Manipulating Constraints to Train Decision Making in Rugby Union

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\textbf{ABSTRACT}

This paper focuses on the paradoxical relationship between game unpredictability and the certainty of players’ actions in team ball sports. Our research on this relationship leads us to suggest a method for training decision making, which we exemplify in the team sport of Rugby Union. The training methodology is based on application of theoretical insights from Ecological Psychology, Complex Dynamical Systems and the Constraints-Led Approach. The paper starts with a critical overview of traditional approaches to studying decision making in sport. Next we describe the sport of Rugby Union to exemplify a complex dynamical system, and explain how that conceptualisation captures the interactions of players within that performance context. We conclude our analysis by describing how to manipulate task constraints to improve decision-making performance, as players search for an appropriate blend of stability and variability in their actions. In the final part of the paper, we suggest some methods to train decision making based on four stages: i) identifying the problem; ii) setting out a strategy to solve it; iii) creating an action model; and iv) building a decision-making exercise. The main conclusion from our work for coaches and sports scientists is that decision making should be improved through training methods that provide an accurate balance between stability of actions, which gives structure to the players’ performance, and variability, which allows them to cope with the uncertainty of situational constraints, such as the behaviour of specific opponents.

\textbf{Key words:} Constraints-Led Approach, Decision-Making Training, Dynamical Systems, Ecological Psychology, Rugby

\textbf{INTRODUCTION}

This paper seeks to raise important questions about the methods used to train decision making in team sports like Rugby Union. Most team-game coaches will agree that a
Competitive game is a source of unpredictability and uncertainty for all players. A major question faced by all coaches is: How can we reduce the uncertainty inevitably faced by players in all performance contexts? Given this major focus, we pose the related question: Why do traditional training methods in team ball games typically prepare players for the certainty of their actions (i.e., consistency as Handford [1] termed it) instead of preparing them for game uncertainty? By uncertainty, we mean unpredictability about the final outcome of the interactions that emerge among team-mates and/or opponents in a match. Even the previous knowledge that players may acquire about their opponents is never enough to solve the problems that emerge during sub-phases of games like Rugby Union. This is a key issue in every team sport: players never know with 100% certainty what their opponents are going to do at every moment of the game.

In order to accurately answer the first question, it may be useful to understand a team sport as a complex dynamical system. Our attempt to theoretically resolve this question will lead us to discuss methods on how to prepare players (regardless of whether they are defenders or attackers) for the interpersonal interactions that occur during a match e.g., in typical 1 vs. 1, 2 vs. 1 or 3 vs. 3 sub-phases of Rugby Union, for example. In answering the second question, we will take the opportunity to critically examine the typical methods used nowadays to prepare teams and players for the problems that emerge in games. A significant number of the exercises suggested in rugby coaching and performance manuals [2-4] are dedicated to developing players’ skills, and teaching when it is most appropriate to use those skills. Traditional methods to coach decision-making and implementation of skills in team games like Rugby Union are deterministic, in the sense that they attempt to leave little to chance and equate performance uncertainty with random variations in play. Consequently, coaching methods are adopted which seek to decrease the variability of actions in players and the uncertainty of their decision-making processes (e.g., practising skills unopposed, or with passive opposition, in order to facilitate the skills performance; or practising repetitive drills to reduce the uncertainty of movement skill performance). (For research on those methods, see Passos et al. [5]). This trend in coaching mirrors a significant proposal in psychological science that automatising motor skill performance can reduce the information-processing burden on individuals [6].

However, competitive team games are not stable contexts in which information is certain. Successful players need to adapt their actions to the dynamically changing environment that characterises the typical team game. Despite the usefulness of traditional training methods at particular periods of the competitive season, we will argue that these kinds of methods are not enough to prepare the players for the non-linear characteristics of a competitive match [7] and that they might actually be encouraging players to become too predictable. A major criticism is that traditional methods focus on the consistent performance of specific movement skills by an individual player or group of players, rather than actually focusing on the player-environment relationship. The former focuses on movement stability, whereas the latter relationship emphasises adaptability and variability in movement patterns as a player interacts with team-mates and opponents, events and objects (e.g., the ball, posts, line markings, etc.).

How can we successfully prepare the players and the teams to cope with the uncertainty present in team games? Focusing attention on the player-environment relationship during training in team ball sports encourages athletes to search for successful solutions to disturb a system (if attacking) or maintain a system (if defending). Movement skills are important because they provide a way for players to create instabilities or maintain stability and to solve tactical problems that emerge during a rugby match. Rod Thorpe, in a communication
to elite Rugby coaches in Otago, New Zealand in 2005, developed the idea that coaching sessions should provide a way of players engaging with the environment in developing his/her own tools to resolve the tactical issues that arise in competitive settings. We propose that a useful way to achieve this goal is through designing practice tasks that include plenty of variability that simulates competitive settings. Some innovative and effective coaches have realized in their coaching strategies an appropriate balance between stability and variability of game performance. Confronting players with variability in practice forms the basis of a *nonlinear pedagogy* which recognises the need to create practice environments for individuals that allow them to seek unique performance solutions. In line with Thorpe’s ideas, it is worth noting that Handford [1] criticized the “one size fits all” method regarding the learning process of technical elements in a generic way across all individuals in team games.

Finally, we briefly discuss some generic performance principles common to several team sports such as the creation and use of the space to advance into opposition territory (when in possession of the ball), as well as creating pressure to recover ball possession when in defence. The theoretical background used on this paper could be used in a variety of team sports, but the examples presented here are exemplified in the sport of Rugby Union as a vehicle of analysis. Due to the specificity of individual, task and situational constraints that characterize each individual team sport context, the implementation of these ideas from nonlinear pedagogy will vary accordingly. For example, because the perception-action couplings that support decision making are context specific, the practical examples discussed in this article may not necessarily be transferable to other team sports. A major point in this regard is that decision-making training should be mainly unique to the task constraints of specific team sports.

**THEORETICAL ASSUMPTIONS OF TRADITIONAL COACHING METHODS**

The “one size fits all” method that Handford [1] criticized contains the implicit assumption that there is a common ‘optimal movement pattern’ which acts as a template for a movement skill towards which each individual player is progressing. In idealising a specific motor pattern, traditional motor learning theories show how they are infused by the assumption of movement programming (e.g., there are assumptions about the existence of a ‘textbook’ tackle, a hooker’s throw, scrummaging technique, a place kick; all of which may be considered as discrete skills and taught using a ‘one-size-fits all’ approach). This concept is based on the assumption that the human brain acts like a computer. It implies that decision making is programmable in learners and that the best way to encourage decision-making skill is from a stimulus-response approach during training. This decision-making approach is conceptualized through information-processing models of motor control, which assume that performers need information input (i.e., the stimulus) and a conversion of this information through a central processor within the central nervous system in order to produce a desired system output (i.e., the response) [8]. In humans, the input is the sensory information (e.g., information on an opponents’ position, verbal communications of team mates, the ‘feel’ of a ball in the hands) sent to the central nervous system from the visual, acoustic and kinaesthetic receptors. System output is the observable patterns of movement (e.g., a pass, a kick or a dribble) required to achieve a specific outcome such as moving the ball to a specific location of the field (e.g., players are taught to perceive information from an opponent’s hip, and not the ball, in order to make a ‘textbook’ type tackle). Players often practice in order to act at a breakdown situation in a sequenced manner so that the first defender to arrive must contest for the ball, followed by defenders covering the far side of the breakdown, then deep in
behind and finally the near side so as to limit the opposing team’s attacking opportunities. This rather simplistic response to a breakdown situation ignores the evolving dynamics of the situation, which may indeed provide players with critical information for finding a more appropriate solution to the immediate problem. These are examples of how the uncertainty of a player’s actions can be reduced in response to situational cues, irrespective of sudden process or outcome changes within the particular performance situation. The success of the outcome “depends primarily on the computational ‘programs’ within the central nervous system that are responsible for selecting and then controlling the movement” [8, p. 298]. Thus, for performance of a skill to succeed, computational models suggest that skills emanate from programs that must be developed and continuously improved through repeated use and practice. Therefore, drills that involve little or no uncertainty or decision making ability are encouraged, so that players can practise achieving the same performance solution repeatedly. Typically, this form of practice occurs with little or no manipulation of the situation (e.g., few task constraints; in the presence of few neighbouring players), to prevent players searching for unique solutions. This is exemplified in drills which involve players stepping or passing around cones and poles, tackling tackle bags, and ‘shadowing’ (i.e., practising offensive or defensive patterns without any opposing players etc.). In summary, information-processing models describe decision making based on the assumption that, in a particular performance context, a specific stimulus (i.e., input information) will trigger a specific automated response (i.e., a programmed output), which is stored in the performer’s memory due to intense and repetitive practice. In traditional theories, decision making is mediated by knowledge structures stored in the memory [9, p. 96].

However, the problem with this traditional theorising is that competitive performance settings are uncertain and unpredictable environments at all skill levels, from novices to experts, characterised by sudden, unexpected and rapid changes in the huge amount of information available from the movements of the ball, team-mates and opponents. In such dynamic performance settings, how can specific movements be programmed to produce a specific response, if the ‘triggers’ (i.e., the stimulation) are unique (i.e., never repeated in an identical way)? This is a question we will try to resolve in the next section by arguing that a different theoretical framework may be needed to explain perception, decision making and action in such complex performance environments. An alternative view is that the unpredictable nature of team sports can actually benefit from the inherent variability that is available to the players as components of complex dynamical systems.

NONLINEAR PEDAGOGY
RUGBY UNION AS A COMPLEX DYNAMICAL SYSTEM
A complex system in nature is composed of many different interacting components. Because team games, considered as complex systems, are highly integrated, being composed of multiple components (i.e., individual players) affords the emergence of rich patterns of behaviour in dynamically changing environments. During a competitive game, the decisions and actions of each player are constrained by multiple causes that produce multiple effects. This is a primary feature in considering complexity during team games [10]. The potential for interaction between players in a Rugby Union match, viewed as a complex system, signifies that it is not possible to accurately describe a specific outcome that occurs in a game as sustained by a single cause-effect relationship.

This aspect of complexity requires understanding of Juarrero’s [11] concept of constraints as causes. Team games can be conceptualised as dynamical systems whose patterns of behaviour are emergent and created by the specific interactions of individual components (i.e.,
behaviours of individual players). Application of this idea to the context of competitive sports means that interactions between players during the important sub-phases of performance (i.e., 1 vs. 1, or 2 vs. 2 situations) emerge during a game. Players form systems and in turn their behaviours are constrained by those systems (see Figure 1). How does this circular causality work? The behaviour of a complex dynamical system emerges when the behaviour of a single player becomes dependent on what neighbouring players (either team-mates or opponents) are doing and on what has been done before. This phase of a complex system’s behaviour occurs when the players’ decisions and actions suddenly become context-dependent, i.e., constrained by the specific interactions in the complex system [11]. In other words, the context-dependent constraints applied by the neighbouring components of the system lead to an interdependency of decisions and actions. The context dependence of behaviour leads to non-linearity that characterizes actions in team sports; i.e., outputs of the interactions are not deterministic (entirely predictable), nor are they completely random (entirely variable).

![Figure 1. Circular Causality of Perception and Action](image)

In order to understand the practical implications of these key concepts from the complexity sciences in team games, let’s consider an example of emergent behaviour in Rugby Union during an ubiquitous 2 vs. 1 situation (i.e., two attackers against one defender). For an attacker who carries the ball, the decision when and where to perform a pass is constrained by several factors, such as the position of team mates and the nearest opponents, the approaching speed of adjacent opponents, the running line speed, the proximity of his/her nearest team-mate, and key boundary markings such as the try line and the side line. In turn, the relative position of each player (i.e., team-mate and opponent) is also dependent on the ball carrier’s behaviour. From this viewpoint, neighbouring components of the team game as a complex system are constraints that shape the interdependence of players’ decisions and actions. This interdependence leads to an emergence of the behaviour of the 2 vs. 1 sub-system, a system that constrains each player’s behaviour. The decisions and actions performed by each component of the sub-system (i.e., players) are no longer independent; they are now context-dependent.

The interdependence of system components makes it challenging to predict in advance the final outcomes of system interactions (i.e., tackle, pass, dribble, or try). This is because the characteristics of the interactions between neighbouring components for each performance of the players in the 2 vs. 1 sub-system are unique. Although the players can display similar patterns of movement on different occasions, those movements are never repeated identically.
(e.g., the players’ respective velocities and running lines are never the same; the players’ relative positions are never the same; the locations on the field with respect to the try line and side line are never identical). Since the constraints imposed by neighbouring components always exhibit different characteristics, it follows that each individual player’s specific decisions and actions must satisfy those constraints. This type of rapid and refined behavioural adaptation forms the basis of practice in all team sports and is made possible by the capacity for variability in movement behaviour in each player. Similar principles of complexity define the capacity of individual players to produce variable patterns of movement in achieving a similar performance outcome. The many components of the human movement system (e.g., muscle complexes and joints) provide each player with the means to adjust his/her behaviour in order to maintain goal-directed activity (i.e., adapt a dribbling action to avoid an approaching defender or adjust the position of the ball in the hands to pass the ball to a team-mate). In complex dynamical systems, a consistent outcome (move the ball towards the try line) can be achieved or maintained by variability of actions of individual components (pass, dribble, kick). The players’ variability leads to system unpredictability which sustains the consistency of actions in teams (attack or defend a try line). Therefore, an implication for practice of these ideas on consistency of outcome and variability of movements is that performers should not be encouraged to develop common ‘optimal movement patterns’ as a type of specific target value. Instead, practice task constraints should aim to get players into a ‘ball park’ area of movement solutions from which they need to practise finding a functional ‘emergent’ action, based on the current context.

Clearly, this theoretical description of decision making and action involves developing an understanding of the concept of constraints. Perhaps the most insightful categorization of constraints is Newell’s model [12], which explains how coordination and control in human motor behaviour emerges. According to Newell [12], players’ decisions and actions are bounded by the interactions of: i) their own individual characteristics such as feelings, emotions, and thoughts (i.e., psychological states); physiological responses, and technical and tactical skills; ii) the characteristics of the specific task, such as the rules, the specific goals to be achieved, boundary lines, the performance-field length, number of opponents involved, number of team mates involved, situational characteristics of opponents (e.g., relative position, approach speed); and iii) the characteristics of the environment, including physical characteristics such as the weather, surface conditions, altitude, and social factors such as societal expectations, the presence of the media, and the presence and characteristics of an audience.

The constraints that bound players’ decisions and actions at every moment of a Rugby Union match are the multiple causes that shape the behaviour of the whole dynamical system (i.e., the game) created by the interactions of adjacent players and the multiple outcomes from those ongoing interactions (e.g., a ruck, a tackle).

PLAYERS-ENVIRONMENT INTERACTION: ECOLOGICAL PSYCHOLOGY
The theoretical background that sustains the training and development of decision making in Rugby Union could also be advanced by insights from Ecological Psychology [13], which emphasizes the role of information available to performers in specific environments that provide affordances or opportunities for actions. Other key concepts that need to be defined include perception and action couplings, as well as the players’ attunement to actions. These insights from Ecological Psychology allow us to understand that tactical behaviours emerging during a Rugby Union match are dependent on the information available in specific contexts; and that, in turn, information is created by each individual player’s tactical behaviours [14]. Indeed, the concept of attunement (discussed later) should be clearly
understood by practitioners because the aim of every training session is for players to increase the degree to which they are attuned to the information of specific performance contexts. This theoretical rationale proposes that the most relevant informational constraints for decision making and controlling action in dynamic environments such as a Rugby match are those that emerge during ongoing performer-environment interactions, not information from past experiences stored as representations in the brain [15, 16]. This idea shows how deterministic solutions such as programming of actions based on past experiences represented in players’ minds are unlikely to provide the adaptive behaviours needed to cope with dynamic performance environments. These arguments are contrary to most traditional psychological models of behaviour which assume that cognitive processes, such as decision making, are internalised in participants, where perception and action are separate subsystems mediated by mental representations of the outside world stored in the brain [17]. An important implication of these criticisms of traditional approaches to decision-making behaviour has been highlighted by Gibbs [18]:

Perception cannot be understood without reference to action. People do not perceive the world statically, but by actively exploring the environment. [18, p. 49].

The need for a tight coupling between perception and action means that, in a Rugby match, an attacker can create information by moving. He/she has to act in order to perceive a defender’s behaviour, who, in turn also needs to act to perceive the attacker’s behaviour. Although an individual may use previous experiences to consider a ‘ball park’ performance outcome solution, in team games an opponent’s specific movements form a major task constraint that shapes emergent decision-making behaviour in each individual performer. Acting on perceived information from an opponent’s movements leads to the emergence of non-linear trajectories of both players as a coupled system, as displayed in Figure 2. Such movements create information which is specific to the game environment that each player must learn to explore (become attuned to) through his/her actions (Figure 2).

Figure 2. Top View of Performance in a 1 vs. 1 Situation in Rugby
Gibbs [18] proposed how perception of an opponent’s actions is dependent on the dynamics of performer-environment interactions. Through on-line perceptual control (using information to regulate action), perception-action couplings can be developed to adjust to environmental demands (i.e., a specific opponent’s actions) and allow anticipation. However, anticipation is only possible if the players are attuned to (i.e., sensitive to or aware of) the most relevant sources of information needed to maintain their goal-directed behaviours. To be attuned to what the most relevant perceptual variables are in a performance context is the basis of outstanding decision-making behaviour in team sports. Attunement is what makes the difference between novices and experts. The latter are more sensitive to the relevant sources of information to successfully perform a task than novices. To improve decision making, training sessions should aim to attune the interaction that a player has with the performance environment (i.e., by including within the practice task information from boundary markings, pitch surface, teammates, and opponents). In other words, all the tasks in a training session should aim to attune key perception-action couplings in performers. To achieve this aim, the information available to be actively explored by players during practice must closely resemble the same task and environmental constraints faced in competitive settings. Otherwise, the perception-action couplings that emerge during practice will be attuned to perceptual variables (e.g., speed of approach towards an opponent) that are different from those available in competitive contexts. A major point of this approach to practice is that it is not enough to try and change a player’s characteristics (e.g., speed, technical skills, etc.) and then expect that such changes will improve performance. Coaches actually need to change the nature of the player-environment engagement. Therefore, the conception of training sessions should be soundly based on the interactions that will occur in a specific Rugby match, and to improve decision making we propose a performer-environment interaction-based approach rather than a traditional performer-based approach.

To develop a performer-environment interaction-based approach to improve decision-making skills, the constraints model of Newell [12] is most useful because it describes how movement behaviour emerges sustained on the interactions of key constraints. This modeling has led to the development of a constraints-led perspective on motor learning (Figure 3) [6, 19, 20] in which the role of the coach is to manipulate the key task, environmental and performer constraints in order to accurately satisfy the demands of competitive performance. Based on the constraints-led premise, in the next section we outline a nonlinear pedagogy for manipulating key constraints to improve decision making in Rugby Union.

MANIPULATING CONSTRAINTS TO IMPROVE DECISION MAKING

The aim of constraints manipulation by the practitioner is for the player to become better attuned to the relevant perceptual variables required to successfully perform a specific task. Manipulating constraints allows performers to search for alternative task solutions (improving their ability to cope with inherent performance variability) in dealing with unpredictability. But as Warren [21] suggested, human behaviour patterns demonstrate two balancing features that need to be accounted for, stability and flexibility:

The patterns are stable in the sense that the functional form of movement is consistent over time and resist perturbation and reproducible in that a similar pattern may recur on separate occasions. On the other hand, behaviour is not stereotyped and rigid but flexible and adaptive. [21, p. 359]
Warren’s insights show that there is not one single stable solution to a movement problem; i.e., no common optimal movement pattern. This observation means that any dynamical system can modulate its behavioural patterns to the immediate task and environmental constraints, which signifies flexibility or adaptive variability, supported by on-line perceptual control of actions.

In that line of reasoning, Handford [1] has suggested that a very important question is: When do performers need stability and when do they need variability? From a pedagogical viewpoint, Handford’s question can be viewed from two perspectives: i) from the technical development perspective; and ii) from the tactical development perspective. Handford’s [1] concerns were more focused on the first perspective when he suggested that, despite the stability needed to produce a specific movement pattern, some elements should be left free to vary in order to satisfy immediate task demands. We can add to these important insights for coaching by proposing how this balance between stability and variability can be applied to tactical aspects of team games like Rugby Union. Tactical behaviours are constrained by the sub-system formed by micro-units of up to three to four players [2, 4]. The stability of this sub-system’s behaviour is provided by the task constraint of being part of a larger dynamical system. This means that players perform their actions inside the boundaries imposed by that global system (e.g., in a micro-unit of three players, the ball carrier will be the player in the front and the supporters must be located behind the ball carrier, one at the left side and the other on the right side). These boundaries avoid randomness in players’ actions, increasing consistency and stability of team actions but also increasing the certainty of the actions to be performed. At this point we also need variability to ensure that the sub-system does not become too deterministic and predictable. Specific tactical constraints will lead to the formation of specific patterns in the dynamical system (i.e., the micro-unit will adopt particular formations). Once this is achieved, the functional behaviour of the micro-unit, as a sub-system of the whole game system, must vary in order to satisfy specific task demands (e.g., the attacking micro-unit may change the angle of the running line in order to exploit the space available from a sudden gap emerging in the defensive line). Consequently, the variability of actions of individuals within the micro-unit increases uncertainty for opponents. Although the performance-outcome requirements of the basic micro-unit are to maintain
forward movement and to keep the ball away from the opponents, specific decisions and actions of individual players in the micro-unit must account for decisions and actions of team mates (which provide stability) and also the number and relative positions of the opponents (which yield variability), both working as instantaneous task constraints on the sub-system.

A more detailed practice example will help us understand this important message more clearly. Imagine a game model that bounds players’ decisions and actions after a scrum or a line out. The task constraint is to form a micro-unit with three attackers (i.e., one ball receiver at the center and two support players, one at the left side and other at the right side, forming a pointing arrow shape), in a specific area of the field ready to receive the ball from the fly half. The aim of this micro-unit may be to advance in space and create a fixation point, since ideally the collective goal of any micro or global attack is to create and penetrate space. If unsuccessful, then this attacking micro-unit needs to re-stabilise through effective rucking and mauling before counter-attacking again. Sub-system stability is provided by the role that each attacker has to perform, as well as the collective goal of the micro-unit, which constrains each player’s decisions and actions. However, the specific way that the players in the micro-unit create that fixation point will vary and is dependent on the defenders’ positions and actions, which in turn constrains the attackers’ search for a solution to maintain goal-directed behaviour (Figure 4).

This example shows how the neighboring components of the dynamical (sub) system (i.e., team mates) provided stability in the micro-unit, whereas adjacent opponents raised the need to seek alternative solutions to maintain goal-directed behaviour, which is only made possible by variability of actions. The example demonstrates a continuous need for a delicate balance between stability and variability of behaviour in any dynamical system, including team games.

However, there are periods of a match (e.g., lineouts, scrums) that demand an increase in stability of actions due in part to significant task constraints such as less space available to be explored or the knowledge of the initial starting positions. This feature leads to an increase in predictability of actions to be performed. In these situations, the attack is easier to predict and hence a defensive subsystem may gain advantage through intent to act out a pre-determined attack structure in a rather closed-system manner. Alternatively, a more open system would reorganise and adapt to the defence in order to attack spaces left in their positioning. Both are commonly used strategies in elite players whereas learners tend to be constrained into more structured patterns and decisions. The less adaptive the defensive lineout is, the greater opportunity this provides the attacking team to pre-call line-outs with relative ease and success, a strategy which could be determined by the defence’s level of ability to adapt to change. From an applied perspective and despite the need for stability of the performance outcome, variability in movement behaviour is always present due to changes in individual constraints (e.g., level of fatigue or emotions), task constraints (e.g., wet ball, number of players in the line-out) or situational constraints (e.g., time to end of the match, score). There is also a need to maintain a certain level of unpredictability of actions, causing uncertainty in the opposition. In summary, despite the contextual demands of greater stability (e.g., set plays such as scrums or line-outs) or less stability (e.g., open play), the tasks comprising a coaching session should seek an appropriate balance between stability and variability.

Finally, in accordance with the three constraints categories in Newell’s [12] model, we can split our practice planning as follows: i) individual constraints with on-field manipulation (e.g., augmented feedback, helping the player to become more aware of relevant information sources) and off-field manipulation (e.g., watching videos, using
imagery, self-talking); ii) task constraints (e.g., changing practice performance conditions including changing rules, changing field dimensions, increasing or decreasing the numbers of players) and iii) environment constraints (e.g., training in wet or dry surface conditions, training at altitude).

Figure 4. How to Explore the Space Left Available in a Micro-Unit
Grey circle represents the defenders’ positions.
White circle with numbers represents the attackers’ positions.
Oval white shape represents the ball.
The numbers represent players’ positions: 10) the fly-half; 11) the blind side winger; 12) the center; 13) the outside center; 14) the open side winger; 15) the full-back.
Full black arrows represent ball displacement.
Dashed black arrows represent players’ displacement.
Dashed grey lines represent the boundaries of the space left available.
Pointed grey arrows represent the possible defenders’ displacements in order to cover the space left available.

TRAINING DECISION-MAKING
We begin this section by paraphrasing the two main questions posed by Greenwood [4] regarding coaching activity: What needs to be improved? and How can we improve it? To answer these questions we follow the theoretical rationale of a constraints-led perspective on motor learning [6, 19, 20] in developing a nonlinear pedagogical methodology with four stages: i) identifying the problem; ii) setting out a strategy to solve it; iii) creating an action model (stability); and iv) building an exercise.
IDENTIFYING THE PROBLEM
As stated before, players support their decisions following interactions with adjacent ‘others’
on the field, with a major focus on the tactical strengths and weaknesses of their teammates
and opponents. Tactical problems within a team arise when actions of key parts of the system
(e.g., players as components of a micro-unit) are not successfully coupled; e.g. when a micro-
unit of four players cannot disturb a defensive line in order to pass the gain line. This
outcome could be due to several causes, such as support players not being able to regulate
the pace and direction of their running lines (i.e., being too flat or too deep, receiving the ball
in front of the defender instead of receiving it in the space between defenders) or due to the
ball carrier not passing the ball at the right time to be caught by a support player in the space
left available by the defenders. Two main features emerge as constraints that lead to such
undesirable outcomes like these: (i) the timing of decisions and actions; and (ii) the space left
available to be used by attackers. For performance analysis, we suggest two guidelines for
coaches (the example is described from an attacker’s perspective):

i) Analyze the relative time that each player has to perform a task. If the moment that the
task was executed (e.g., a pop pass to a support player) allowed the penetration of space
in the defensive line, then it was likely to have been performed at the ‘right’ time. The
relative time to perform a task (e.g., the pass and reception) should be analyzed with
respect to the interpersonal distance between attackers and defenders.

ii) Analyze how players use the space left available by defenders. If that use of space
allows attackers to cross the gain line (e.g., a support player altering his running line to
receive the ball in the space left available by two defenders), then it is likely to have
been a ‘good’ use of space. If only one or none of these situations occur, then a problem
has been identified.

SETTING A STRATEGY
After problem identification, coaches should decide what kind of constraints must be
manipulated in order to solve the problem. Following the constraints-led perspective, the first
step to face the problem is to detect action possibilities; this could be done with off-field
manipulations. For example, video analysis is a powerful tool to recognize patterns of play
and detect action possibilities. Another example is the use of notational analysis, which
provides statistics of opponents’ patterns of play that allow identification of strengths and
weakness. Finally, there is the use of cognitive strategies such as imagery or self-talking
which are useful techniques to detect and anticipate action possibilities. Detecting action
possibilities provides the coach with important information to build an action model, and this
will lead to the second step in the strategy: to define the main characteristics of the action
model such as the initial conditions and the final desirable outcome to be achieved. These
steps involve setting the number of players needed to execute the action possibilities, as well
as identifying the role of each player in the model.

CREATING AN ACTION MODEL
Based on the action possibilities previously identified, the coach should develop an action
model which is a collective movement pattern that aims to provide stability to the team’s
collective actions through task constraints, such as relative positioning and outlining of roles
to be performed. An action model needs to define the players’ functions according to their
position in the micro-unit; i.e., whether they are the ball carrier, first and second receivers,
and inside and outside supporters. For each position, it is also necessary to define the actions
to be performed, the desirable running lines, and the distance to the defensive line the ball
should be passed from and received. All the actions of the players involved in the micro-unit
aim to open a space in the defensive line that allows the ball receiver to enter and cross the
gain line.

Despite the tight task constraints imposed by this action model, each player in face of
opponents has ‘order for free’ as the micro-unit seeks to maintain its goal-directed behaviour.
In this case, the term ‘order for free’ refers to the potential for self-organization or self-
adjustment between the players that is inherent to the sub-system which is still able to
achieve its intended goal. As stated earlier, the aim of the micro-unit is to advance in space
and create a fixation point (e.g., a ruck). To achieve these goals, players within the micro-
unit should adjust their decisions and actions to the time and space left available by the
defenders. To exemplify, maintaining the tasks constraints imposed as components of a
micro-unit, after receiving a pass from the fly-half, the ball carrier may have the intention to
move forward, promote contact and create a ruck. But due to a delay in a defender acquiring
a suitable position in the defensive line, the ball carrier noted that the outside supporter had
space available right in front, so the most functional decision to emerge should be to pass the
ball and immediately support the ‘new’ ball carrier. In other words, a successful action model
requires an accurate balance between tasks constraints that avoid randomness in each
player’s actions, and the ‘order for free’ that allows each player to seek the best solution to
maintain the goal-directed behaviour of the micro-unit.

BUILDING A TRAINING EXERCISE
Developing a training exercise aims to allow players to explore the variability of the
performance context to improve the quality of their decisions and actions. To build an
appropriate training exercise, we suggest manipulating individual constraints based on two
approaches:

i) On-field manipulation – task goals can be reinforced through feedback, maintaining
motivation and effort towards the desired outcomes, and instructional feedback can
also set rules that work as boundaries to direct players’ behaviours.

ii) Off-field manipulation techniques aim to improve the players’ atentional skills, through
watching DVDs, videos, using imagery, and self-talking.

Despite the importance of individual-constraints manipulation, task-constraints
manipulation is the most powerful tool available to coaches for improving the players’
decisions and actions in a performance context. Task constraints manipulation involves four
main points:

i) Changing rules allows coaches to create their own rules without losing game logic. It
is important that the original tactical/skill problem be reflected in the new modified
game format. A good example is to set up a practice game so that players can only carry
the ball with two hands. If they fail to do this, possession is lost to the opposition.
Imposing this rule encourages young players to learn to run with two hands on the ball,
which also increases passing options. To improve tactical skills, coaches can set up a
rule so that the ball receiver only receives the ball when running in the channel between
defenders. This rule as a task constraint aims to improve the positioning of the receiver
with respect to the ball carrier, as well as decision making to change the running line
and/or increase running speed.
ii) Changing field dimensions is important if a basic goal of an attacker is to make things difficult for defenders. To implement this task constraint coaches could widen the practice field, leaving more space available to be explored by attackers. In this practice situation, defenders must work together to restrict space which means that their decisions and actions have to take account of their adjacent team mates. In contrast, if the goal is to increase attacking difficulty, coaches could narrow the field dimensions, which will leave less time and space for decision making and actions. Applying this task constraint will demand a higher level of accuracy of the actions to be performed by the ball carrier in order to safely pass the ball to the support players. A fundamental 2 vs. 1 (two attackers against one defender) practice task is a good example where this constraint manipulation can be applied.

iii) Manipulate player starting-positions; this coaching strategy varies the amount of time attackers and defenders have to act (e.g., varying offside line or getting players to start deep or shallow).

iv) The number of players involved in a practice task (i.e., team mates as well as opponents) can be increased or decreased. As with the previous point, these task-constraints manipulations concern the space left available to be explored by the players. Once again, if the goal is to increase the difficulty for defenders, coaches can involve more attackers in the task; and if the goal is to increase attackers’ difficulty, then more defenders can be involved. A good example is the drift defence practice task, where the defenders are outnumbered by the attackers, which means that the defenders have to act collectively drifting and maintaining their relative positions. Keeping the defensive line intact will drive the attackers to the side lines, reducing the space and time left available to be explored by them.

Finally, the least accessible constraints on individuals for manipulation are environmental constraints. However, training in different weather conditions (in low or high temperatures), on wet or dry surfaces, at different altitudes, under artificial lights or with a ‘biased’ match officials or ‘hostile’ spectators in simulated matches, are examples of environmental constraints that can be manipulated during practice.

CONCLUSION
Decision-making skills of players can be best enhanced under practice task constraints that provide an accurate balance between variability and stability. Stability provides structure to the players’ performance; while variability allows them to deal with the uncertainty of situational-specific task demands, created by the specific opposition and performance conditions, for example. To achieve this balance between stability and variability, training sessions should be based on practice tasks with constraints that are being constantly manipulated by coaches. Forcing players to satisfy specific task constraints imposed on them directs them to explore the playing environment for unique solutions to the problems created by opponents and the positioning of their own team-mates. For this reason, these practice tasks should simulate very closely many different competitive situations that are likely to be faced, which implies constraining field dimensions, number of players involved and their starting positions, and the pace that each task has to be performed. This list is not exhaustive by any means and there are numerous other useful constraints to manipulate by coaches including the fatigue levels of players during sub-phase practice, the nature of playing equipment (e.g., in Rugby Union, ball size which is scaled to hand size in young children) and environmental constraints such as performing in front of an evaluative audience.
Through attending to the small details of practice performance, coaches can enhance the validity of their manipulations of practice task constraints resulting in effective learning and positive transfer of player actions to the performance environment. Finally, despite the stability imposed by their goals and roles, players should be provided with opportunities to exploit the ‘order for free’ that is available in many team ball games, since this experience will allow them to develop tactical understanding of benefit in competitive matches.

Table 1. A Nonlinear Pedagogical Methodology with Four Stages

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<th>Identifying the Problem</th>
<th>Setting out a Strategy</th>
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| Tactical problems      | The first step is: i) to detect action possibilities through off-field manipulations, such as video analysis and statistics; ii) to detect and anticipate action possibilities through cognitive strategies, such player review sessions, imagery and self-talking. | Provide stability to team’s collective actions through task constraints. Provide variability with ‘order for free’. The model should acquire equilibrium between stability and variability of players’ actions. | Constraints manipulation.  
  1. Individual constraints: On-field manipulation with feedback.  
  2. Task constraints: changing rules, changing field dimensions, changing the numbers of players to be involved.  
| Causes:                |                        |                          |                      |
| 1. Timing of decisions and actions. |                        |                          |                      |
| 2. Space left available. Space related to player movement trajectories (running lines) which help create the space to be penetrated. |                        |                          |                      |
| Guidelines:            | The second step is to create an action model: setting initial conditions, defining the desirable outcome, as well as the number of players involved and the role of each player. |                        |                      |
| 1. Analyze relative timing to see if space in the defensive line is being created or not. |                        |                          |                      |
| 2. Analyze how players use the space left available; if they are allowed or not to cross the gain line. How the players penetrate the space created. |                        |                          |                      |

REFERENCES


