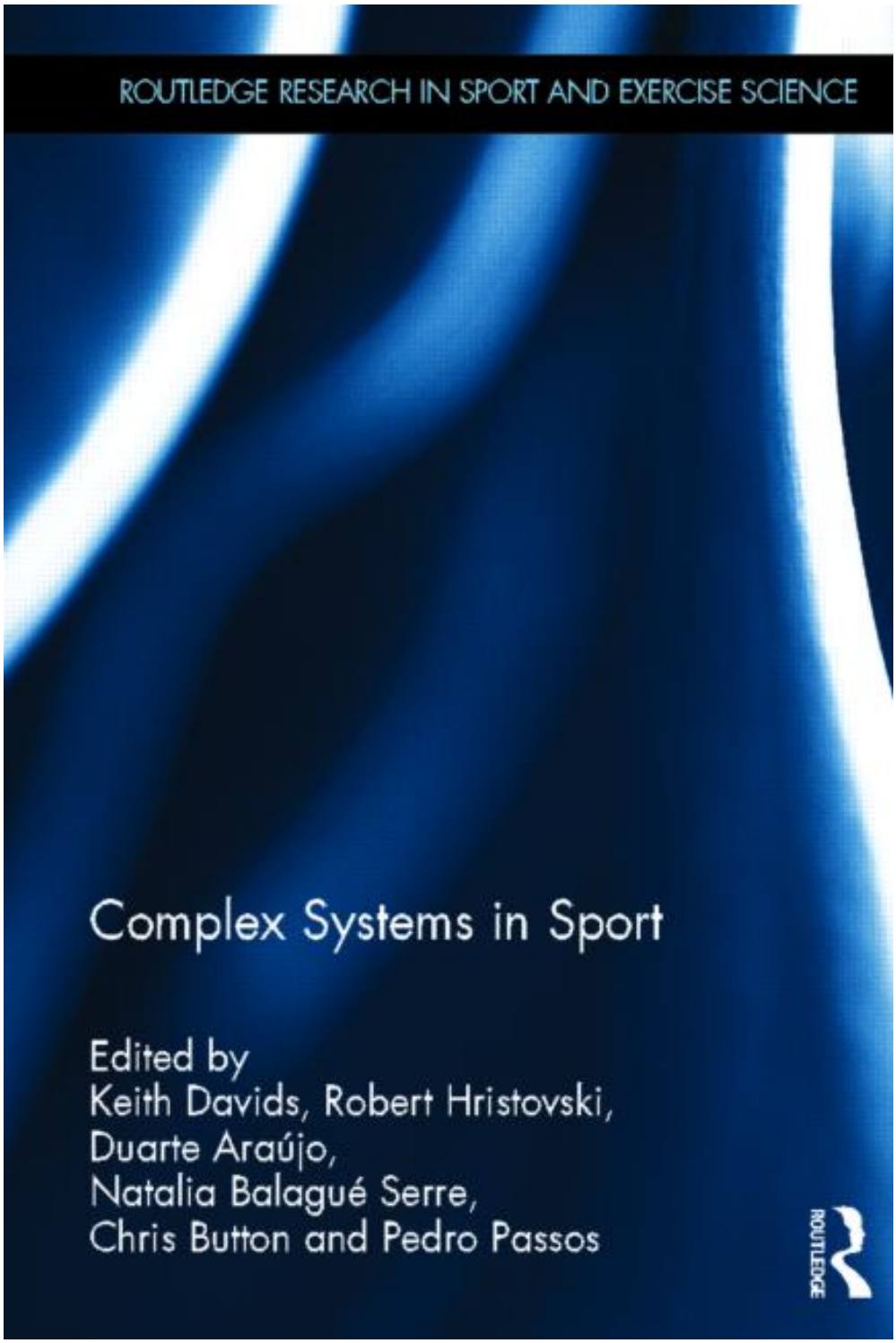

ROUTLEDGE RESEARCH IN SPORT AND EXERCISE SCIENCE
Complex Systems in Sport
Edited by
Keith Davids, Robert Hristovski,
Duarte Araújo,
Natalia Balagué Serre,
Chris Button and Pedro Passos
ROUTLEDGE

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15 Creativity in sport and dance

Ecological dynamics on a hierarchically soft-assembled perception–action landscape

Robert Hristovski, Keith Davids, Duarte Araújo, Pedro Passos, Carlota Torrents, Alexandar Aceski, and Alexandar Tufekcievski

Innovative and creative goal-directed behaviours in complex neurobiological systems, such as apes and birds, has been studied extensively (see, e.g. Reader and Laland 2001; Taylor *et al.* 2010) and involves the discovery of novel patterns of behaviour by an organism. There has not been the same focus on creative behaviour in sport, although much research in sport sciences and pedagogy has been aimed at improving athletic performance. Traditionally, performance optimization methods have been implemented to identify the set of movement parameters that might maximize competitive outcomes for specific elite athletes (e.g. Bartlett 2007). However, as in the case of Dick Fosbury, the elite high jumper, sometimes exploration of novel movement patterns can not just improve performance but actually push it to a new, higher level.

Such advances occur, not by optimizing model parameters of an existing well-established technique but by construction of new coordination patterns. This creative advance can resolve problems with a previous technique, shape performance outcomes and enrich movement culture, making specific sports more diverse and more aesthetically attractive. On the other hand the sociocultural influence on the performer or the team put strong constraints of nonspecific and specific kind (for more on this issue see Hristovski *et al.* 2011). The changes in socioculturally induced nonspecific task constraints, like the type of tool used or environment on which is acted upon, may be instrumental in eliciting innovative performer–environment relations (e.g. Bril *et al.* 2005). On the other hand, specific social influences, i.e. imitation of extant performer–environment relations, are constraining athletes to comply with these movement forms within the sociocultural milieu. However, complying with extant movement forms is just the opposite from creativity defined as *process of exploration and production* of novel and functional behaviour. Drazin *et al.* (1999) and Sternberg and Lubart (1996) provide detailed explanations of these two basic types of creative behaviour, respectively.

Inventions of novel performance solutions occur regularly in sport and have been well documented in activities like track and field, exemplified by the

'O'Brien' (or rotational) technique in shot put or the 'straddle' and 'Fosbury flop' techniques which replaced more traditional and less successful 'scissors' and 'eastern cut-off' high-jump techniques. In the last few decades alone in gymnastics, 14 novel technical elements have appeared. Yet despite this process, creativity in sport performance has seldom been the subject of systematic research, revealed by the absence in sport science of established theoretical rationales for studying and explaining creative behaviour. In the following text, we present a model of creative behaviour in sports and dance and some new empirical results based on the ecological dynamics approach (Araújo *et al.* 2006).

Multistability as a prerequisite for creativity in neurobiological systems

The multitude of solutions or states available in complex performer–environment systems is a consequence of the wealth of potential nonlinear couplings available between system components (or between system agents in sports teams as social neurobiological systems (e.g. Challet *et al*. 2000). Degeneracy, pleiotropy and multistability exemplify performer–environment properties that support such nonlinearity and complexity. In short, degeneracy means that different structural components may be assembled to satisfy the same task goal constraints and pleiotropy means that the same structural component can have a role in satisfying different task goals. Multistability (see Chapter 1 and 2 for definition) is a prerequisite for an important property of complex systems metastability; i.e. the capacity to possess numerous functional, coexistent pattern-forming propensities (e.g. Bressler and Kelso 2001; Kello *et al.* 2008). It is a prerequisite, since metastable dynamics can exist only in systems which have more than one attracting states under the same longer-term constraints. In such systems, the behaviour can dwell for some time in the vicinity of the attractor or attractive point and then switch to another one. The monostability of linear systems does not allow such metastability. This property of performer–environment systems, allows system states (*qua* performance solutions) to be soft-assembled, emerging under specific constellations of boundary conditions as constraints. These system states are not preformed but emerge under interacting constraints, basic principles that underpin the constraints-led perspective on skill acquisition in sport (Davids *et al.* 2008; Davids *et al.* 2013; Davids *et al*. 2003; Araújo *et al.* 2004, 2006; Davids *et al*. 2005; Chow *et al.* 2006; Newell 1986).

The distinctive configurations of constraints between learners, based on a platform of system degeneracy and pleiotropy, are manifested in how each individual attempts to satisfy specific task constraints during practice. Inventing a new technique or a movement form (i.e. coordination) is always defined as being in the coordination stage of learning, which can be afterwards, through practice, made more functional (for more detailed discussion, see Hristovski *et al*. 2012). The invented coordination, of course, may be supported and contextualized by already-stabilized skills. Individual creativity is a product of the interactions of three nonlinear properties: cause–effect nonproportionality, parametric

(constraint) control and multistability in complex systems (for definitions, see Chapter 1 and 2; Hristovski *et al.* 2009). Within these interactions, nonlinear pedagogy (e.g. Chow *et al.* 2006) frames the individuality of learning pathways and individual creation of performance solutions for a given movement task. Based on these arguments, we next outline a nonlinear, complex systems model of creativity in sports and physical activity.

Ecological dynamics on a hierarchically soft-assembled potential landscape: a model outline

The empirically-based, hierarchical structure of human movement variability (see e.g. Chow *et al.* 2008) provides an *explanation* of the behavioural characteristic of creativity within the framework of statistical mechanics of disordered systems; i.e. systems with many different but *ordered* states, particularly the replica symmetry-breaking framework first developed by Parisi (e.g. Parisi 1979). The hierarchical structure of movement variability implicates a rugged landscape with many nested metastable minima (Hristovski and Davids 2008), within the global basin of attraction. For clarification, one such landscape is depicted for fixed task constraints in Figure 15.1.

The main idea behind this model is the absence of any simple symmetries of potential order parameters (see Chapter 1 and 2) governing discrete and whole body movements. In other words, in principle, it is hard to relate two or more actions through simple symmetry transformations. For example, in the HKB

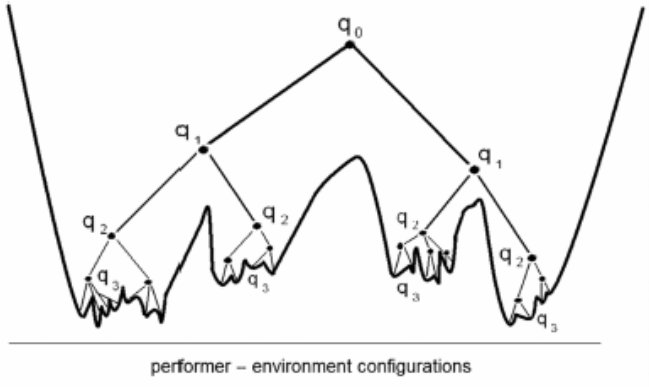


Figure 15.1 Schematic (i.e. one-dimensional) presentation of the corrugated hierarchically soft-assembled potential landscape with two confining barriers on both sides (reproduced with kind permission from *Nonlinear Dynamics, Psychology and Life Sciences*, Springer)

(Haken, Kelso and Bunz) model (Haken *et al*. 1985), the relative phase order parameter exhibits mirror (change of the sign) symmetry, which allows one to relate a set of patterns; i.e. values of the order parameter, with those symmetries. However, a set of whole-body movements/postures or multiarticular discrete movements in sport or dancing, generally, cannot be related by simple symmetries and their rearrangements. Hence, the relatedness of any set of discrete and whole-body movements may be made by the so-called overlap order parameter q, which measures the mutual correlation of this kind of actions. It can be defined as a cosine of the angle between two random vectors, i.e. *replicas*, in real or formal space of any finite dimension (e.g. Domany *et al*. 2001). Under absolutely relaxed constraints, one may expect that these replicas are totally uncorrelated and their average correlation is $<q> = 0$. We can say that the system is replica symmetrical. Any replica, i.e. performer–environment configuration, can emerge. However, under constraining influences of the task, properties of the individual performer and the environment, this symmetry and ergodicity is broken and clusters of correlated actions arise (for detailed examples, see Hristovski *et al*. 2011, 2012). Some similar replicas, i.e. configurations, are more likely to occur and some are unlikely. Constraints break system symmetry, produce a phase transition and also create ergodicity breaking high barriers on the both sides of the potential landscape, confining all available actions within the internal space (Figure 15.1). It can be observed that the action landscape *soft-assembles* under specific constraints configurations.

These correlated clusters form a hierarchical landscape. Actions lying in one attractor basin (see Chapter 1 for definition), separated by smaller barriers are more correlated than those separated by higher barriers. Thus, we can define order parameters at each level, with those defining lower levels depending on increasingly subtle constraints. These order parameters form a tree-like structure. Note that, while slowly changing (i.e. quasi-stationary) interacting constraints, are forming the deterministic structure of the landscape (see Figure 15.1 and the previous text), there is also a need of stochastic agitation force within the performer–environment system, mainly contributed by the interaction between performer's intention to move and the unpredictable and quickly changing physical and information constraints, which are the driving force of reconfigurations. Hence, both the deterministic structure *and* the stochastic drive interact in reconfiguring the systems dynamics. The exploratory dynamics within this landscape, may be seen as a hopping of the system from one basin to another or equivalently as a *random walk on a tree*. The *hopping* or the random walk has a meaning of reconfigurations within the system that are taking place. Hopping over larger barriers means larger reconfigurations and vice versa.

This modelling shows how *exploration* is a requisite of creative behaviour; i.e. inventing novel or innovating extant movement forms and actions with respect to the extant sociocultural milieu (for details see Hristovski *et al*. 2011). Without it, a complex neurobiological system cannot find novel functional behavioural solutions. In Hristovski *et al*. (2011), exploratory breadth Q was defined as being equal to the average escape probability over all possible state basins of attraction

(see Saxton 1996), $Q = W_e$. Escape probabilities for each movement mode are defined as $W_e = 1 - W_c$, where W_c is the conditional probability of staying inside the same attractor (Hristovski *et al*. 2009). In other words, W_c measures the trapping strength of the attractor; i.e. the probability of being able to achieve the same performance outcomes sequentially. The larger the average escape probability W_e the larger the exploratory breadth Q of the system and vice versa. In general, it can be said that: *for any performer–environment system containing a large amount of degrees of freedom, there always exists a set of constraints which maximizes the functional action versatility, i.e. exploratory breadth, defined as maximum action entropy* (see e.g. Hristovski *et al*. 2006; Pinder *et al*. 2012). A more thorough exposition of this model and an experimental example of novel action emergence in martial arts can be found in Hristovski *et al*. (2011) and Hristovski *et al*. (2012).

In the following section, we further illustrate how this theoretical model provides an analysis of movement exploration structure and dynamics applied in context of dance improvisation. The general predictions of a hierarchical structure and softly assembled dynamics were preliminarily tested. A conceptual model of creativity in team sports within the general framework of dynamical systems is also presented.

How creative behaviours emerge under ecological constraints in dance and team sports

Creative behaviour in contact improvisation dance: a soft-assembled hierarchy model analysis

Contact improvisation is a form of dance where contact points between and movements of partners constrain each other's subsequent movements. What are the creative aspects of contact improvisation? Contact improvisation may be thought of as a bank of emergent human movement forms and an expression of continuous *exploration* and *discovery* of idiosyncratic postures and actions supported by immediate affordances; i.e. opportunities for action. It is used systematically as a *dance research method* for identifying innovative set choreography. The invented novel forms of movement, being themselves creative products, could afterwards be stylized and put to a further use. These properties of contact improvisation make it a highly creative activity satisfying both, the *process* and the *product* definitions of creativity as a phenomenon (for these definitions, see (Drazin *et al*. 1999; Sternberg and Lubart 1996). This characteristic of contact improvisation fits nicely within the general approach in our experiments for discovering the dynamical, perception–action landscape of sport/dance performers which involves probing system activity by letting it evolve autonomously under specific task constraints manipulations over a period of time.

Here, we describe some results of an analysis of a typical contact improvisation session lasting 450 seconds under no special instructional constraints, except those provided by the contact with the partner, i.e. visual and haptic information,

and the force of gravity. Sequences of actions/postures were analyzed to determine their complex dynamical characteristics. Actions/postures were defined on a coarse-grained scale containing 52 movement/posture components, such as support/contact characteristics and directions and planes of motion of body segments according to established observational methodology (see Torrents *et al.* 2010; Castañer *et al.* 2009). To the active components a value of 1 was ascribed and to the inactive components a value of 0. Hence, a binary matrix was formed with a time resolution of 1 second. Each 1-second window was defined as a 52-component binary vector representing the action configuration during the same time interval. Reconfigurations, i.e. mutations, of action patterns were calculated as Hamming distances between any two binary vectors. For example, the change of one component of the vector from 1 to 0 or vice versa has a Hamming distance equal to 1. Hence, the Hamming distance actually measures the height of the potential barrier between two configurations. Overlap order parameter q was used to determine the structure of the potential landscape of the dancer and its dynamic properties. The overlap was defined in two intrinsically related association measures: as a cosine similarity and as a Pearson correlation between two binary configuration vectors. A hierarchical principal component analysis (HPCA) was performed on the data using the second measure (for the plausibility of using principal component analysis on binary variables, see Joliffe 2002, p. 339), with the aim of detecting the possible nested attractor basin structure of the dancer's action landscape. In order to determine not only the structure of dancer's complex movement patterns but also their exploratory dynamics, the dynamic overlap $q_d(t)$ was calculated as an average cosine autosimilarity of the overlap between configurations with increasing time lag.

The HPCA initially revealed 25 principal components. Seven primary principal components accounting for 81.3% of the total variance were taken into account. The first, the fifth, the sixth and the seventh principal component were weakly but significantly correlated $\langle q \rangle = 0.401 \pm 0.02$. The other 18 principal components contained statistically rare and short-lived reconfigurations having a role of fluctuations. This structure is interesting in itself. While the dominant dynamics were confined within the seven principal components, the reconfiguration space was with significantly higher dimension. This gives a picture of lower-dimensional global dynamics connected by high-dimensional quick reconfigurations. Seventeen movement–posture components had very high scores on these seven principal components. Consequently, the dynamics were saturated predominantly by these *emergent* movements-posture patterns.

The secondary level consisted of two principal components containing the seven primary principal components as substructure. Hence, the HPCA procedure reduced the dancer's dynamics dimensionality from 449 configuration vectors to the two slowest collective variables (order parameters) containing seven faster variables, each of which was formed by even faster movement/posture configuration vectors. The median dwell time of these configuration vectors was 5.4 seconds. This structure revealed a metastable dynamics in a soft-assembled hierarchy of collective variables with different characteristic time scales (for intuitive

understanding, see Figure 15.1). The global and the slowest collective variable consisted of degrees of freedom such as foot–floor surface support, support of the partner with lower and upper limbs and the trunk-torso-back-pelvis surfaces. They were present, with only quick interruptions, over the whole observation timescale. This persistent collective variable formed the global basin of attraction and continually constrained the faster degrees of freedom such as a change in the direction of movement, lateral or forward flexion of the trunk, arm movements, and so on. These degrees of freedom under constraining influence of the slow collective variable formed shorter-lived metastable states (local basins of attraction) on the lower hierarchical level. In other words, the slowest collective variable formed rather persistent pinning surfaces between partners, nucleuses, around which more quick movement motifs were created.

In the upper panel of Figure 15.2, one can see a zoomed example of metastable dynamics of the first 35 seconds, where the action system of a dancer transits from one local metastable configuration attractor basin to another, meanwhile dwelling inside one of them for several seconds. These four principal components extracted from the first 35 time-ordered configurations were correlated $\langle q \rangle = 0.64 \pm 0.05$ and belonged to a secondary global confining attracting basin (secondary principal component). At each moment, several opportunities for action coexist, owing to informational constraints from the partners and the floor, the gravity and the abundance of nonlinearly coupled degrees of freedom within the system of dancers. Which one of these coexistent propensities will become a temporary solution, i.e. a creative product, depends on subtle and quick information, i.e. fast perceptual-motor degrees of freedom and decisions dressed with randomness, e.g. who will lead and who will follow in the immediate future interval. Aside from their common motive to move, randomness is a crucial part of the dynamics because partners do not deterministically guide each other, i.e. with perfect probability ($P = 1$). Each temporary posture or movement solution is a creative product embedded within the creative exploration dynamics. Hence, 'exploratory' or 'process' and 'product' properties of creative behaviour are becoming obvious (Drazin *et al.* 1999; Sternberg and Lubart 1996).

The darkest areas of the centre panel of Figure 15.2 correspond to maximum overlap q values of certain configurations with the certain principal component and represent the locally attracting configurations. The increasing lightness in the conturogram signifies a lower overlap and represents the local attracting basin around the attractor configurations. One can notice that from the darkest areas (local potential minima) going outwards the lightness increases, reaching in some areas the lightest grey colour, which represents saddles or barriers of the potential landscape. Looking at the lower panel of Figure 15.2, where Hamming distances count the number of reconfigurations or mutations that have occurred, we see that those lighter shaded areas correspond to the intervals of reconfigurations of the action system of the dancer. Hence, reconfigurations correspond to crossing over the potential barriers (saddles) between two metastable minima.

The evolution of the cosine autosimilarity, i.e. the average dynamic overlap $\langle q_A(t) \rangle$, is given in Figure 15.3. If the dancers stayed in one posture during whole

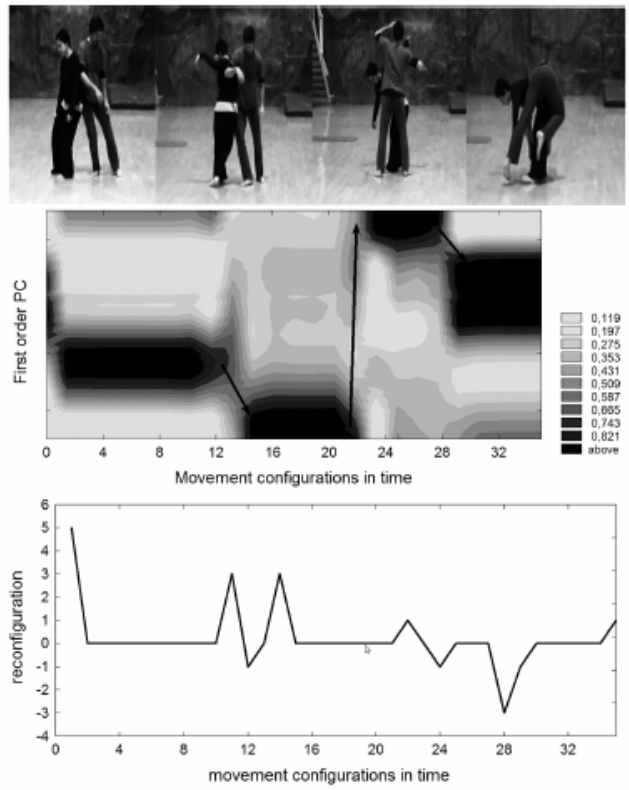


Figure 15.2 (Top) snapshots of the four metastable states of dancers for the first 35 seconds of improvisation; (middle): overlaps q of the four metastable body configurations with principal components (axis Y) and pathway of their dynamics. Overlap values are given in the legend on right; (bottom): reconfigurations are given as nonzero Hamming distances of the dancer's action system; after some reconfigurations take place, the action system relaxes and dwells in a state where no further reconfigurations occur for some time; i.e. zero reconfiguration; this process represents the metastable

observation time lasting seven minutes, the average dynamic overlap would be a constant equal to one; i.e. $\langle q_d(t) \rangle = 1$ for all time lags (see the dashed line on Figure 15.3). On the other hand, if during the performance, the dancers were exploring distant configurations of the whole state space (a case of unbroken ergodicity), the average dynamic overlap $\langle q_d(t) \rangle$ would drop to zero exponentially fast for the observation time of seven minutes (see the dotted curve on Figure 15.3). Neither of these cases was obtained in the observed performance. The fact that the relaxation of $\langle q_d(t) \rangle$ was *not* exponential, means that there was no single characteristic time of the dynamics. In other words, the dynamics contains a distribution of relaxation times and thus a distribution of attractor basins of different depth (barriers of different height), which is consistent with the predictions of the model of soft-assembled hierarchy explained briefly previously. According to the model, Figure 15.3 can be interpreted in the following way. The dancer explores subsequent movement configurations, which are correlated; i.e. lying within a local basin of attraction defined by the correlated principal component substructure and makes, on average, small gradual reconfigurations. On average, after longer times, s/he hops into attractor basins which are less correlated with previous ones; i.e. moves within another set of principal components. These reconfigurations with time accumulate and bring the dancer far enough from a certain initial configuration. That is why the dynamical overlap $\langle q_d(t) \rangle$ decreases for the first 35 time lags, forming the initial relaxation dynamics. The linear fit in log–log plot of this initial relaxation was $\beta = -0.203$; with explained variance $R^2 = 0.977$. This variable roughly shows the *rate of exploration* of the system. One can see that even movement configurations separated by 20 seconds possess overlaps larger than 0.5. However, on average, movement configurations separated in time by more than 35 seconds show a constant average overlap of approximately $\langle q_d(t) \rangle = 0.45$. This is the value of the

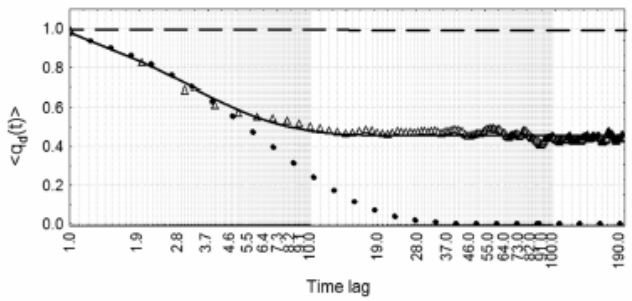


Figure 15.3 The profile of the average dynamic overlap $q_d(t)$ for different time lags; its dynamics proceed on three timescales (from seconds to several minutes) and does not converge to zero during the observation time scale

average overlap of all the dancer's movement configurations that emerged within the seven-minute contact improvisation. In other words, this is the self-overlap value of the superbasin of attraction confining all of the metastable valleys of movement configurations captured by the hierarchical principal component structure. Since the dynamic overlap forms a plateau at values far from zero, the system does not explore arbitrarily distant movement configurations (ergodicity is broken on the observational time scale of seven minutes), because the slowest collective variable (see the previous discussion), confine the emergent metastable opportunities for action and, consequently, the movement dynamics, in a relatively large but limited region of performer–environment state space. Nevertheless, the plateau value $\langle q_d(t) \rangle = 0.45$, shows a relatively high exploratory; i.e. creative fluency of the system. The fact that the dynamical overlap, during the observation time of seven minutes, did not decrease to zero means that the global relaxation (equilibration) time of the slowest, order parameters (secondary principal components) diverged (did not go to zero) and the system was in a nonequilibrium state. This means that while there was an equilibration within the confined region (primary principal components), the space of all possible configurations remained far from being fully explored. Such slow dynamics is consistent with predictions of the previously discussed theoretical model of soft-assembled hierarchical dynamics. The exploratory breadth of dancer's movement system Q (see previous section) defined as an average escape probability from a certain configuration was $Q = 0.37$, showing a significant exploratory capacity under relaxed constraints.

In this section we have shown how exploratory, i.e. process and product aspects of creative behaviour can be analyzed within the model of soft-assembled hierarchy. The creative process unfolds on more time scales, owing to the hierarchical structure of the perception–action landscape. The soft-assembled hierarchical landscape model predicts also other interesting phenomena, such as aging: the more time the learner spends in a confined and thus correlated region of the landscape, the less responsive s/he becomes to a change. Based on the obtained consistency of the experimental results with respect to the predictions of the theoretical model, we further hypothesize that, together with Q, the slope of initial relaxation β and the value of the $\langle q_d(t) \rangle$ plateau, are good candidates for assessing the creative capacity of performer–environment systems under different types and strengths of constraints (for details see Hristovski *et al.* 2011). Future work is needed to test other predictions of the model.

Conceptual modelling of creative behaviour in team sports: the need to play within critical regions of interpersonal distance

Attackers' interactions aim to actively explore space–time windows that emerge because of defender displacements. On the other hand, defender displacements aim to cover the possible paths to goal, which demands high levels of interpersonal coordination among the players in defence. However, space–time windows will only emerge if the attackers' movements are powerful enough to disturb the

defenders' interpersonal coordination and, to do that, attackers' actions must be performed within short distances of attacker–defender interpersonal distance (Passos *et al*. 2008).

Thus, sudden changes in the attacker–defender structural organization can only happen when the attacker–defender systems moved towards regions of very short interpersonal distances, where the contextual dependency among players emerge, characterizing the performance region as critical. Within these critical regions, the players' contextual dependency moves the system from equally poised options to a single option, that emerges under the influence of task and environmental constraints. In other words, within these critical regions, creativity occurs as ongoing performance solutions emerge and are annihilated, until a sudden change occurs where a single, i.e. creative solution, emerges (Passos *et al*. 2009). In this sense, within critical regions, *exploratory* metastable behaviour emerges as a precursor to the *creative product*, i.e. the single solution. Hence, both the exploratory and product phase of creative behaviour exist (Drazin *et al*. 1999 and Sternberg and Lubart 1996). The players' contextual dependency creates local information that originates at a specific moment in time and space where a gap in the defensive system emerges and the attackers exploit it to move closer to the goal or even score. This process underlines the notion that creativity in team sports is based upon a self-organization mechanism that only occurs within critical regions.

Creativity in team sports is sustained by the nonlinear interactions among players, which enable nonproportional, abrupt and unpredictable environment for the opponents. As in any other social system, the way that each player interacts with others in the neighbourhood of play influences the behaviours of players within the same team and this is a requisite to disturb the actions of opponents (Fajen *et al.* 2009). From an attacker's perspective, the decisions of the ball carrier and support players are based on the perceptions that they have created of the defenders' relative positioning, running-line trajectories and proximity to each other (Passos *et al*. 2008). On the other hand, the decision making of defenders depends on the perception that they have of the ball carrier's actions as well as the behaviours of the support players (Passos *et al.* 2008). These variables include interpersonal distances, the speed and running-line trajectories that contain important information concerning the attackers' ability to perform different actions. These variables contain information that are perceived by the players and specify the action possibilities of each opponent or teammate (Gunns *et al.* 2002; Weast *et al.* 2011). This is where creativity emerges, with the need for attackers to perform deceptive actions that creates the impression of multiple different possibilities for action. These deceptive actions can also be characterized by intrateam coordination, where attackers perform a set of previous established movements that are intended to open a space–time window against a stable opposing team. This is when creativity is needed again and players need to reorganize, avoiding defenders. This reorganization process is grounded on situational information concerning defenders' relative positions, number, speed and distance to goal (Travassos *et al.* 2011; Cordovil *et al*. 2009; Passos *et al.*

2011). These sources function as task constraints that attackers use to avoid defenders. The reorganization of attackers is grounded on situational information that emerges because of opponent players' nonlinear interactions and is self-organized.

Typically, attacker–defender interactions are characterized with many subtle fluctuations in the attacker–defender balance but also with few abrupt changes in the attacker–defender structural organization, meaning that suddenly the attackers gain an advantage and are in a crucial position to score.

To summarize, in this chapter, we have outlined a model of creative exploration and solution (product) emergence as a soft-assembly of actions under ecological constraints. The obtained structural and dynamical hierarchy of the creative behaviour, consistent with the model predictions, was demonstrated in a contact improvisation dance example. The creative process unfolds on *different timescales*, owing to the hierarchical structure of the perception–action landscape. Hence, creativity is a nested process, both structurally and temporally. The experimental examples provided here are extensions of those in Hristovski *et al*. (2011), where an emergence of a novel punch in martial arts was treated within the framework of the same theoretical model. The role of slowly changing or constant environmental and personal constraints, (i.e. gravity and morpho-anatomical structure in creative exploratory activity) is provided by their slow contextualizing function. Quickly changing and stochastic physical and informational constraints form the base of the unpredictability function in creativity. Through this process they mould the goal-directed activity of complex systems potentially leading to inventions of new movement forms or team actions. By manipulation of these key constraints, athletes structure different types of contexts which eventually lead to soft-assembly of novel forms of actions. In this way, highly motivated athletes, by self-generated experimentation in the full space of constraints, may facilitate the emergence of new and functional action forms.

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