour within a meaningful situational context, i.e., action. (2) Psychological states and processes are considered and explained with regard to their functional relation to action. (3) Constitutive for any action is the functional integration of (a) person and environment; (b) intrapersonal processes; (c) time perspective with regard to the past, present and future. Accordingly, action theory is a systems approach highlighting ‘action’ as the key concept in psychological theory building and frame of reference for research and intervention. The implications of this perspective, which was developed at the Psychological Institute of the German Sport University Cologne throughout more than 30 years, cannot be outlined here at full length (see for detailed information Nitsch, 2004). Instead, the focus will be – briefly summarised – on selected aspects which may lead to a more differentiated understanding of the peculiarities, strengths and shortcomings of the ecological approaches under discussion.

THE STRUCTURE OF ACTION SITUATIONS

Time perspective. Present situations and actions depend on preceding situations and actions based on (a) direct influences and (b) indirect influences mediated by subjective interpretations of the past (see Figure 2). The organisation of present actions additionally involves anticipating future situational changes and structural and functional demands of the subsequent
action (e.g., throwing a handball is already anticipated while catching that ball). To prevent possible misunderstanding: The term ‘situation’ is not used synonym to ‘environment’, but refers to the person-environment relation as specified later including a third component.

More generally, investigations of human behaviour within its environmental context can only be appropriate and complete, when they take into account both situation-action history and future perspective. The ecological conceptions commented above referred quite differently to this aspect: explicitly by Krebs (“chronosystems”) (2009) and Kaminski (2009) (“stream of action”), however more or less emphasising the past; Fajen et al. within a very narrow scope only (“prospective control of action”); no statement on this issue by Hammond and Bateman.

**Situation components.** Within the ecological conceptions discussed above, behaviour has been considered as a function of person and environment. However, we are continuously confronted with the problem of structuring the person-environment relation by ourselves, i.e., actively and intentionally solving adaptation tasks. In this sense, *action* means dealing with the environment in the perspective of a particular task. Thus, the situational con-

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**Fig. 2. Action-related time perspectives.**

![Diagram showing action-related time perspectives with boxes for past, present, and future situations, actions, and interpretations connected by arrows.](image-url)
Text of action is constituted by the functional interrelation of three components: person, environment and task (Nitsch & Hackfort, 1981, p. 278; see Figure 3). Optimising this interrelation is the general objective of action and the general intention of practical interventions. The ecological conceptions discussed above partly refer to task properties, but not in the sense of a constitutive component of the behavioural context equally ranked to person and environment.

Concerning the fundamental problem of biological adaptation, the interrelation of person, environment and task needs further differentiation (see Figure 3): The configuration of those properties of the situation components which determines the urgency of adaptation is called valence relation. The configuration of those properties which determine the difficulty of adaptation is called competence relation. Thus, the actual situation specifies what should or should not and can or cannot be done, how, when and where. Both the properties of person, environment and task themselves as well as the twofold interrelation between them can be considered from an outside (objective) or an inside (subjective) perspective. This leads to a further central aspect of action theory.

Fig. 3. The situational context of action.
Subjective situation definition. The perceived configuration of person, environment and task – resulting in the subjective definition of one’s own situation – is considered as the essential basis of intentional behaviour, i.e., action (Figure 4). Consensual situation definitions are essential for social communication and interaction. Problems would occur, for example, when the view of an athlete dissent from the view of his or her coach.

Each of the situation components is subjectively appraised with respect to the two situation dimensions mentioned above: (1) valence related to the subjective attractiveness or repulsiveness of the situation; (2) competence related to the subjective controllability of the situation (see Figure 4). Then, deciding on acting or not acting depends on the perceived degree of valence and competence, and the valence-competence relation.

Within a system concept of situational dynamics, there are two situation variations of principle interest: (a) A subjective change in one of the situation components leads to an altered perception of the other ones: For example, the perception of one’s capabilities will change depending on the given task; altered personal properties (e.g., due to increasing fatigue, learning, falling ill or growing older) will result in a change in the perception of given tasks and

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![Diagram of subjective situation definitions](image.png)

Fig. 4. Structure of subjective situation definitions: Appraisal dimensions related to situation components.
environmental conditions. (b) The characteristics of the situation components and their interrelations are permanently changing throughout the course of an action.

Taking an outside perspective, subjective situation definition is completely outside the scope of the ecological conceptions of Barker (see Kaminiski, 2009), Hammond & Bateman (2009), Fajen et al. (2009). Krebs (related to Bronfenbrenner) and Kaminski (expanding the Barkerian conception) explicitly refer to subjective experiences, however without further elaborating this aspect in the sense of a systematically structured theoretical construct. Furthermore, focusing on the (objectively defined) competence aspect only is, in particular, a characteristic ingredient of the conception of Fajen et al. (2009).

THE FUNCTIONAL ARCHITECTURE OF ACTIONS

Dispositional levels of person-environment interaction. The organisation of action involves the interplay of different levels (see Figure 5) which are characterised as follows: (a) At each level, different dispositional properties of the person specify his or her potential capabilities for action, i.e., physical ones (in the sense of anthropometric properties, e.g., body height, leg length, weight, volume etc.), biological ones (referred to the neuro-physiological, endocrine and metabolic functioning of the organism), mental ones (e.g., intentions, cognitions, feelings; mental skills) and social ones (internalised social values and role expectations; social skills). (b) The personal disposition systems are considered as functional interdependent. For example, anthropometric properties (physical disposition system) have potential impact on energy expenditure during action (biological disposition system); internalized social values and expectations (social disposition system) potentially constrain the individual’s decision making and intention formation (mental disposition system). (c) Different personal disposition systems specify different relations to the environmental context. (d) Each level of action organisation is governed by specific rules of functioning.

Without going into details here, the essential point is: Each of these levels – physical, biological, mental and social – establishes specific sets of

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5 As (real) dispositions, they are merely potential until they are (selectively!) actualised by changes within person and/or environment which make active behaviour or its adaptation to the altered conditions necessary. 
6 In an extended sense, these personal dispositions may be considered as differentiating the concept of „effectivities“ by Fajen et al. (2009).
objective constraints and subjective options of action (see also the distinction between “real” and “perceived affordances” by Norman, 1999). Now, it becomes clearer what was already mentioned above: The discussed ecological concepts refer very differently and selectively to these levels of action organisation, ranging from anthropometric properties (“body-scaled affordances”, Fajen et al., in this issue) to social conventions related to Bronfenbrenner’s “macrosystem” (Krebs, in this issue).

**Phase structure of actions.** Action involves more than overt behaviour. The notion of “person as an active agent” in ecological theories should not be reduced to the objective person-environment relation. It has also to be applied to the processes within the acting person. A first account to this point is differentiating the functional time structure of action from a psychological point of view. This leads to the triadic phase model of action (see Figure 6). If we want to sufficiently understand what happens in the person-environment interrelation, then we have to take into account what happens in each of the three phases: anticipation, realisation and interpretation. None of the discussed ecological conceptions systematically outlines the time structure of actions in the sense of a sequence of functionally specified phases.
Action control systems. The second account to the ‘active agent’ notion is stimulated by evolution theory, particularly with respect to the differentiation of behaviour control mechanisms throughout the development of mankind. Adopting this perspective, human action control is considered to operate in three different but functionally interrelated ways (see Figure 6). Each of these control systems – cognitive, emotional and automatic – is specialised with regard to particular functions in the overall control of the action, and may become dominant in the case of voluntary, emotional or habitual action. In dissent from other emotion concepts, emotion is understood as a basic function in the orientation, activation and regulation of actions. Understanding action as controlled by three functionally specialised systems may open a more differentiated perspective on the person-behaviour-environment relation than the discussed ecological conceptions offered or applied.

Conclusion

The general credo of sport psychological intervention is helping persons or groups to do the right thing, in the right way, on the right place, at the right
time. Attaining this goal in a systematic, efficient and responsible way requires a sound theoretical basis. Undoubtedly, the ecological approaches commented above provide very fruitful contributions to an extended theoretical understanding of sport activity, its further investigation and practical improvement.

Environmental properties are described in physical, behavioural and/or sociological terms. It should be a challenge for future conceptions to systematically apply psychological terms in a specific sense: A promising starting point may be differentiating basic intentional orientations in the person-environment interrelation. This would lead to characterise environmental contexts according to their relevance to these orientations, e.g., gaining and maintaining the individual’s safeness, competence, experience and identity from a physical, mental and social perspective.

Furthermore, the functional role of language in motor learning and motor control as well as its mediating function in the person-environment interaction deserve particular attention.

Of course, taking into account all of the multifarious aspects within a single investigation would lead to unmanageable complexity. However, it is necessary to make reductions in a systematic manner keeping in mind that the focus is on a more or less small part of the whole picture, and this part has to be compatible with the context it refers to. In this sense, the action-theoretical frame of reference may be considered as ‘cognitive map’ which helps to structure theory building, research and intervention.

The common message of the ecological conceptions is: “Be aware of the properties of the objective environmental context while intending to improve the behaviour which takes place within this context.” However, this message needs an essential supplement: “Don’t forget the person who intentionally acts within this context.”

REFERENCES


Exercise psychology is a diverse and highly-active field. Within this field, ecological frameworks are providing strong conceptual guidance to a number of research domains. A particular strength of ecological frameworks, as the four papers in this Special Issue demonstrate, is their focus on how people and environmental attributes interact, in differing physical activity contexts.

There is much to be gained from developing and applying ecological approaches to physical activity behaviours. Ecological approaches are particularly needed if we are to comprehensively address the challenges of increasing the physical activity participation levels of whole populations (Biddle & Mutrie, 2008; Sallis & Owen, 1999). There is the potential to reduce a significant portion of the burden imposed by ‘diseases of inactivity’—particularly type 2 diabetes and cardiovascular disease (United States Department of Health and Human Services, 1996), and breast and colon cancer (Lee, 2003). More than half of the adult populations of industrialised countries being insufficiently physically active for health benefits (Bauman, Armstrong, Davies, Owen, Brown, Bellew & Vita, 2003).

While there have been public campaigns to promote physical activity in many industrialized countries for ten years or more, together with community-based initiatives to increase participation, population-wide increases in activity generally have not been evident. For example, in Australia, population levels of physical activity have been static and may have declined in some groups (Bauman et al, 2003). Thus, there is a strong case that substantial, ubiquitous and long-lasting environmental and policy initiatives are needed. These include, for example, the provision of walking and bicycle paths, accessible community

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facilities for activity, and incentive systems that can reinforce physically active transport choices. These are argued to provide the most promising opportunities for making physically-active choices easier and realistic for those who live in automobile dependent, highly-mechanized environments. Environmental and policy strategies are now a well-established component of public-policy initiatives to promote physical activity (Sallis, Bauman & Pratt, 1998).

Ecological frameworks help to guide such environmental and policy initiatives designed to promote physical activity. Conceptually and practically, exercise psychologists are responding to the challenge of understanding and influencing physical activity through, among other goals, identifying the relevant environmental changes. Evidence-based approaches are crucial, if environmental-change strategies are to make a real difference. Broadly-based perspectives, drawing upon ecological frameworks, are providing helpful guidance to research, practice and policy.

The streams of psychological thought that have helped to guide behavioural research on the environmental determinants of physical activity are complex, and have been shaped, to significant extent, by ecological frameworks developed within our discipline. The four major articles in this Special Issue nicely illustrate the broad and specific ecological frameworks that can help in understanding and influencing physical activity behaviours.

At the broadest level of ecological thinking, Bronfenbrenner’s ecological systems perspective (Krebs, 2009), provides a comprehensive model of the multiple levels of factors that may act to influence behavioural choices. Barker’s behaviour settings construct (Kaminski, 2009), focuses more-specifically on environmental attributes; Barker’s approach considers how socially-constructed environmental contexts may act to constrain some behaviours, and to promote the performance of other behaviours. Brunswik’s probabilistic functionalism (Hammond & Bateman, 2009), shows how the inherent complexity of behavioural choices in complex environments may be addressed. Gibson’s framework (Fajen, Riley & Turvey, this issue) provides a compelling perspective on affordances – how opportunities for particular actions are provided by multiple sources of information from relevant environmental cues.

The explicit recognition of multiple influences on particular actions and behavioural choices, characterise ecological thinking. Health behaviour research, particularly studies of determinants and interventions to influence physical activity, take broad guidance from such ecological models — models that draw upon the style of thinking that is illustrated by the papers in this Special Issue.

Ecological models of health behaviour have two major attributes: 1) multiple levels of influence on behaviour; and, 2) behaviour specific models that
relate to the unique determinants of particular behavioural choices. Ecological perspectives on physical activity have been proposed by exercise psychology and exercise-science researchers (see, for example, Giles-Corti, Timperio, Bull, & Pikora, 2005; Owen, Leslie, Salmon & Fotheringham, 2000; Sallis & Owen, 2002; Spence & Lee, 2003). What these perspectives have strongly in common is an emphasis on multiple levels of influence on behaviour and the utility of behaviour specific ecological models. The focus of behavioural research on physical activity is becoming increasingly differentiated, with particular physical activities (for example, sport participation, resistance exercise for health benefits, walking for exercise, walking for transport) being examined as distinct behaviours that may have distinct determinants.

Kaminski’s contribution to this Special Issue relates particularly to these ecological models of health behaviour. Kaminski highlights Barker’s behaviour settings construct, identifying a key role for those social and physical situations in which behaviours take place: ‘... people are but one component of the larger behavior-setting system, which restricts the range of their behavior by promoting and sometimes demanding certain actions and by discouraging or prohibiting others...’ (Wicker, 1979, page 4). Sallis and Owen (2002) argue that the explicit treatment of relations between the person and physical-environment settings to be the defining feature of ecological models applied to health behavior. We emphasize the environmental domain because its inclusion distinguishes ecological models from other models and theories, and because much less is known about environmental correlates of, and influences on, physical activity. In sport and exercise psychology, consistent with a social-cognitive perspective, the focus of theory and research studies tends to be on factors within the individual and in the immediate social environment, as opposed to broader sense of physical and social environment influences (Sallis and Owen, 2002).

The utility of ecological models of health behaviour may be illustrated with reference to understanding the multiple levels of factors that may act to influence adults’ walking. In the context of the public health goal to increase regular, moderate-intensity physical activity, the behavior of most relevance, and which should be most amenable to influence by environmental and policy changes, is walking. In this context, walking for transport and walking for recreation and exercise may be identified as distinct classes of physical activity behaviour; quite-different correlates of walking for transport and of walking for recreation and exercise have been identified. Reviews of the health literature indicate that access to recreation facilities and the aesthetics of activity settings are related to recreational physical activity and to walking (Humpel, Owen & Leslie, 2002; Owen, Humpel, Leslie, Bauman & Sallis, 2004). Reviews of the transportation research and urban planning literature indicate that ease of pedestrian access to
nearby destinations is related to active transportation choices, particularly walking (Saelens, Sallis & Frank, 2003). Thus, different variables will need to be assessed in studies of walking for recreation and exercise, relative to what would be assessed in studies of walking for transport.

An ecological model for each of these particular classes of physical activity behaviour emphasise different variables acting at different levels. For example, health concerns and other individual-level attributes may be highly-salient determinants of choices to walk for recreation or exercise. On the other hand, walking for transport may be influenced more-strongly by the proximity of destinations such as transit stops or stores (Humpel et al, 2002; Owen, et al., 2004; Saelens et al, 2003; Giles-Corti et al., 2005). Ecological models strongly suggest the importance of assessing such multiple levels of influence, in order to tease out interactions between factors and may be operating at different levels of influence on particular behaviours. Initial progress in this new field of research has been rapid, as evidenced by a recent ‘review of reviews’ (Gebel, Bauman & Petticrew, 2007), which highlighted the fact that the majority of such studies have used cross-sectional designs, so that the evidence on causality (that is, ‘do environmental changes actually change behaviour?’) is limited. Nevertheless, consistent environmental correlates of physical activity have emerged. For example, walking for recreation or exercise is associated with aesthetic attributes such as greenness and the presence of natural features; walking for transport is more likely in the presence of destinations such as stores and community facilities. Whether such factors are causally related to physical activity can only come from prospective studies, and ideally from controlled intervention trials (Bauman, 2005; Gebel, et al., 2007). There is also the need for more-consistent applications of the relevant methodological tools for analysing the potentially complex paths of causation that ecological frameworks help to identify (Bauman, Sallis, Dzewaltowski & Owen, 2002).

These examples illustrate some of the ways in which ecological frameworks, broadly defined, are helping to guide a new area of public health research that has significant implications for improving health outcomes. Ecological concepts are helping to shape such research within exercise psychology, in directions that are scientifically-useful and practically-relevant.

REFERENCES


Reply to Comments:
The need for representativeness persists

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In this brief reply to comments on our paper, we first wish to express our gratitude for the thoughtful comments by Abernethy, Beek, and Nitsch regarding our work. We are also grateful to the editors for suggesting our participation in the production of this special issue of the journal. It will be apparent that this is our first publication in the literature of sport psychology, and that we have learned a great deal from it. Hammond, the academic, and Bateman, the tennis professional, have each deepened their respect for this discipline. Hammond now sees the considerable research competence within the field that of which he was previously unaware. More than that, however, he now sees the great promise sport psychology holds for breaking out of the boundaries traditional experimental psychology has created for itself over this past century. That promise may be realized because the nature of the discipline requires it to move in the direction of ecological psychology and the representative design of experiments, as aptly demonstrated by the study that we will examine in more detail below, Williams, et al (2002). And Bateman now sees the potential for an “outer” psychology that will be capable of producing the kind of knowledge that a tennis professional can use to improve his students’ skills. We both look forward to advances in the field that will make a difference.

We now turn our attention to the methodology that guarantees the future usefulness of those studies. As we stated in our paper, in order for a result to generalize to conditions beyond those in the laboratory the environmental conditions to which an experiment is to generalize should be specified in advance to the best of the ability of the researchers. This is what Egon Brunswik termed “representative design” of experiments. This is a shift in
methodology that has enormous consequences for theory and practice. Is it a shift that has already taken place, as implied by the comments of Beek, Abernethy, and Nitsch? We think an examination of the literature reveals that it has not, and we hope that our more detailed examination below of a particularly good study will convince readers and our commenters that our arguments provide useful insight for future research.

In his comments on our paper, Beek provided a generous list of studies that he said are “specifically concerned with the relation between the athlete and the environment.” The purpose of this list was to demonstrate the degree to which we had overstated the proportion of studies that ignore this relationship. Not wishing to get into a debate over numbers of studies, we will concede that the list of such studies is indeed large, much larger than Beek chose to list. However, we will not concede that the studies all satisfy the requirements of generalization, namely the requirements of representative design. Do all those studies contain references to specific circumstances to which the results are to generalize? Do those studies lay out a specification – and justification – of the properties of the ecology to which the results are intended to apply? Do they indicate how these properties are matched by the properties of the experiment? Do they make explicit the logical form of inference from experiment to ecology? They do not. Rather, they justify their work, if at all, by a simple appeal to the empty concept “real world” (See Williams, et. al. (2002)). Only in one paper (Williams, et. al. (2002)) does the term “representative” even appear, and there only twice, each time paired with “real-world” or its cousin “realistic”.

Despite the list of references we are not persuaded that representative design is common in the sport psychology literature. Rather we find that the research cited by Beek, though looking at the “outer” game as we termed it, exemplifies the conventional methods of experimental psychology, methods for which we propose an alternative. We will not claim that the conventional form of research is useless; our central argument is that one form of research should not rule over a discipline to the exclusion of all others. No one methodology should be employed without critical assessment of the putative strengths and weaknesses of each in relation to the goals of the research. Nor should it do so without instruction to students about such strengths and weaknesses. Nor should any one method rule because of a misplaced characterization of “real science”. Representative design and the argument for it are needed if sport psychology is to break out of the confinements of conventional psychology where indifference to the nature of the ecology outside the laboratory is the norm.

In our paper we gave a concrete example of a study from the sport of tennis that satisfies the criteria of representative design. Now we will exam-
ine, from a Brunswikian perspective, another study of tennis, this one referenced by Beek. It is a study of a “real-world” task, anticipation in tennis, conducted by Williams et al. (2002).

Disregard for the nature of the ecology to which results are to be generalized is so common, and so much a part of conventional psychology, that it occurs even with sophisticated researchers who have already acknowledged the shortcomings of conventional research. Williams and colleagues are that sort of sophisticated researchers who carry out their work in a manner that shows concern for ecological generalization but who also show how failure to come to grips with the details of the ecological situation of interest tarnishes an otherwise brilliant study. They are interested in “anticipation”, surely a widespread feature of sports behavior. But anticipation of what by whom?

In their experiment, Williams and colleagues had three goals. First they wanted to measure whether and how better players were more skilled than less skilled players in anticipating the direction of tennis shots using visual cues and visual search patterns. To do this, Williams and colleagues set up an elegant system using video simulation of highly skilled models hitting shots in two different directions. Participants wore high technology goggles allowing the experimenter to capture the gaze of both highly skilled and less skilled participants as they anticipated the simulated shot directions of the highly skilled models. From this Williams and colleagues were able to confirm that better players did indeed better anticipate the direction of tennis shots. Williams and colleagues were also able to identify different cues used for this purpose and were able to identify differences in visual search patterns between the two groups of participants, not a small accomplishment.

Second, Williams and colleagues wanted to develop a training program to teach less skilled players to use the visual cues and visual search patterns of the better players. Williams and colleagues used control groups and placebo groups in addition to two different experimental groups in the learning experiments, one explicit learning group and one guided discovery group. Williams and colleagues found that less skilled players could be taught to anticipate better the direction of tennis shots, under the experimental conditions in which they had learned the skills, using the visual cues and visual search patterns of the more skilled players. The results of this experiment can only be considered a remarkable achievement.

As the final goal of the study Williams and colleagues wanted to see if the learned skills would transfer to the “real world”. In order to test the transfer of the anticipation skills, Williams and colleagues used a field test to represent the real world task. In the field test, four groups tried to anticipate the shot direction of live, highly skilled players. The four groups consisted of two
groups of less skilled players, one an explicit learning and one a guided discovery learning group, a placebo group and a control group. Williams and colleagues found that the skills did transfer to the field test. Both the explicit and guided discovery learning groups significantly lowered their decision times, without significantly affecting their response accuracy. Again, this result is a remarkable achievement.

Despite the success of these experiments and the careful manner in which they were carried out, we would now like to examine them from a Brunswikian perspective. We will first look at the methodology of the experiments with an eye toward whether they satisfy the criteria of representative design. Next we will use Brunswik’s lens model and lens model equation to see if theory might give us insight into how best to conduct future research into visual anticipation in tennis.

**Methodology**

Williams and colleagues allude to our fundamental concern with the methodology of this study when, in their Conclusions and General Discussion section they write “There is also controversy as to whether perceptual training programs should be used with experts, intermediaries, or novices.” (p. 268) We will address this again in our discussion of theory below, but for now we’ll point out a methodological shortfall of the study regarding skill level. Williams and colleagues were careful to sample two groups of participants, highly skilled and less skilled. However, Brunswik pointed out (1943, 1956) that the logic of generalization, which calls for sampling of participants, must also be applied to tasks. In this set of experiments, only highly skilled models were used. Therefore any hope that the results of this study will generalize to less skilled models is just that, hope. It is not based upon the logic and methods of the study. In fact, since in tennis highly skilled players rarely, if ever, compete against less skilled players, we strongly doubt that the results of these experiments will generalize to the ecology where the less skilled players are competing against other less skilled players. It is the case that lesser skilled players differ from highly skilled players in both their method of striking the ball and in their consistency in directing it to various target areas (more on this below). We suggest, and Brunswik’s representative design demands, that if the ultimate goal of the study is to enhance the visual anticipation skills of less skilled players for use in matches against similarly skilled opponents, the use of models of varying skill levels will make such “real world” generalization much more likely.
Theory

Our second point — a greater interest in theory — can also be related to the Williams et al (2002) study. Specifically, Brunswikian theory, as reflected in research involving the lens model in general and the lens model equation in particular (for examples see Hammond and Stewart, 2001), speaks directly to Williams and colleagues’ interests and shows why the skill level of the interacting players makes a difference with regard to visual anticipation.

We start from the premise mentioned above that highly skilled players have a lower level of uncertainty in their game than novices; they are simply more consistent. The lens model and the lens model equation offer a pictorial and quantitative description of this situation. From the theory we can make a prediction regarding the efficacy of visual anticipation for various skill levels.

The lens model depicts a) participant or subject’s judgment ($Y_s$), b) the environmental variable to be judged ($Y_e$), c) the cues available from the environment ($X_i$) and used by the participant to make the judgment, d) the relation between the proximal multiple fallible indicators (identified by Williams

![Lens Model Diagram](image)

Fig 1.
et al) present in the environment that make possible reasonably accurate judgments of distal variables and the participant’s judgment, c) the relation between each of the indicators and the distal variable. In the case of the Williams and colleagues visual anticipation study, the distal variable to be judged (Ye) is the shot direction. The judgment of the subject is on the right hand side (Ys). The cues available from the environment used by the subject to judge shot direction (hip, torso, arm, racquet movement) are in the center. The accuracy of the participant’s judgment (shot actually left or right compared to the judgment) is the achievement (ra). Mathematically the relationships depicted in the lens model can be written as an equation, the Lens Model Equation, the general form of which is

\[ r_a = GR_y R_e + C \sqrt{1 - R_a^2} \sqrt{1 - R_e^2} \]

Fig 2.

For present purposes we can ignore the second component of this equation and consider only

\[ r_a = GR_y R_e \]

where \( r_a \) is the subject’s achievement (accuracy of judgment), \( R_e \) is the value of the multiple correlation between the indicators (\( r_{ai} \)) and the subject’s judgment, (Ys in Figure 1), \( R_e \) is the multiple correlation between the indicators (\( r_{ei} \)) and the distal variable (the environment, \( Y_e \) in Figure 1), and G is an indication of the degree to which the weights (and function forms) of the environmental variables match the weights (and function forms) of the cues used by the participant in judging the environmental variables. (Note: For a description of the Lens Model Equation, see Stewart, 2001; for a more detailed description of the Lens Model Equation, see Cooksey, 1996, pp 205-242.)

The model and the equation show that the value of \( R_e \) provides a limit to the value of \( r_a \), that is, a limit to the achievement of the participant in the ecology with the specified value of \( R_e \). The erratic play of the novice means that \( R_e \) for a participant trying to judge the shot direction of the novice will inevitably be low. The limit for a subject trying to judge the
shot direction of a highly skilled player is likely to be higher (because of his or her more consistent play and therefore higher \( R_e \)). We can conclude that anticipation will necessarily be less accurate (\( r_a \) will be lower) when anticipating novices than when anticipating experts. (Note: Hammond & Stewart (2001) offer other examples of the importance of this specific consideration of ecological characteristics, and the use of the Lens Model Equation)

From this theoretical analysis, we suggest that studies of the sort that Williams and colleagues undertook will be most valuable using highly skilled models and participants. Due to the limiting nature of \( R_e \), teaching participants to increase their \( R_s \) will bear little fruit (little increase in \( r_a \)) if \( R_e \) is quite low. But in highly skilled players, \( R_e \) is relatively high. Therefore, increases in \( R_s \) will pay greater dividends in higher \( r_a \). Therefore, the most fruitful tennis research into anticipation should be conducted with an eye toward its most valued market, namely highly skilled players. This is a conclusion derived from Brunswik’s lens model that can be tested empirically for validity.

A Personal Note from Hammond in Closing

I enjoyed Araújo and Davids’ introductory chapter to this special issue because it represents a clear break from conventional experimental psychology. I knew all the people — Barker, Bronfenbrenner, Brunswik, Gibson — whose work they describe, and saw what they were going through, a kind of excommunication from “real science”. I thought they were right then and I know they were right now. I saw Roger Barker and Egon Brunswik get particularly bad treatment, scorn and laughter. I never dreamed that they would be exhumed, so to speak, in the positive manner and with the skill and competence Araújo and Davids have managed. And to think that it is happening in a sports journal is beyond belief. So I have four cheers for these two. That chapter is a remarkable event, and I think the above four would be very happy about it. As perhaps the last psychologist to see them in action, I am grateful.

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(No) Final Comment: What I have learnt

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Final: When I was granted responding to commentaries as well as to the colleagues’ target articles I imagined proceeding as follows: While studying all these contributions thoroughly I would, in particular, look out for spots in the texts where I felt to have been misunderstood or misinterpreted, so that I could, after all, aspire and achieve final clarification by some further explication.

Not final: The more I really progressed in reading all these papers the more I had to realize how unrealistic my initial view had been. I got lots of important new information. Yet, in accord with the accrual of new information, also a growing bulk of questions emerged, a plethora of new problems needing further discussion. So, I rather came up with the idea that what seems to be needed now is something like a workshop where all the – even more than ever before - pending questions and problems could be discussed in adequate detail. Hence, what I am able to present here will not be more than kind of a personal interim balance which I would take as a base when going into further discussions. Avoiding misunderstandings and misinterpretations would, first of all, require attaining an adequate conception of the mutual interrelations between the different positions. This demands, in my view, differentiating these ecological approaches – beyond their fundamental commonalities — on at least three different levels, or locating them within three different frames of reference ("ecological realities", "primordial articulations", "strategies of conceptualization").

“Ecological” approaches: Common denominator

The main authors’ task has been to demonstrate that “ecological” approaches have to offer something special and, moreover, something useful...
to sport psychology in comparison with traditional, “non-ecological” approaches. Yet, the terms “ecology” and “ecological” can adopt quite different meanings. So, the question arises whether the “ecological” approaches presented in this issue have, despite of all their diverseness, something in common. I tend to see this common denominator in their plea for a specifically “ecological” methodological viewpoint and strategy applicable to research as well as to practice, combined with a caveat against more or less “un-ecological” proceeding. These two methodologies are quasi asymmetrically related to each other. Sure, both aim at furthering human life either by extending and revising knowledge or by improving practical competence. But the first (the “ecological”) one tries to accomplish this in a “naturalistic” way, i.e., through maintaining, as far as possible, close contact to human life in its natural course and its habitual circumstances. The second one prefers employing specifically composed arrangements (e.g., experiments, tests, interviews) more or less detached from ordinary daily life, for the sake of reduced complexity, enhanced precision and economy in knowledge production, thereby, however, running the risk that these arrangements are no longer “representative” enough for what happens in “real life” (“Ecological psychology is a transducer science [as opposed to a psychology where the psychologist functions as an operator thereby intruding into the data generating process] ....its data record behaviour and its conditions in situ”, Barker, 1968, p. 143; “Bronfenbrenner had criticized the narrowness and artificiality of the research designs traditionally used ...”, Krebs, in this issue, 2009, “The laboratory must be like life”, Gibson, 1979, p. 3; “the lesson environment must in some way represent, or at least resemble, the match environment”, Hammond and Bateman, 2009, p. 12).

Thus, the attribute “ecological” here has a relational, in particular, a methodological meaning which presupposes the existence of some kind of “reality”. “Representativeness”, i.e., (more or less sufficient) correspondence between “arrangements” and “proper reality”, appears as the core problem, where “ecological” implies a slightly normative connotation in favour of “naturalness”.

“Reality”: Fundamental and “ecological” ontologies

Evidently, the four ecological approaches in question have, as concerns their fundamental methodological orientation, much in common. They all have to position themselves with respect to the basic problem of “representativeness”. All of them, therefore, need relating to some kind of “reality”,
committing themselves thereby to a particular ontology. Just in this regard, however, these approaches differ considerably and momentously. Hence, since they all apply the attribute “ecological” also to “realities” this term not only can adopt an “ontological” meaning too but this ontological meaning differs among the approaches substantially. Furthermore, the specifically “ecological reality” may be delimited within a much wider, fundamental ontological frame.

Gibson (1979) starts with a most inclusive fundamental ontological frame. “The world of physics encompasses everything from atoms through terrestrial objects to galaxies” (p 8). But then he narrows down to “...the intermediate band of terrestrial sizes, the environments of animals and men ... (p. 9) . And “We are concerned here with things at the ecological level, with the habitat of animals and men ...” (p. 9). So, he decides to reserve the term “environment” for surrounding conditions at the “ecological level”.

Barker, about ten years earlier (1968), chose, in a paragraph about the “order in the pre-perceptual environment” (p. 154), a remarkably similar fundamental ontological frame, from “carbon atoms” to “solar systems”. However, where he tries to delimit his specific “ecological reality” within this encompassing ontological frame he constitutes merely sort of a subset inside of Gibson’s “ecological level” which might be characterized as “human everyday life”. He depicts it either in a narrative format (e. g., Barker, R. G. et Associates, 1978, p. ix f.), or in kind of a metaphor, “if a satellite with cameras for recording human behaviour was positioned over any considerable portion of the world, it would show that human activities are by no means uniformly or randomly distributed over the earth ...” (Barker, 1978, p. 192).

As concerns “reality” in Bronfenbrenner’s ecological approach, I couldn’t find yet a hint on a comparable overarching ontological frame. However, without doubt, his specific “ecological reality”, as well, amounts to not more than a subset within Gibson’s “ecological level”. For the purpose of delimiting Bronfenbrenner’s specific “ecological reality”, Barker’s satellite should, in principle, be applicable too. Its cameras, then, would simply ignore part of the phenomena, yet, they had to run much longer than the ten years of the Barkerian ones, through lifetimes, sequences of generations, even eras (cf. Krebs, in this issue).

In order to demonstrate the usefulness of Brunswik’s ecological approach Hammond and Bateman (in this issue) concentrate their argumentation right from the beginning upon methodological aspects, illustrated by means of one rather concrete example (tennis). So, it remains questionable whether the Brunswikian position could be compared to the other approaches with respect to “ecological reality”, all the more since the authors
explicitly oppose making use of the term “real world”. The asymmetrical relation between a “proper reality” and an “arrangement” bound to aspire “representativeness” manifests itself here merely in the relationship between – in Barker’s sense – the behaviour setting genotypes “tennis match” and “tennis lesson”.

What follows? Obviously, the approaches in question differ with regard to rather fundamental presuppositions. Since they all, nevertheless, characterize themselves through the attribute “ecological”, one more source for the ambiguity of this term — a differential one — has been identified. This insight should caution against harmonizing, short cut attempts to integrate these approaches. Still more differences between them will become evident if we progress from this rather global view to comparing details of their reality articulation.

**Primordial articulating and taxonomizing “ecological realities”**

However differently these four “ecological” approaches may delimit and characterize their ecological realities in toto, they all — by referring to these realities in their texts — make use of some kind of interior (conceptual) articulation. However specific these approaches may constitute their ecological realities, all their exponents are themselves also participants in ecological realities. As such they have to acknowledge that these realities have already been “articulated” (pre-scientifically) in a very long socio-cultural tradition. Thus, ecological psychologists cannot but adopt much, if not most, of this traditional articulation that presumably has been developed for the sake of orientation and communication. Yet, ecological psychologists are affected by this issue in a quite specific, nevertheless almost vital way. If, actually, correspondence between “arrangements” and “proper reality” (“representativeness”), appears as their core problem, then, evidently, they need kind of a coding system that enables describing and appraising this correspondence. The more poorly ecological realities are (descriptively and conceptually) articulated, the less precisely and reliably can representativeness be characterized and appraised, and vice versa.

If we compare and analyse the four approaches with regard to interior articulation of ecological realities we can find — on a first, primordial level — basic categorical sub-fields and dichotomies (I termed them “domains” in my paper) as well as some fundamental structuring principles. There seems to be much congruence between the camps on this level. Some examples of *primordial sub-fields* and *dichotomies* (cf., e. g., Barker, 1968, p. 137ff., referring also
to Brunswik, 1955; Gibson, 1979) are: Individual (organism, person, agent) vs. surrounding conditions (habitat, context, environment); person-(organism)-environment-unit (-system) (transactional view); individual (individual system) vs. supra-individual (social) system (relationship, dyad, group, collective, population); “internal world” (first-person perspective, “experience”) vs. “external”, “observable” world (third-person perspective); behaviour (activity); “geographical” (spatial, physical) environment; “psychological” processes, states etc. vs. somatic, “physiological” processes, conditions etc.; time; event; permanence (relative stable conditions) vs. change (processes); “natural” vs. (relatively) “artificial” partitioning of fields or dimensions.

With respect to primordial structuring principles, I tend to distinguish, in a metaphorical sense, between a vertical and a horizontal mode of subdividing. The first (vertical) one is usually termed as “nesting”-principle (or “embedding”). Its application enables switching between (“emergent”) levels within a hierarchy of different degrees of granularity (“scales”). The second (horizontal) one, taxonomizing, results, at best, in a well-founded, systematic, and exhausting subdivision of some field on any level.

These two structuring principles can, in principle, be applied to all kind of sub-fields and dimensions, e.g., persons, person-environment-systems, activity, “internal world”-phenomena, social systems, physical environment, time, events, changes etc. (e.g., Barker, 1968; Gibson, 1979; numerous examples can also be found in the articles of this issue and in their references).

What follows? This kind of fundamental categorical fields and these structuring principles can be understood as a framework by which ecological realities are primordially articulated. It sets the stage for all further, more differentiated (descriptive and conceptual) articulations. Each ecological approach can and must decide in which way and to what extent it makes use of this articulatory potential (Hammond and Bateman, e.g., claim regarding representativeness with respect to “persons” as well as to “objects”, 2009, p 7). More precisely, more detailed articulations are guided and constrained by these basic preliminary decisions. These more detailed articulations, in turn, determine to a considerable extent which research questions or practical problems can and will be posed as well as which designs can be applied to deal with these problems.

More specific modes of coping with the complexity of “ecological realities”.

Still more intricate problems surface, if ecological approaches, in particular also those involved in sport psychology, advance beyond committing
themselves to a particular primordial articulation of their ecological realities. Shortage of space enforces, of course, extremely simplified reasoning.

Every human being deals, in everyday life, with ecological reality’s complexity in a relatively flexible and efficient, nonetheless also rather global, all-embracing way — as superficially as possible, as thoroughly as necessary. Wherever a scientist turns to reality (s)he is bound to fulfil kind of a mission that requires considerable effort since high quality standards have to be met. Thus, (s)he cannot afford treating thoroughly more than a rather closely limited section or aspect of reality. Hence, anytime (s)he will inescapably be confronted with the problem how to deal with the rest, i. e., with reality outside the limited area of his/her specialization. (McGrath, 1981). Evidently, scientific approaches try to tackle this problem by means of quite different strategies, as we will see in a moment.

The tremendous complexity and comprehensiveness of an ecological reality’s universe offers countless possibilities of specialization to establish oneself in any sub-fields, levels, scales. Where a scientist settles down could be motivated in rather different way. (a) (S)he comes across a (scientific or practical) problem which requires to be adequately located within taxonomical frameworks, and there (s)he starts and continues working. (b) Particular sub-fields, levels, or scales may, as such, inspire raising pertinent “site-specific” questions or problems. (c) (S)he adheres to a particular theory or empirical approach and searches for a fitting counterpart in reality for the sake of exemplification and checkout.

What about the world of sport?

Sport, in the broadest sense, can be found almost everywhere in ecological realities, throughout a great many primordial sub-fields, levels, scales. Let’s consider but a few illustrating examples.

One person; primordial category “events”; in particular “transactions” (activity-environment-units); in particular “tennis”-related activities; hierarchy of time-scale variations, where we choose a segmentation in “natural” temporal units (instead of “artificial”, metric ones; Gibson, 1979, p. 12). Let’s get in on the level of “a shot” (cf. Hammond & Bateman, 2009), going on (not without considerable arbitrariness, indeed) through the levels point; game; set; match; tournament; project “taking part in a one-day tennis tournament” (including approach from home and return); a day; a week; the period of preparing for a tournament; a season; the period of cooperating with a particular coach; the period of membership in a particular tennis club;
career as tennis player. – Proceeding from the “shot”-level in the opposite direction on the time scale we can find transactional units like “catching a flying ball”, “orienting a glove” (Fajen et al., 2009); reflexes (Hammond & Bateman, 2009), “actones” (Barker & Wright, 1949). – Another illustrative example of this kind of hierarchization starts from the everyday life event-genotype “catching soap” (Van Orden, Holden, & Turvey, 2003, p. 333).

The universe of each level’s events lends itself to being taxonomically systematized. Thus, taxonomizing the events, e. g., within the unit of “a day”, in appropriate granularity could be part of the empirical basis of defining a “mesosystem” (Krebs, 2009). “Career (as tennis player)” meets the level that Bronfenbrenner seems to focus on primarily (Krebs). The “tournament” level, here applied to an individual, can be interpreted as “participating in a multi-setting synomorph”, composed of “behaviour settings” and their sub-settings (Barker, 1968; Kaminski, 2009), whereas these entities, as such, are primarily defined as supra-individual event-units.

So, I could add lots of similar exemplifications based on different conjunctions of primordial parameters. They all could demonstrate that ecological realities are interspersed with a stupendous diversity of manifestations of “sport”. I am convinced that they all comprise psychological aspects and psychologically relevant problems. Hence, I don’t see any reason why sport psychology, in principle, should not be interested and involved in all of these manifestations, on whatever level and in whatever domain (track-and-field sports and gymnastics, water sports and motor sports, competitive sport and mass sport, school sport and rehabilitation sport, endurance sport, sport for disabled and aging persons, sport competition and sport training, coaching athletes and teams etc.; cf., e. g., Araújo & Davids; Krebs; Owen; all 2009).

**Scientists’ strategies of coping with ecological realities’ complexity**

Wherever, within this overwhelming diversity, a sport psychologist settles down for treating any challenge in compliance with scientific standards (s)he is confronted — as it was said before — with a kind of “stress” which results from the discrepancy between the specificity of his/her particular field of interest and the diversity of its broader surroundings, let alone the complexity of his/her ecological reality in its entirety. Though, of course, this stress affects empirical science in general, it strikes “ecological” approaches with an exceptional vehemence. “settling down” in a specific site of an ecological reality usually implies (a) focusing on particular phenomena and
bringing them to the fore; (b) narrowing them down, labelling and describing them initially by means of disciplined everyday language: (c) imposing on them (or discovering in them) a specific research question or practical problem; (d) articulating this focal field — beyond its everyday language articulation — scientifically by means of concepts, (more or less elaborate) models, theories, hypotheses, thereby enabling a more precise and workable phrasing of (more or less multifarious) questions and problems; (e) utilizing these conceptualisations as a framework for aspiring deeper understanding, more precise explanations, or solving practical problems by means of supplying empirical evidence.

The conceptualisation of a focal field implies its localization within the framework of primordial structures. Thereby ecological reality’s “rest” outside the focal field may as well appear more clearly structured which then may necessitate coping with “specificity stress”. As regards this kind of coping, the ecological approaches convening in this issue seem to differ remarkably. I would suggest differentiating between three main coping strategies, “phenomenal and/or conceptual self-restriction”, “moderate expansion”, “global conceptual integration”. They all make use of (in part the same) sub-strategies. Sure, these strategies are not deliberately chosen, yet, I think their “implicit” application can be inferred from several indicators. Again, I have to apologize for the unavoidable sketchyness of the argumentation and simplifications in the evidence brought forward.

(a) Phenomenal and/or conceptual self-restriction. This strategy comes up to contenting oneself with “specificity”, i. e., concentrating one’s interest and activity on a focal field defined through a conjunction of rather limited primordial parameters (e. g., few levels on a time or event scale, few variants among the diversities of different other domains like persons, surrounding conditions etc.), in particular regarding the world of sport(s) (cf. Nitsch, 2009, p. 40). Who nonetheless somehow transcends this field into any neighbourhood remains strongly situated within his/her original orientation. Which of the ecological approaches in question (or authors in this issue’s articles) could, in my view, be assigned to this type of strategy?

Hammond and Bateman focus primarily on (transactional) event units like “getting to the ball” or “hitting the ball” (spanning around seconds), considering several variants, and on the higher-level unit “learning process”, again including variants. Although they mention also “embedding” higher-order event-units like point, game, set, match they seem not to be interested in considering them event-units with emergent characteristics of their own, requiring appropriate conceptual articulation and giving rise to level-specific research questions and practical problems as well.
Similarly, Fajen, Riley, and Turvey — arguing within Gibsonian perspective — focus primarily on transactional short-term units like “interceptive actions” (where “direct perception” and “affordances” appear to be suggested as theoretical articulation) as well as on higher-level processes called attunement and calibration. They, too, refer to higher-order events like “training”, wherein attunement could be “developed”, or even to “development” on an ontogenetic time-scale. Yet, they also seem not to be interested in dealing with the specific emergent characteristics of these processes. (Another particularly impressive prototypical example of a primary focus deserves being mentioned here, catching a bar of soap slipping out of hands while taking a shower, Van Orden, Holden, and Turvey, 2003).

Some of the commenting authors characterize their own position in such a way that it may appear justified assuming a certain affinity to this type of strategy (Abernethy focussing on “expert performance” and “skill learning”; Beek on “control and learning of movement”; perhaps also Owen because of his main focus on “walking”).

This strategy’s main asset consists, I think, in promoting systematic, consistently progressing in-depth research in close connection with theory development.

Yet, I see also potential risks. I cannot bring up but one illustrative aspect. “Self-restriction” in the aforementioned sense could possibly deem it justified keeping one’s distance from more or less neighbouring approaches, because the phenomena they are focusing upon are supposed to have no noteworthy or relevant impact on one’s own focal field. This could lead to somewhat like a perspective and theoretical encapsulation. But if it turns out that this presupposition is wrong, then this kind of encapsulation would hinder further development of one’s own approach. Let’s take two examples. Evidently, being specifically “instructed” has some impact even on transactional processes that happen on a time scale around seconds or even milliseconds (Van Orden et al., 2003, p. 346). But shouldn’t we also assume that the process of “appropriating” (perceiving and understanding) an instruction (e. g. about “strategies” that have to be acted out in a match) has relevant impact on making factual use of the instruction afterwards as well? So, the question arises whether or how, e. g., the theories of “direct perception” and of “affordances” could be consistently integrated with theories of speech perception or whether, perhaps, they need some revision and expansion. – The same holds, in principle, for considering the “behaviour setting” concept. Obviously, someone participating in a specific behaviour setting — let’s say a particular training session — knows that (s)he is participating, as well as (s)he knows, afterwards, that (s)he has left it. All the time in between, (s)he is
“situated” in it – as well as in all its sub-events —, i. e., lives (not only, but also) “on grounds of” the entirety of the specific “behaviour setting-knowledge” at his/her disposal. How could evidence and assumptions like these be related, again, e. g. to the theories of “direct perception” and of “affordances” which operate on micro-levels of transactional events and time? Or could and should these two “focal fields” really be kept apart at the expense of neglecting pending further theoretical development?

(b) Moderate expansion. Ecological approaches of this type are from the outset framed with intent to cover a relative broad range of an ecological reality. They, too, have an origin, a “focal field”, from where they expand empirically and conceptually to reality levels above and below. Thereby, they tend to adapt their primary conceptualisations to the emergent characteristics of the respective levels and domains, safeguarding, however, that the different levels remain consistently interconnected. This kind of expansion appears “moderate” in several respects. It does not extend too far from the origin. It contents itself with coarsely segmented scales and taxonomies. I found two examples.

Barker’s behaviour setting may be considered his “focal field” (1968; Kamiński, 2009). The conceptualisation of this supra-individual event-unit is expanded upwards to still more complex socio-physical units like “multisetting synomorphs”, “authority systems”, “communities”, even “societies”. The behaviour setting (e. g., a training lesson) is kind of a dynamical meeting ground between individual systems (as participants) and an (enabling and constraining) supra-individual socio-physical system. Expansion downwards leads to (supra-individual) sub-settings of different hierarchical levels as well as to respective subordinate transactional event-units (“episodes” and “sub-episodes”) in the stream of individual participatory activities.

Bronfenbrenner’s interest concentrates also on the conjunction of an individual system (viewed here on a much longer time-scale) with supra-individual systems (Krebs, 2009). Contrary to much evidence, I would prefer viewing what he calls “mesosystem” (relations between “microsystems”) as his “origin” since the lower-level “microsystem” appears somewhat vaguely, rather sociologically than psychologically, defined, in comparison with the Barkerian behaviour setting, from which it is claimed to be derived. Expansion upwards leads to the conceptual structures “exosystem” and “macrosystem”, “society”, expansion downwards from the microsystem somehow to “proximal processes” in the participating individual system and further on to an ensemble of determining sub-structures and sub-processes.
Merits of this kind of strategy are that it embraces a relatively broad variety of potential (mainly contextual) determinants and hence can provide lots of heuristic suggestions for more specializing in-depth research. Thereby, it may counteract premature specialization and encapsulation.

On the other hand, this strategy is apt to cause problems for research and theory building because of the conceptual coarseness of its expansions and the challenging multifariousness of the phenomena it aspires to encompass. Thus, its proponents may tend to resort to correlational types of arguing and research design and hence abstain from developing process theories and process related research.

(c) Global conceptual integration. This strategy also aims at establishing systematic interconnections between domains and levels of an ecological reality or between scientific approaches anchored in different domains and levels. Ideally, it aspires at a theoretical structuring of an ecological reality in its entirety or at a theoretical coordination of a plurality of widespread approaches in it. It seems to presuppose that attempting such kind of theoretical standardization is objectively reasonable and heuristically useful. So, a conceptual tool has to be found that appears appropriate for integrating a diversity of more or less heterogeneous approaches. This task relates here primarily to the ecological approaches convening in this issue. Sure, this conceptual tool is grounded somewhere in a specific domain and on a particular level too. From there, however, it may be tentatively generalized throughout an ecological reality in its entirety. Again, I found two examples.

Nitsch (2009) recommends making use of an action-theoretical meta-perspective. This may appear plausible since wherever we come across whatever manifestations of sport we will meet acting persons whose acting is somehow founded in intentionality. This perspective should not be understood as a “closed theory” but rather as a multi-faceted frame of reference whose constituents could be adapted to different application contexts. It claims to incorporate characteristics of a systems theory.

Araújo and Davids (2009), though asserting they would not aim at “integrating” the different approaches, nevertheless afterwards propose (and exemplify) “integrating ideas of dynamical systems theory and of the various ecological schools”. This should, finally, render possible a universal formalization of pertinent phenomena (e.g., patterns of coordinated movement) at all scales of analysis from a mathematical point of view and thus constitute an all-embracing explanatory framework.

What could be considered strengths of this strategy? It even exceeds the integrative claim of the aforementioned strategy and encourages keeping in view the entirety of an ecological reality, in particular here the diversity of
manifestations of sport. It may, empowered by its widespread conceptual framework, initiate and further interconnections between different perspectives and approaches and generate new kinds of research questions as well as instigate further theory development.

What are potential risks and drawbacks? I think that this type of strategy is in danger of overusing and overstraining its integrative conceptual tools. Integration may then be attempted by means of more or less abstract conceptualisations or even on a nominal level. When generalized to levels and domains distant from their proper “defining” focal field the conceptual tools may — possibly unnoticed — heavily increase in ambiguity. They may lose sufficiently precise contact to the empirical (emergent) specificities of more or less “distant” realities. Let’s take but a few simple examples. Could the action-theoretical perspective in all its flexibility really be expanded to transactional events like “catching a bar of soap slipping out of hands” for which Van Orden et al. consider the concept “interaction-dominant dynamics” (337f.) much more appropriate than what they call “component-dominant dynamics”? Or does the mathematised conceptual format of “dynamical systems theory” really appear adequate if we have to tackle the problem how to optimise the wording of a coach’s instruction?

Sub-strategies of reducing complexity

Those three strategies could also be understood as different configurations of sub-strategies which all, somehow or other, are apt to mitigate the aforementioned “specificity stress “ and to help reducing complexity. Yet, besides their easing effects they can also entail detrimental repercussions as, for instance, restricting the representativeness of an approach’s research “arrangements” and hence the generalizability of its concepts and its findings, increasing the incompatibility with other approaches and thus hamper communication and complementing research cooperation. The sub-strategies defined and exemplified in the following should be taken merely as a provisional sample discovered at first sight. Possibly, on closer inspection there could be identified many more. They cannot be illustrated by more than a few selected examples each. Properly, of course, each of the approaches could – and perhaps should – be analysed and characterised in all its facets in the light of these descriptive instruments.

(a) Truncating and coarsening horizontal expansion. Wherever the approaches in question settle down and position themselves within different primordial domains, they vary substantially in taking into account the differ-
ent pertinent universes and in taxonomizing them. The smaller this range and the less differentiated and systematised this range is left the less we are able to judge representativeness and generalizability of an approach.

Thus, psychological approaches operating within the world of sports obviously vary considerably with respect, e. g., to the number and type(s) of sport disciplines they are taking into account as well as with respect to coarseness and kind of taxonomizing the universe of sport disciplines. The same is true – mutatis mutandis — for modes of practicing sport (e. g., competition, training, exercising, recreation), types or patterns of sporting activities, sub-processes included in these types, states of the persons involved (e. g., degrees of expertise, degrees of being handicapped etc.)

(aa) Doing without taxonomizing. Fajen et al., though mentioning several sport disciplines, do not aspire taxonomizing this universe systematically. Nor do they try to survey and to taxonomize the variants of human activity’s sub-processes. Thus, it remains unquestioned whether or how processes, e. g., like emotions or reasoning or ruminating or solving mathematical problems are covered by their theory. Nor do they seem to aspire taxonomizing perceptual processes in all their diversity. Understanding the point of a joke, e. g., happens even more quickly than catching a ball. Thus, its perceptual implications should not be less interesting and relevant than those of interceptive acts or movement behavior in general.

(ab) Arbitrarily limited taxonomizing. Fajen et al., differentiate between three categories of affordances (body-scaled, action-scaled, social). This seems to be kind of an incomplete taxonomy since it appears possible that still further variants could be identified on the same taxonomical level. (By the way, Barker came already quite close to the affordance concept when characterizing “physiognomic perception” as one possible manifestation of “synomorphy”, 1968, p. 30). The enumeration of sport-related variants of Bronfenbrenner’s “micro-systems” (Krebs) appears as another example of an “open” taxonomy.

(ac) Coarsened (plausible) taxonomizing. Prototypical examples are Barker’s taxonomies of (11) “action patterns” (1968, p.55 ff.) and of (5) “behaviour mechnisms” (p. 68 f.). (In contrast, his taxonomizations of a community’s behaviour settings have a quite different status because of an elaborate empirical basis; Kaminski, 2008). Further examples are Hammond’s and Bateman’s distinction between “proximal” and “distal” stimuli, going back to Brunswik, and their dividing part of an athlete’s spatial surroundings (on the tennis court) in three “zones“ (2009).

(ad) Loose (plausible) taxonomizing. Krebs’ article describing Bronfenbrenner’s approach contains numerous taxonomies of this type, regarding, e.
g., “personal attributes” (disposition; resources; demands) or proximal (sport-related) processes (stimulation; skills learning; practice; specialization). The same holds for Nitsch’s article where he, e. g., subdivides the time dimension in past, present, and future or where he distinguishes four “disposition systems” (social, mental, biological, physical). I termed this type “loose” taxonomizing because, looked at in detail, the boundaries of these taxonomical units appear somewhat fuzzy so that they seem to allow for overlap.

(b) Truncating and coarsening vertical expansion. What has been explained with respect to “horizontal expansion” of approaches holds, mutatis mutandis, also for expansions in vertical direction, i. e. in systems of hierarchically nested levels of domains or scales.

(ba) Ignoring neighbouring levels. The classical Barkerian approach concentrates essentially on current activities happening within behaviour settings. It neglects considering processes that come into view if we switch upwards to a level where we could observe and conceptualise different types of learning processes. Fajen et al. focus on time-scale levels where they come across, e. g., “inceptive acts” and their procedural details. If they would open their perspective stepwise to the emergent characteristics of happenings coming into view several levels “above” in time-scale, there, again, they would be confronted with the question whether or how these level-specific phenomena could be adequately interpreted by means of concepts like “direct perception” or “affordances” (cf. Kaminski, 1988). Bronfenbrenner’s concept of “proximal processes” seems to be located primarily on a relatively “high”, i. e., “coarse”, time-scale level. It could, in principle, certainly be favourably differentiated and elaborated further through involving “deeper” levels. The same applies to the classical Barkerian conceptualization of “streams” of transactions.

(bb) Usurping other levels. A possible manifestation of this sub-strategy could be diagnosed in case we would find merely asserted (and not level-specifically substantiated) that phenomena coming into view on higher time-scale levels are nothing else but lower level phenomena (e. g., “direct perception”).

(bc) Coarsening inter-level relations. Pertinent examples are Bronfenbrenner’s dichotomising distiction between “molar” and “molecular” activities (Krebs, p. 6??) and his hierarchizations of contextual conditions in “microsystems”, “mesosystems”, “exosystems”, and “macrosystems” as well as of the time-scale levels (“microtime”, “mesotime”, and “macrotion”). The same holds true for Barker’s distinction between “action patterns” and the lower-level “behaviour mechanisms” (1968).
(c) Expanding approaches at the expense of softened conceptualisation standards.

What is meant here will become transparent through the following examples.

(ca) Eclectic incorporation of vaguely defined concepts. This sub-strategy enjoys an exceptionally widespread use. The conceptual core system of an approach and the arguing within this frame of reference is enriched by concepts whose meaning is defined either simply through common use in everyday life or through almost general, unspecific use among psychologists. This type of expansion strikes particularly in cases where the concepts brought in appear at first sight more or less incompatible with presuppositions of the core theory (cf. also Nitsch, in this issue). Let’s take Gibson’s theoretically highly demanding book (1979) as a symptomatic example. Amidst his arguing we can find rather significant concepts like consciousness, awareness, attention, self-awareness, extracting (invariants), reading, comprehension, thinking, problem solving, inference, believing, recall, neither of them, however, appears in the subject index. Similarly, in Fajen’s et al.’s article we can find concepts like judging, being unaware, distinguishing, knowing, knowledge, attempting, making decisions, inferences, mental calculations, selecting, control, whose precise conceptual meaning remains – as far as I could see – undefined. In Hammond’s and Bateman’s article this relates to concepts like, e.g., intuition, reflection, cognition, attention, emotion, motivation, goal setting, strategy, analysing circumstances, choice.

(cb) Exempting observed pertinent phenomena from conceptualisation. Hammond and Bateman describe (2009) how a tennis player has to cope with several tasks almost concurrently (moving around, recovery after each hit, and improve particular strokes). However, they obviously do not consider theoretical articulation of this kind of multiple acting nor its consistent integration into their core theory. The same holds true for Fajen et al, describing different examples of multiple acting as well, e.g. (p. 32), maintaining upright posture, locomoting, and dribbling the ball.

(cc) Regressive defining. Bronfenbrenner relates in defining his “microsystem” concept (cf. Krebs) to Barker’s behaviour setting concept degrading thereby, however, the precision of its conceptual content.

Conclusion

The attribute “ecological” may, applied to psychological approaches, adopt different meanings. Interpreted methodologically, it spotlights the problem of “representativeness” of particular arrangements in research as
well as in practice, in relation to conditions in some “proper reality”. Interpreted ontologically, the attribute “ecological” questions what could and should be considered “proper reality”. Scrutinising and comparing several “ecological” approaches reveals basic differences between them as concerns the location of their main focus of interest within “proper reality”, in particular here within the world of sport. Rendering possible effective communication between these positions requires understanding their complex inter-relations. Focussing on these basic differences helps unearthing several frames of reference that enable characterizing these approaches in their particularity and thereby also defining their multiple interrelations. Accordingly, these approaches have been categorized with respect to their specific “ecological realities”, the “primordial articulation” they have chosen for these realities, and with respect to more detailed “conceptualisation strategies”. After all, I am convinced that the primary question should not be which of the ecological approaches on the market is the best one for sport psychology. Instead, the primary challenge must be to define the problem fields in the world of sport as well as the tasks of sport psychology in it, and then we could ask which of the approaches is most appropriate and effective for which of these tasks.

REFERENCES


Reply to commentaries on “information, affordances, and the control of action in sport”

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The guest editors and four commentators raised many interesting and important issues about the ecological approach to perception and action in sports. They offered some excellent suggestions for further developing and applying the ecological approach, but also raised some concerns and pointed out some of the challenges. Our goals in this reply are to respond to these concerns and challenges, and clarify the position that we expressed in our original article. We reply to the remarks of each commentator in turn, but point out similarities in their remarks wherever they exist.

Abernethy

Abernethy questioned whether differences between novices and experts can be linked to differences in affordance perception. We certainly would not want to claim that improvement in skill level is entirely attributable to changes in affordance perception. But it would be somewhat surprising if experts were not better able to distinguish between actions that are within and beyond their capabilities, especially considering the fact that experts typically have more experience performing near the limits of their action capabilities.

Abernethy made two arguments to support his doubt that experts and novices differ in their ability to perceive affordances. The first argument was based on results of a study by Pepping and Li (1997), who showed that inexperienced volleyball players can perceive the maximum height that they
could jump to block an opponent’s shot. However, it does not follow from this finding that inexperienced players are just as accurate as experienced players. Because none of the subjects in that experiment were expert volleyball players, a direct comparison between experts and novices was not made. Moreover, the conditions used in that experiment were quite unlike those experienced during the course of an actual volleyball game (e.g., the ball was suspended from the ceiling). Thus, the study by Pepping and Li cannot be used to draw any conclusions about expert-novice differences in affordance perception.

While other studies have also demonstrated equivalent affordance perception by experts and novices (e.g., Oudejans, Michaels, Bakker, & Dolné, 1996), expert-novice differences in affordance perception have been documented. Hove, Riley, and Shockley (2006) found, for instance, that expert hockey players were sensitive to the manner in which variations in the inertial properties of hockey sticks affected the sticks’ suitability for precision and power actions, whereas novices initially lacked this sensitivity. With only a modest amount of experience performing the power (slap shot) and precision (puck interception) tasks, however, the novices also became sensitive to how the distribution of mass along the length of the hockey stick affected its suitability for power and precision tasks.

The latter finding from the Hove et al. (2006) study leads to the second issue raised by Abernethy—that changes in affordance perception can occur after short periods of practice, far more quickly than changes associated with skill acquisition. Indeed, studies have shown that sometimes very little experience is needed to re-learn one’s action capabilities following changes in body dimensions (e.g., Mark, 1987). However, this does not mean that one’s ability to discriminate between possible and impossible actions is not further refined with continued practice. Moreover, it may be that the ability to rapidly recalibrate or re-attune perception is necessarily prior to skill development. Once again, however, the existing literature does not allow us to draw any definite conclusions. This is clearly an issue that warrants further investigation.

A related factor that we briefly touched upon in our initial discussion is that improvement in skill is accompanied by changes in the affordances that are available to an athlete. Some insight into this process can be gained from studies of perceptual-motor development (see Berger & Adolph, in press, for a review), which show that the emergence of new action capabilities must be accompanied by a process of perceptual learning whereby the actor recalibrates to new action capabilities and in some cases re-attunes to different perceptual variables.
Abernethy goes on to suggest that there is a contradiction between two statements in our original article: (1) “good athletes...rarely attempt to do things that are beyond their limits” and (2) “athletes often try to gain an advantage by pushing the limits of their capabilities.” There is nothing contradictory about these statements. For example, competitive cyclists and skiers often take sharp bends at the fastest speed possible without losing traction. The point is that top athletes are not only stronger and faster, but they also seem to know their limits better than the rest of us.

Abernethy pondered over the position that a Gibsonian ecological psychologist might take regarding recent findings on motor resonance in the mirror neuron system and related proposals for common coding of perception and action (e.g., Gallese, 2005; Knoblich & Flach, 2001; Prinz, 1997). We are somewhat skeptical of the ultimate explanatory power of the mirror neuron system in humans. Our skepticism is anchored, in part, in the fact that claims about functions of the mirror neuron system vastly outpace the empirical support for those claims (see, e.g., Oztop, Kawato, & Arbib, 2006). Setting aside this skepticism for the sake of the present discussion, however, the basic notion of motor resonance is interesting in that, as noted by Abernethy, the approach underscores the fundamental reciprocity that exists between perception and action. The notion of resonance in the mirror neuron system is, moreover, broadly consistent with Gibson’s (1966) preliminary ideas on the neural processes involved in perceiving and acting.

But if the mirror neuron system is resonating, then we should be tempted to ask, resonating to what? Should the empirical support obtain for the claims made about the mirror neuron system in humans, it would not obviate the need to better understand the informational support for perception-action; in fact, we would argue, it would underscore that need. This and related questions raised by the hypotheses of common coding, motor resonance, and embodied simulation have guided recent work on affordance perception conducted from an ecological psychology framework (Ramenzoni, Riley, Davis, Shockley, & Armstrong, in press; Ramenzoni, Riley, Shockley, & Davis, 2008, in press). As illustrated in that recent work (see in particular Ramenzoni et al., 2008), in our view a shortcoming of the motor resonance and common coding perspectives is that they have heavily emphasized the roles of neural and representational structures to the exclusion of the role of the specifying information available to the visual system. Common coding, embodied simulation, and motor resonance as they have been expressed in the literature so far all amount to variations on the theme of indirect perception, and thus they all carry the same baggage as other explicitly representational approaches to perception. As such, we disagree with Abernethy’s sug-
gestion that in our target article we presented a mere caricature of cognitive psychology. The underlying assumptions — that the world is not specified (or is underspecified), and that epistemic contact is with a representation of the world rather than the world itself — remain even in these putatively more sophisticated, contemporary cognitive perspectives.

Finally, Abernethy pointed out that the ecological approaches presented in the target articles may not presently be articulated or developed in such a way as to readily translate to the playing field in terms of coaching and pedagogy. We agree, though we echo Abernethy’s optimism in his concluding statement that ecological approaches will have important roles in the development of theories of perception-action that can be applied to improve sport performance. Certainly a great deal more work remains in order to realize that goal.

Beek

Beek raises two primary concerns in his commentary. Both, we feel, are keen insights that reflect specific avenues for developing a Gibsonian approach to perception-action, in general, and to sport behavior, in particular. The first relates to the question of how an actor selects from among the wealth of behaviors afforded at any one moment during behavior outside the laboratory — the well-respected problem of the individuation of affordances (see Kugler, Shaw, Vicente, & Kinsella-Shaw, 1990; Shaw, Kugler, & Kinsella-Shaw, 1990; Shaw, Turvey, & Mace, 1982; Turvey & Shaw, 1995; Turvey, Shaw, Reed, & Mace, 1981). Beek presses further, asking how an actor comes to know which among the various behaviors afforded would be most likely to satisfy the actor’s goals. Echoing Cutting (1982), Beek insists that the concept of affordance does not adequately constrain behavior in this regard (see Nitsch’s commentary also). Shaw et al. (1982) presented an affordance formalism that in this regard is broader than the view we sketched in our original article. The Shaw et al. formalism involved four terms — (1) an animal term, (2) an environmental term, (3) a term expressing the mutual compatibility of the animal and environmental terms, and, the crucial term for the present discussion, (4) the occasion or particular circumstances under which the animal is behaving (e.g., whether the animal is afraid, or engaged in a specific activity such as foraging or nest building, or, in a sport context, whether the athlete is anxious, or whether one team is aggressively attacking to try to score a goal before time in the match expires). The charge for the formalism is to express how, in perceiving an affordance, the animal perceives the complex coordination of the four terms as a single particular.
Integration of occasions with the animal-environment system has been perhaps the least developed aspect of the theory of affordances. In part, this is because instructions given to participants in an experimental task often set the occasion, obviating the need for researchers investigating the accuracy of affordance perception or the informational specification of affordances to address the issue further. But perhaps also this aspect has been less developed because the occasion term is theoretically and empirically challenging.

Gibson (1986) discussed at length the difference between his concept of affordance and related concepts such as the Gestalt psychologists’ notions of valence and demand or invitation character (see Gibson, pp. 138-140; see also Nitsch’s commentary). To the Gestalt psychologists the very existence of demand character depended on an observer’s needs and motivations. In the framework expressed by Shaw et al. (1982), and consistent with Gibson’s (1986) earlier theorizing, the affordance itself does not change depending on the occasion, but the individuation of one particular affordance from the vast set of affordances available does. The challenge is to integrate the occasion term in a manner consistent with Gibson’s view, that is, to paraphrase Gibson (p. 139), to avoid confusing the affordance with the special attraction one might have to the affordance when a particular set of circumstances obtains.

Beek’s second concern is with the theoretical implications of studies that suggest observers and actors do not always rely on variables that specify relevant properties of the environment. This is a ripe area for research and for continued debate about specification (Jacobs & Michaels, 2002, 2007), in particular about the possibility of “non-specifying” information and cues. As we indicated in our original paper, a number of studies have demonstrated that convergence on specifying variables sometimes requires extensive practice and feedback, and that initially observers may rely on non-specifying cues and perceptual heuristics. Beek goes one step farther and suggests that even experienced athletes may rely on such variables in the kinds of complex, time-pressured environments that are encountered during sports. This is an interesting issue, but we believe it can be framed differently. We grant it may seem that in some situations actors rely on variables that do not specify a particular affordance or environmental property that it would be desirable to perceive in order to optimize performance. Nonetheless, those variables specify something, so such findings do not undermine the theory of direct perception. Because the structure in the optic (or auditory, haptic, etc.) array arises lawfully, the optic array is always specific to the environment (see also Stoffregen & Bardy, 2001). In these cases the variables selected by the actor may not specify what the actor optimally needs or intends to perceive, but in many cases the variable that is detected (and consequently, the affordance,
object, or event that is perceived) may still allow for acceptable performance — the actor may not behave optimally but still is able to satisfy the goal at hand.

But there is another possible explanation for what often appear to be cases of reliance on non-specifying variables — an explanation that relates also to the individuation of affordances and occasions. Consider the behavior of a hermit crab (see Shaw et al., 1982, pp. 215-224). Another creature, the sea anemone, might afford something to eat, serving as a protective shield, or serving as a portable enclosure for the hermit crab on the respective occasion of the hermit crab being hungry, of having lost the actinians that it carries on its shell as protection, and having lost its shell. On the latter occasion the hermit crab may strive to perform an impossible action: To enter the body of a sea anemone. To an observer it might seem that the hermit crab incorrectly perceives the body of the sea anemone as something that affords entrance. The more apposite ecological stance is to note that the sea anemone is in the equivalence class of objects that afford the hermit crab exploration and investigation as possible portable enclosures. The hermit crab detects information specific to an object to be investigated on the occasion of being “naked” (and not information specific to an object that affords entrance). It detects information specifying the right action. Trying to enter detachable objects that afford any degree of access will lead eventually to the hermit crab donning a protective covering. At issue here is the human observer’s tendency to incorrectly attribute an intention to the crab (“to enter the body of the sea anemone”) that it does not have and, in consequence, express surprise that the crab did not detect the specifying variable for a barrier to entry but some non-specifying variable (unbeknown to the observer, a variable that is non-specific for a barrier to entry but specific for an object to be investigated).

Owen

Owen does not specifically comment on our paper, but raises interesting questions about the utility of ecological approaches in promoting exercise and public health. We note here that ecological psychology and the affordance concept have potential implications for design and architecture, as has been discussed in the context of the implications of Gibson’s ecological approach in human factors (see, e.g., Warren, 1995; Zaff, 1995). Human factors psychologists interested in affordances have emphasized that products (or buildings, or urban environments) can be designed in such a way as to
make salient a behavior that is afforded and desirable. We speculate that exercise-related behaviors (such as taking stairs rather than an elevator) could be promoted by carefully designing an environment with an explicit concern for the health- and exercise-promoting behaviors afforded by the environment.

Nitsch

Nitsch’s commentary raises a number of important concerns. We respond to several but not all of them below. We first note that the other commentators raised concerns similar to Nitsch’s about perceptual learning and specification (see our response to Beek’s comment about non-specifying variables) and about how the affordance concept does not adequately constrain behavior because motivations and intentions do not factor into the definition of affordances (see our response to Beek’s comment about selection of affordances). We also note before addressing Nitsch’s specific comments that Shaw (2003) addresses many of the issues that seem to be motivating several of Nitsch’s criticisms.

Many of Nitsch’s deeper criticisms seem to stem from our anti-representationalist stance. We do not apologize for that stance and as such find it difficult to reach a compromise position with Nitsch on several of the specific comments related to this issue. But there are points of clarification to be made and opportunities for us to state more clearly and carefully our positions on several of the issues raised. One of Nitch’s specific critiques boils down to the claim that even if perception is not sensation-based and constructive, this does not rule out a role for mediating cognitive and representational processes. Perhaps not, but if perception is not sensation-based and constructive, then what would be the theoretical motivation for assuming that cognitive processing and representations play an important, causal role in perception? In addition, Ullman’s (1980) claim about tautology that is echoed here by Nitsch simply misses the mark, as discussed (in varying degrees of explicitness) in commentaries on Ullman’s article by Jones and Pick (1980), Mace (1980), Reed (1980), and Shaw and Todd (1980).

Nitsch goes on to criticize studies of attunement and calibration on the grounds that they focus merely on the result of learning and tell us nothing about how such learning occurs (beyond merely, “by practice”). This is simply not true. These studies go well beyond demonstrating that learning occurs. As a collection, the studies that were cited in our original paper have addressed questions about how the space of information variables is searched, the effects
of different kinds of practice, feedback, and performance criteria, and the extent to which learning generalizes to new conditions. These studies provide the necessary empirical foundation upon which to build a theory of learning. One such theory was recently proposed by Jacobs and Michaels (2007). Earlier and additional formulations of learning within the ecological framework can be found in Fowler and Turvey (1978), Johnston and Turvey (1980), Shaw and Alley (1985), and Adolph and Berger (2006).

Nitsch claims further that affordance theory cannot be a comprehensive framework for perception-action because the view does not clearly recognize the role of prior experience. Our position on this issue—which follows from the work of Eleanor Gibson (1969; Gibson & Pick, 2000)—is that prior experience is very important; it guides the exploratory, information-generating and information-gathering processes that are characteristic of perceptual activity. This is precisely why we think that expert-novices differences in affordance perception should be further explored. The issue of cultural, conventional, and rule-based constraints—issues that (particularly with regard to the latter) are possibly very important for utilizing the concept of affordances in sport performance—is indeed a challenging one. One of the most controversial examples posed by Gibson (1986) is that a mailbox affords posting a letter. It certainly does, but only as a matter of convention. This convention is nonetheless a reality, and we find it uncontroversial to claim that a mailbox affords posting a letter in a culture with a postal system that uses mailboxes as depositories for outgoing mail. The challenge arises, we believe, with the claim that a person with appropriate knowledge of the culture and postal system can directly perceive “letter-post-ability” when confronted with a mailbox, as opposed to indirectly perceiving this affordance through an inferential process based on association of visual features of mailboxes with prior knowledge of the function of mailboxes. Articulating Gibson’s theory of direct perception of affordances with cultural and conventional artifacts such as this is, we believe, one of the grand challenges for extending the theory of affordances, but we do not believe that because it is a challenge the effort should be abandoned.

Two of Nitsch’s other comments can also be addressed quickly. First, what Nitsch refers to as “action traps” were discussed by Gibson (1986), who termed them “negative affordances.” Certainly these may be of considerable importance in sport. Second, we did, as Nitsch commented, choose not to discuss the concept of “emotional affordances” introduced by Norman (2004), because in our view Norman previously (1988) confused the concept of affordance so fundamentally that his use of the term “affordance” hardly resembles the way ecological psychologists use the term.
In their introductory article to this special issue, Araújo and Davids echoed our point about the importance of affordance perception in sport. We are particularly encouraged to see them offer additional examples of how to apply the theory of affordances to the design and implementation of practice environments, understanding the coach’s perspective, and observational learning in sports. We also share Araújo and Davids’ enthusiasm for more thoroughly integrating the information-based, ecological approach to perception with the dynamical systems approach to action. Such an integrated view has been explicitly articulated on a number of occasions (e.g., Fitch & Turvey, 1978; Kugler, Kelso, & Turvey, 1980, 1982; Kugler & Turvey, 1987; Turvey & Shaw, 1995), and, moreover, is at least implicit in the work of many ecological psychologists working within a Gibsonian framework (particularly by Shaw, Turvey, and colleagues). Warren’s (2006) theoretical framework represents the most thoroughly developed synthesis of these ideas to date. He characterizes the agent and environment as a pair of dynamical systems, coupled by both mechanical forces and informational flow fields. The behaviour that emerges from this interaction is referred to as the *behavioural dynamics*. Attractors in the behavioural dynamics correspond to intended states and maintain the stability of behaviour, repellors correspond to states to be avoided, and bifurcations give rise to transitions in behaviour. A central theme of Warren’s framework is that behaviour is not commanded by a central controller. Rather, the agent learns mappings from information in (e.g., optic) flow to movement that bring about desired states (i.e., goals). The process of perceptual attunement, which was discussed in our original paper, would seem to play a key role in discovering these information-movement mappings that correspond to stable solutions. Similarly, the process of calibration ensures that the actor learns how its movements influence the pattern of optic flow. Finally, knowing what patterns of flow can and cannot be brought about would allow the agent to perceive affordances. Thus, there is room for developing the concepts of attunement, calibration, and affordance perception within Warren’s behavioural dynamics framework.

**Acknowledgment**

Supported by grants from the National Science Foundation (SBR 0423036 awarded to MTT, BCS 0236734 and BCS 0545141 awarded to BRF, and CMS 0432992 and BCS 0716319 awarded to MAR).
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Proximal processes as the primary engines of development

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The objective of this paper is to discuss proximal processes as a key concept for the understanding of the bioecological paradigm, as well as to answer the comments regarding the use of the Bioecological Theory of Human Development as a theoretical framework for the field of sport psychology. In a similar vein with Gibson, who created the term affordance to explain environmental properties taken in reference with the person, Bronfenbrenner created the term proximal processes to describe the interaction between the person’s attributes, the characteristics of the environment, and the properties of time, as the primary engines of development. The order of the answer follows the sequence in which the comments were presented. In this reaction paper we try to clarify some weakness pointed in our major paper, related to the four components of Bronfenbrenner’s Bioecological Theory: proximal processes, biopsychological characteristics of a developing person, the parameters of the ecological context, and the dimension of time.

Introduction

When Bronfenbrenner proposed his bioecological paradigm (1995), he described the four basic elements of the new paradigm: person, process, context and time (PPCT). Specifically to explain the role of process in the PPCT design, he defined two new propositions for his theory. The understanding of these two new propositions to evaluate the importance of Bronfenbrenner’s contribution to the field of ecological psychology should be compared to the understanding of affordance to those who want to use Gibson’s theory. The aim of this paper is to discuss proximal process as a key concept for the understanding of the bioecological paradigm, as well as to answer the comments regarding the use of the Bioecological Theory of Human Development as a theoretical framework for the field of sport psychology.
Proximal processes

In 1995 Bronfenbrenner wrote a comprehensive chapter about developmental ecology through space and time, as a future perspective to develop research designs oriented to the process of development. He started his chapter describing two new proposition. In the first one he stated that, especially in its early phases, human development takes place through “processes of progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the persons, objects and symbols in its immediate environment” (p. 620). He completed his proposition with the comment that “to be effective, the interaction must occur on fairly regular basis over extended period of time” (p. 620).

The second proposition defines the dynamic forces of these interactions between person, context and time. In his last published book, in 2005, Bronfenbrenner described this second proposition as interdependent with the other propositions of the bioecological model and subject to empirical test:

The form, power, content, and direction of the proximal processes producing development vary systematically as a joint function of the characteristics of the developing person (including genetic inheritance); of the environment – both immediate and more remote – in which the processes are taking place; of the nature of developmental outcomes under consideration; and the continuities and changes occurring in the environment over time, through the life course, and during the historical periods in which the person has lived. (2005, p. 6).

Bronfenbrenner (1995) underlined proximal processes as mechanisms of development, however, he wrote that “little is known about the operation of these processes and their effects, for the simple reason that, to date, they have seldom been incorporated in the kinds of research models that are required for their investigation” (p.626). He believed that the first step for remedying this situation was to formulate concrete hypotheses and corresponding analytical models.

Preliminary responses

Abernethy made a comprehensive analysis of the potential of the four ecological approaches to sport cognition presented in this especial issue, according to their contribution to enlarge knowledge in the field of sport psychology. He found a common feature among the four approaches that is a central focus on the interdependence between individual and environment.
An important remark made by him is that contemporary cognitive models are less striking in their differences to the ecological approach when compared with the older cognitive models.

In order to analyze the common feature among the four presented theories Nitsch designed a theoretical framework including the constitutive components of these theories, their particular contribution to instigate theoretical, methodological and practical problems in the field of sports, as well as their relation to a comprehensive understanding of the human action. Before he started his analysis he pointed that all the four approaches share the assumption that to study human behavior it is necessary to investigate the environment in which that behavior takes place.

When Owen commented the four articles included in this especial issue, he pointed Bronfenbrenner’s theory as the “broadest level of ecological thinking”, and added that the bioecological perspective provides a comprehensive model of many factors that may act to influence behavioral choices.

My reaction to Beek’s comments will address to his conclusion that the “alleged merits of Bronfenbrenner’s conceptual framework for studying and addressing concrete problems in sport psychology do not really became apparent”. Of course Bronfenbrenner didn’t give specific examples of how to use his bioecological model in the field of the sport sciences and maybe I had failed with the task of translating his theory into concrete examples of how to study success and failure in the sport setting. But, the possibility of changing the focus of the research from confirmatory to explanatory design is a new possibility to investigate in the field of sport psychology.

In the beginning of their article commenting the four ecological psychologies Araújo and Davids made a very clever statement addressed to Gibson, Brunswik, Barker, and Bronfenbrenner theories. Unlike other areas such as psychoanalysis, behaviorism and cognitive psychology, which have a history and tradition of frequent academic symposia and specific scientific journals, “nothing like these arguments can be found in literature between Gibsonian, Brunswikians, Barkerian or students of Bronfenbrenner” (Araújo & Davids 2009).

**Complementary responses**

In Abernethy’s opinion, the unique characteristic of Bronfenbrenner’s bioecological theory of human development is the fact that the theory stresses the need to account for individual differences and the changes that occur over time with the interplay between maturation and experience. Bronfenbrenner
insisted that the element time has especial importance in research designs based on the bioecological model. He said that to show that development has actually occurred, “the research design must demonstrate, or at least make plausible, that the elements in the design, and their dynamic relationships to each other, have influenced the biopsychological of the developing person over an extended period of time” (Bronfenbrenner, 2005, p.7).

Abernethy agrees with the possibility of using the bioecological model as a theoretical framework to study the process of development of sports talent. However, he emphasized that it would be valuable to consider the sports talent models that are not explicitly ecologically motivated. This suggestion may open new avenues for studies in sport psychology, and it has to be taken into consideration for those dedicated to integrate theoretical paradigms into designs for research in sport science.

Expressing his opinion regarding Bronfenbrenner’s bioecological theory Nitsch commented that it is “a very fruitful frame of reference for developmental research and intervention”, because it offers a systematic description of the areas and factors influencing human development. At the end of his comment he asked for precise information on how proximal processes operate in detail. Viewing continuities and changes as the outcomes of proximal processes operate, or how the attributes of a developing person (i.e. an athlete or a coach), parameters of context (i.e. a place for sport practices, an athlete family home) and dimensions of time (i.e. before competition, during competition, after competition) in interaction is a difficult task. It is easier to see the interaction between person and environment in linear and static terms, a view that alternates between focusing the person (i.e. an athlete) either in one (i.e. a place for sport practices) or another microsystem (i.e. the athlete family home).

Although Bronfenbrenner didn’t write explicitly about proximal processes in the sport setting, it may be helpful to look at the statements regarding proximal processes that he included in the revision of the bioecological model. He wrote that human development occurs through process of “progressively more complex reciprocal interaction between an active, evolving biopsychological human organism and the person, objects and symbols in its immediate external environment (Bronfenbrenner, 2005, p. 6). Translating this assumption into a hypothetical example let us imagine a young soccer player that has just initiated practice in an organized soccer program. The program’s main goal is to win a soccer tournament, which is a competition organized by the National Soccer League. Using the bioecological model to study how the proximal processes could operate, first, we have to control the interactions among the form (i.e. the young player’s behavior), the power (i.e.
how important is the soccer program for the young player, for his/her teammates, for the coach, for the parents, etc.), the content (i.e. the variability of practice that the players can afford in the soccer program), and the direction (i.e. to win the soccer tournament). Second, there are the interactions between factors (person, process, context and time). Because Bronfenbrenner concluded that “proximal process is posited as the primary engines of development” (2005, p.6), it will vary systematically as a joint function of: (a) the characteristics of the young athlete (i.e. cognitive, social, emotional and psychomotor skills), (b) the characteristics of the environment, both immediate (i.e. the activities afforded in the soccer field, the interactions between the young player, the coach and his/her teammates, and the roles that the player can assume) and more remote (i.e. the office of the National Soccer League), (c) the nature of developmental outcomes under consideration (i.e. recognition that the teammates and coach show to the young athlete’s values), and (d) the continuity and changes occurring in the environment over time (i.e. after five months of practice).

In summary, to understand how proximal processes operate, considering our hypothetical example, the soccer team has to be considered as an unit of analysis, and all the interactions derived from that unit must be taken into account. In other words, the bioecological system perspective provides a model that focuses on multiple levels of the sport phenomenon simultaneously (i.e. players, coaches, families, places of sports practice, community, life), and it also emphasizes the interaction between behavioral units (i.e. what happens during the game is affected by what occurs in the family place and vice versa). The result is that the bioecological model helps coaches, parents and players to understand behavior in context and shows how these units of varying size and levels of complexity mutually influence each other.

The following comments are an attempt to answer some points of Owen’s analysis. If for one hand Owen didn’t discuss any specific case of how to apply the bioecological model in the field of sport sciences, for the other hand, his example regarding the Australian population levels of physical activity suggests the need of provision of walking and bicycling paths, accessible community facilities for activities, and incentive systems that can reinforce physically active transport choice. Undoubtedly Owen’s suggestion is in agreement with Bronfenbrenner’s concept of macrosystem:

The macrosystem consists of the overarching pattern of micro-, meso-, and exosystems characteristics of a given culture, subculture or other broader social context, with particular reference to the developmentally instigative belief systems, resources, hazards, lifestyles, opportunity structures, life course options, and pattern of social interchange that are embed-
ded in each of this systems. The macrosystem may be thought of a societal blueprint for a particular culture, subculture, or other broader social context, (Bronfenbrenner, 2005, p.150).

Beek was very objective and precise in his comments. In order to explain his point of view regarding the four theories he stated that his interest is “in the control and learning of movement in the context of skilled actions”. In the field of motor behavior the area of motor control is the study of neurophysiological factors that affect human movement. In that case there is no doubt that Bronfenbrenner’s bioecological model is an incomplete theory (it doesn’t explain the complexities of the brain function), but if we consider motor control as a personal attribute (a resource that could be viewed as a competence or dysfunction), Bronfenbrenner’s model could be helpful to allow us to study the interrelation between the neurophysiological factors and the characteristics of the environment, during the acquisition of a new motor skill (i.e. a young tennis player learning how to serve). Besides motor control other cognitive and emotional attributes are involved in the acquisition of a new motor skill (i.e. motivation, anxiety, attention), being the bioecological model well suited as a theoretical framework.

Let us examine some major variables which have been investigated in most of the studies of sport psychology, more specifically those related of athlete’s motivation and anxiety. Using Bronfenbrenner’s model both motivation and anxiety have to be viewed as behavioral dispositions that can set proximal processes in motion and sustain their operation or, in a negative way, actively interfere with, retard or even prevent their occurrence. Up to now the recurrent model to study motivation and anxiety of athletes is the Inverted “U” Curve, which shows the interdependence between levels of performance and psychological activation. In my opinion the bioecological model allow us to go beyond the linearity between performance and psychological activation and to study the dynamics between the actions of these two variables.

Specifically addressing my contribution to this issue, Araújo and Davids formulated six objective, smart, and provocative questions related to Bronfenbrenner’s ideas in sport and exercise psychology. I will take the challenge to answer each of the six questions, but I am aware that rather than simply answer these questions, I have to be convincent that Bronfenbrenner’s theory has potential to develop new research design to be used in sport psychology.

The first question asks how one can operationally distinguish exosystem from mesosystem, and those from the macrosystem. In order to identify exosystem and mesosystem we have to decide who is the “developing” person, because either exosystem or mesosystem are forces generated by direct
or indirect participation of the developing person in one or more microsys-
tem. For a player that participates in a specific place of sport practice (i.e. a
tennis court, a soccer field with his/her teammates, and with his/her family
supporting at home, the system of force generated by the interaction of these
specific microsystem may be considered a mesosystem to him/her, and an
exosystem to his/her teammates. To understand the difference between the
concept of macrosystem and those of the other levels of the context
(microsystem, mesosystem and exosystem) let us make an analogy with the
concepts of population and sample in a descriptive research design. The
population puts the limits for making inferences from the research findings
(the macrosystem delimitates the scope of the culture or subculture to study
a specific phenomenon) and samples are representative parts of the popula-
tion (microsystem, mesosystem and exosystem are all interrelated parts of the
macrosystem.

The second question is addressed to how one can distinguish the influ-
ence of proximal processes from those of microsystem, the microtime, or the
person. The third question is about of how we can trace these influences.
Maybe we can give one comprehensive answer for these two questions. Let
us try the possibility to show these mentioned differences by taking the way
that Bronfenbrenner presented the four elements of his model. He elected
proximal process as the core of the model, and only the remained three ele-
ments, person, context, and time were subdivided. In a research design using
Bronfenbrenner’s model the investigator should examine the influence of the
proximal process by controlling the interaction between the three other ele-
ments. This procedure should demonstrate the interaction between factors.
To see the interaction within factors, the investigator would control within
the personal attributes (behavioral dispositions, biopsychological resources,
and demands), within the parameter of context (microsystem, mesosystem,
exosystem, and macrosystem), and within the dimensions of time (micro-
time, mesotime, and macrot ime).

The fourth question interrogates how the characteristics of the person
can be measured. If we understand the personal biopsychological resources
skills (competences and dysfunctions) such as cognitive, psychomotor, emo-
tional, or social skills, the already existing cognitive, psychomotor, emotional,
or social tests should be used to measure personal resources. The difference
would be in the way that the results of these tests are interpreted. Instead of
using linear analysis to control the effect of independent variables in the
respective dependent variables (emphasis on the main effect), the analysis
could consider all the variables of the design as interdependent ones (empha-
sis in the interaction effect).
The fifth question argues how we know if the personal characteristics are generative or disruptive. The last question is a complement for that fifth, because it asks if the answer for the previous one is a judgment of the researcher. I will answer the sixth question with an agreement with the commentators. Yes, in my opinion the interpretation if the personal attribute is a generative or a disruptive one depends on the interpretation of the researcher (Bronfenbrenner’s view is not in disagreement with the phenomenological approach). To complete the answer to this question and to answer the previous one, I will use one concept very common in texts of sport psychology that is the concept of perceived competence (Harter, 1984; Valentini, 1999; Walling & Duda, 1995). To know if the personal characteristics are generative or disruptive the researcher has to decide it considering the environmental situation (i.e. a very tall boy may have positive physical attributes to be selected for a basketball team and negative ones to be selected for gymnastics).

Final remarks

After this attempt to clarify some ideas that were not clear in the target paper regarding Bronfenbrenner’s bioecological theory of human movement, some final remarks seem to be needed. First of all we would like to emphasize that all the opinions expressed by the commentators about the potential that the bioecological model has to be used in sport psychology are very relevant and well done. If the richness of the Bronfenbrenner’s proposition and its potential to create new avenues for investigation in sport psychology is not clear, it is more a limitation of mine than that the theory is not “good enough” to be used to understand the complexities of sport psychology.

Second, for those who are not familiar with the terminology used by Bronfenbrenner, the term proximal process is the one which may cause misunderstanding. Like affordance in Gibson’s theory, proximal process is a key concept that explains how the PPCT design operates. As Bronfenbrenner stressed, “without it, much invaluable information is lost not only with respect to the developmental power of proximal processes themselves, but also with regard to the ultimate effect of the characteristics both of the person and of the environment” (1995, p.626).

It is my hope to see more sport scientists interested to translate Bronfenbrenner’s ideas into comprehensive research designs in sport psychology. I could not finish this paper before express my gratitude to Duarte Araújo and Keith Davids for the opportunity that they gave me to write about Bron-
fenbrenner. Probably many other colleagues could do a better job than I did, writing with higher precision about why Bronfenbrenner’s theory has to be included as a fruitful possibility to enlarge knowledge in sport psychology, but maybe none of them would have been happier to accomplish this task than I was.

REFERENCES


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