Physical Therapy in Sport 15 (2014) 131–135

Contents lists available at ScienceDirect

Physical Therapy in Sport

journal homepage: www.elsevier.com/ptsp

Masterclass

A theoretical model to describe progressions and regressions for exercise rehabilitation

Sam Blanchard [a,*], Phil Glasgow [b]

[a] Brighton & Hove Albion Football Club, American Express Stadium, Village Way, Falmer, East Sussex BN1 9PL, United Kingdom
[b] Sports Institute of Northern Ireland, University of Ulster, Newtownabbey, Co. Antrim BT37 0QB, United Kingdom

A R T I C L E I N F O

Article history:
Received 21 October 2013
Received in revised form
8 May 2014
Accepted 9 May 2014

Keywords:
Physiotherapy
Clinical reasoning
Exercise prescription
Exercise progression

A B S T R A C T

This article aims to describe a new theoretical model to simplify and aid visualisation of the clinical reasoning process involved in progressing a single exercise. Exercise prescription is a core skill for physiotherapists but is an area that is lacking in theoretical models to assist clinicians when designing exercise programs to aid rehabilitation from injury. Historical models of periodization and motor learning theories lack any visual aids to assist clinicians.

The concept of the proposed model is that new stimuli can be added or exchanged with other stimuli, either intrinsic or extrinsic to the participant, in order to gradually progress an exercise whilst remaining safe and effective. The proposed model maintains the core skills of physiotherapists by assisting clinical reasoning skills, exercise prescription and goal setting. It is not limited to any one pathology or rehabilitation setting and can adapted by any level of skilled clinician.

1. Introduction

Exercise prescription forms part of the core skills of physiotherapy practice (Taylor, Dodd, Shields, & Bruder, 2007). Effective progression and regression of exercises can significantly enhance clinical outcomes for all patients whatever their level of function. Progression is described as "the act of moving forward or advancing towards a specific goal" (Kraemer & Ratamess, 2004). A number of key factors influence the decision to progress or regress an exercise; for example, the ability of the participant to cope with an exercise, the end goal or skill they are required to perform, the equipment available to the therapist and the working environment. This core skill is underpinned by sound clinical reasoning, which involves a combination of scientific and professional theory (Jones, Jensen, & Edwards, 2008).

Moore (2004) describes exercise prescription as more of an art than a science. Although considered a core skill, exercise prescription can be a challenging task for many therapists. When aiding learning in students or new graduates, the use of theoretical models can facilitate knowledge integration and influence clinical reasoning (Patel, Arocha, Chaudhari, Karlin, & Briedis, 2005). However, to date there are limited theoretical models or published literature to support the detailed thinking process required in exercise prescription and progression (Edwards, Jones, Carr, Braunack-Mayer, & Jensen, 2004). The decision of when to add an external stimulus, change the environment, increase resistance or reduce stability can be daunting for physiotherapists.

This can be particularly challenging when working in elite sport where; a physiotherapist may have access to an injured athlete for many hours a day, seven days a week. In this case it is important that an exercise program is varied and individual yet specific in order to ensure progress, confidence and avoid monotony. Applied clinical reasoning is therefore central to the effective design of any rehabilitation programme.

2. The use of theoretical models in exercise

The use of models in therapy and exercise rehabilitation is not new. Physiotherapists with an understanding of strength & conditioning will be familiar with periodization models that structure training plans into phases (microcycles, mesocycles and macrocycles) (Chad, 2010). Periodization models find their origins the General Adaptation Syndrome (GAS) described by Hans Seyle (1956), which highlighted the super compensation phase of physical adaptation in response to a stressor. If this stressor continues at the same level for an extended period of time, the body may enter a phase of maladaptation or exhaustion. Periodization models were

* Corresponding author. Tel.: +44 (0)7867 456 721; fax: +44 (0)1273 878 238.
E-mail address: sam.blanchard@bhafc.co.uk (S. Blanchard).

http://dx.doi.org/10.1016/j.ptsp.2014.05.001
1466-853X/

developed in order to effectively stimulate adaptation through the manipulation of a range of variables while avoiding any maladaptation (Gamble, 2006). The classical approach to periodization has been termed "linear", characterised by an increase in intensity which is matched by a decrease in volume throughout any given cycle (Wathen, Beachle, & Earle 2000). Periodization models have evolved into modern, "non-linear" programs that account for the variable nature of super compensations of metabolic, neural and motor functions, none of which occur in a linear fashion (Chad, 2010). These models can assist therapists and coaches with the planning of training loads and variations, but they fail to provide a clear foundation for progression or regression of stimuli to a given exercise.

Stimuli can be either external or internal. Gentile (1998) refers to two separate, but linked processes, explicit and implicit. An explicit process may be understood as the relationship between the performer (or in this case a patient), and the environment, for example a skier reacting to the condition and gradient of a slope. Whereas, implicit processes depend on internal feedback mechanisms within the patient, for example stimulus of Pancian and Ruffini receptors in capsuloligamentous structures during movement. Gentile (1998) challenges the therapist to create a learning environment to challenge these processes and perform prolonged practice necessary for implicit learning to occur.

The length of time required by an individual to master a task has been described as a linear function that begins quite rapidly with the introduction of a new task and then plateaus or slows over time as practice continues (Gentile, 1998). As already suggested, biological and neural responses to exercise do not behave in a truly linear fashion and as such a more nuanced approach to exercise progression is required.

A safe and effective rehabilitation plan should always be low-risk, high demand (Mendiguchia & Brughelli, 2011). Guadagnoli and Lee (2004) have proposed that effective motor learning depends on the provision of the optimal amount of information; too much or too little information can retard learning. This principle is highly applicable to exercise progression and is reflected in the model presented here. Progression of a given exercise will increase the amount of information available, however if this is too rapid, the patient's capacity to interpret the information will not have increased and will ultimately result in failure of the skill task. This is important in rehabilitation as this may pre-dispose to re-injury or indeed secondary injury.

Mendiguchia and Brughelli (2011) presented an algorithm to develop functional abilities of an athlete while minimizing risk of injury. The algorithm was designed specifically for hamstring injuries returning to sport. The authors clinically reason the management of hamstring injuries from acute insult through to return to sport, advocating the benefits of early movement, amongst other interventions, at a time that preceded the "POLICE guidelines" by Bleakley, Glasgow, and Macauley (2012), which encourage optimal loading of injured structures as opposed to complete rest. A criticism of the Mendiguchia and Brughelli (2011) algorithm is the requirement from the reader to memorise the sequence, with the absence of any visual representation.

Similarly, Ebert and Edwards (2013) proposed a progressive rehabilitation algorithm for patients following Autologous Chondrocyte Implantation (ACI) in the knee. Whilst remaining mindful of an individual approach to rehabilitation, the program is structured and specifically aimed towards the rehabilitation of a unique operation and therefore applicable only to a certain population. Both Mendiguchia and Brughelli (2011) and Ebert and Edwards (2013) papers are recent examples of systematic progressions in sports medicine. Unlike historical examples, the model presented in this paper can be applied to any injury at any stage, offering the therapist a guideline for progression.

3. A proposed new model for exercise

The model presented here aims to simplify the reasoning process behind the prescription of exercises and may be applied to any given exercise within any setting, not exclusive to the rehabilitation setting.

4. Outline

The model illustrated in Fig. 1 aims to help clinicians visualise the gradual progressions of any one given exercise and to clinically reason the progressions within that exercise.

An important element of physiotherapy treatment is effective goal setting (Baker, Marshak, Rice, & Zimmerman, 2001). The goals of rehabilitation should be established from the outset of the programme and should involve the patient, coach (if applicable) and physiotherapist. The primary goal could be an individual skill or a set of skills. In the illustrated model, the first block (1), is the most controlled level of a given exercise. The patient controls the exercise by regulating movement using intrinsic factors such as proprioceptive feedback via mechanoreceptors and adapting motor patterns. The therapist's job at this stage is to ensure the patient has nothing else to concentrate on other than these intrinsic elements. The exercise is controlled externally by the therapist by monitoring these motor patterns and providing the necessary feedback on technique and limiting as many variables as possible. This is the one element of an exercise that will remain consistent throughout the progression or regression process.

The horizontal axis represents time and the vertical axis the level of difficulty of the exercise. The starting exercise (1) may be progressed by manipulating a number of variables, including (although not exclusively): Duration, Speed, Distance, Repetitions; the exact number of variables is dependent on the specific exercise and the goals of rehabilitation. As stated, during block (1) of the rehabilitation process, the focus of the exercise remains intrinsic, where the patient remains focused on the task or movement required without having to think about any external factors. Throughout stage (1), the linear progression can be extended by the clinician to reflect the predetermined goals (i.e. The distance of running, this can start as a short distance and increase under the therapist's guidance).

The next stage of progression may be to add an extrinsic component to the exercise (2) such as a change in stimulus or the environment in which the exercise is performed. Guadagnoli and

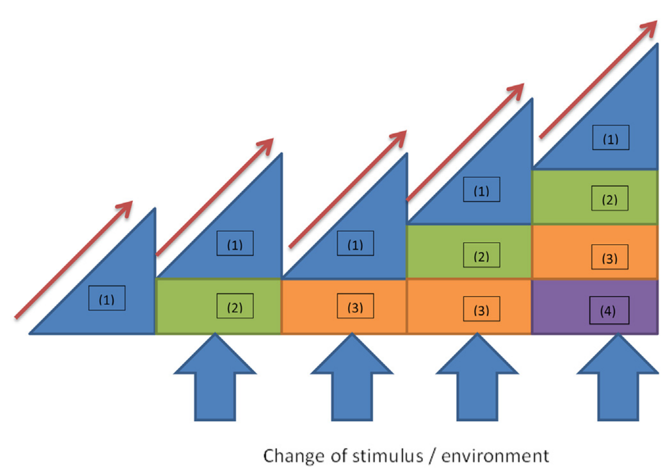

Fig. 1. A theoretical model for exercise progression as a continuum.

Lee (2004) state that the conditions of practice, such as surface type and weather, will contribute to the functional difficulty of a task. As such, environmental constraints should be considered as an important part of a progressive program. The initial component of the exercise (1) remains the same, but with the addition of this second component (2), it is possible to visualise a minor regression in the linear axis on the model. This may involve a reduction in the duration, speed, distance, repetitions to a level that allows for adaptation to the new stimulus. This is then progressed again with time as determined by the therapist. It is this visual "step" in the model that suggests exercise prescription is not a truly linear progression. The therapist understands that decreasing the repetitions or the speed for block (1) is not a regression of the overall goal, but instead ensures that the addition of a new stimulus does not overload the patient with too many components too soon and that correct execution of the skill task is maintained. This is also important to adequately protect the healing structures.

The concept presented in this model is that the introduction of new stimuli, and therefore new progressions, can be interchanged with one another without causing a dramatic progression in the difficulty of the overall exercise. As illustrated in Fig. 1 above, one stimulus (2) can be removed and replaced with a different stimulus (3), before being combined at a later stage, thereby adding to the overall progression with time. With each progression, this model facilitates consideration of the role of alternative variables that may need to be regressed.

The number of added stimuli is dependent on the exercise and the goals of rehabilitation defined from the outset. Therefore, in theory, the number of stages along the horizontal axis and number of progressions along the vertical axis are virtually unlimited and are at the discretion of the clinician.

Example. *An injured football player, approaching mid-stage rehabilitation of a lower limb injury.*

It is assumed that the player has already progressed to a stage where is he fit and able to run. Applying the model to one exercise, where (1) is running. For the player, this is an intrinsic component, where the only component to focus on is the technique involved in running:

The linear progression of this exercise could be the speed at which the player runs. The therapist's job at this stage is to assess appropriate movement patterns and technique, ensuring there are no compensatory strategies. The therapist must also ensure the absence of pain, both during and after the exercise. After a determined amount of time (this may be days or may be during the session), the addition of an external stimulus to this exercise could be running with a football (2). With the addition of the external stimulus, the player now has to concentrate on something outside of their running technique; it is important to regress the speed of running so that the player does not start running at full pace straight away with a ball, but instead builds up this speed with guidance from the therapist within an appropriate time frame.

In a sport such as football, it is important for the player to change direction, so the next progression could be a change of direction. However you may not want to do this for the first time with an external stimulus such as a ball, so block (3) is added and block (2) is removed. Once both skills have been mastered and progressed linearly, the two blocks (2) & (3) can be combined, as seen in tier 3.

The final progression could be to run, with the ball, change direction and pass the ball 5 m (4). In this example, it may be reasoned that you can safely add the progression of (4) without removing (2) & (3), as a short range passing drill may have been completed prior to the player being able to run. The number of external stimuli blocks that could be added to this model may continue beyond what is shown in Fig. 1, as the therapist may add plyometric components, elements of competition, other players and so on in order to progress the exercise to meet a sport specific goal.

5. Complex scenarios

Fig. 1 demonstrates a very simple, straight forward progression of an exercise or set of exercises. The ability of the therapist to add or remove the "blocks" from the proposed model ensures flexibility for more complex situations. As stated, the length of the horizontal axis is unlimited, allowing the model to fit within a larger meso or macro cycle if required. Fig. 2 demonstrates a slightly more complex model, with undulating tiers along the horizontal axis. The examples of exercises and progressions have been labelled; the task presented is hopping. If a participant can safely hop demonstrating suitable landing mechanics (tier 1) with propulsion (tier 2) and clear an obstacle (tier 3), it should not be assumed that the participant can cope with the addition of a perturbation during this more complex movement. For this reason we see a regression at tier 4 (introduction of perturbation) by removing the propulsion and hurdle elements (tier 2 and 3). This progression can be transferred to many contact sports, such as jumping for a corner in football or a line-out in rugby.

5.1. Manipulation of environmental variables

The environment structure of a rehabilitation program is an important responsibility for a therapist (Gentile, 1998). If we assume that Fig. 2 was completed indoors therefore limiting external factors such as weather and surface conditions, Fig. 2 can then be extended along the horizontal axis by moving the exercise outside onto pitch or a track. The new external stimuli created by weather or surface conditions may mean that the therapist wishes to regress the model back to its first tier of just "Hopping". This would be added at the end of the 6 tiers of Fig. 2 to create a new 7th tier, with

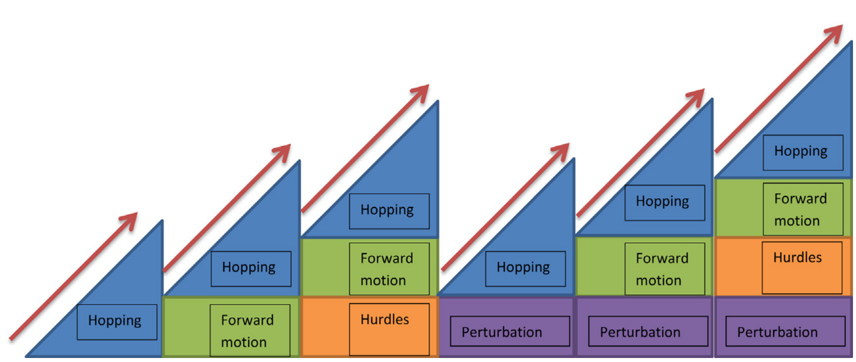

Fig. 2. An example of a more complex progressive model with undulating tiers.

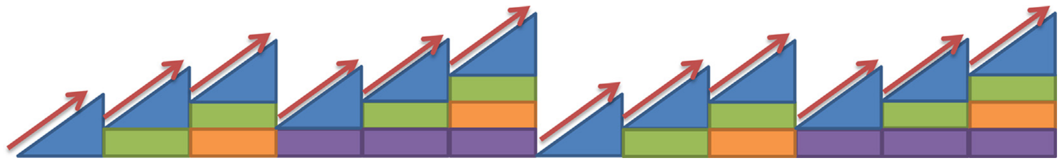

Fig. 3. An extension of Fig. 2 assuming that the exercise moves from a stable, indoor environment to an unstable outdoor environment.

a similar progression throughout the 8th, 9th 10th tier and so on, building along the horizontal axis (Fig. 3).

The above example demonstrates how this model fits into a larger periodized program and facilitates visualisation of how one singular exercise, such as hopping can be progressed to another singular exercise, such as running, which then starts its own model of progressions.

Other aspects to the model involve knowledge of healing times and physiological adaptations. The therapist could use SMART (Specific, Measurable, Achievable, Realistic, Time frame) (Barclay, 2002) goals within each tier. We know that the time for neurological adaptation or neuromuscular co-ordination is of shorter duration, up to 6 weeks, than the time it takes for an increase in stiffness of a tendon, up to 14 weeks (Folland & Williams, 2007). The early stages of a program may dedicate more time to allow for healing rates of physiological adaptation, whereas late stages of a program that focus more on kinetic chain movement patterns may present as shorter time frames. This will effectively change the width of one tier compared to another.

6. Using the model as part of a “return to sport” program

For many team sports where a season can exceed 35 weeks, achieving a varied training program can represent a sizable challenge (Gamble, 2006). The same challenge can be said for therapists who are expected to return injured athletes to training mid-season. It is important for a therapist working as part of a larger team with access to sports science or strength & conditioning to consider how this model fits with a return to sport. If the athlete is close to returning to a team training program, it may be that the non-linear relationship needs to match the conditioning program of the squad. This in turn creates new challenges in order to maintain different neuromuscular and metabolic training goals (Gamble, 2006), ensuring the athlete is not only recovered from the isolated injury, but also has an overall level fitness that allows them to train without risk of a secondary injury.

Before any athlete is returned to their training, be it individual or team, the mechanism of the original injury should be reproduced in a controlled environment. Laskowski, Newcomer-Aney, and Smith (1997) state that rehabilitation is incomplete without individual sport and position specific drills completed pain free and without loss of function. If it is a contact sport, a block should be added to the final tier to include a contact element before exposing the player to uncontrolled contact in a competitive environment. This final tier should be sport and patient (player) specific. The tier should replicate the demands of the sport and position that individual is expected to undertake, including all the equipment, movement patterns and level of fatigue required for that player to compete and train safely.

7. Summary

The spectrum of clinical, environmental and contextual challenges posed to physiotherapists is highly variable; however the core principles of physiotherapy remain constant. The model presented in this paper provides therapists working in any clinical setting with a tool to assist safe and logical clinical reasoning while allowing flexibility between stages. Every physiotherapist will have a different set of exercises that they favour to achieve the same outcome, this model allows for personal experience and preference yet maintain the focus on clinical outcome. The model is not restricted to any one injury or post-op procedure but instead can be used in any rehabilitation design.

The theory of applying this model is not new, many physiotherapists will use a similar approach subconsciously, however the visual aid provided by adding and removing individual blocks or subcomponent of a skill to build a step-by-step progression will aid therapists in effective exercise prescription.

The model may also be beneficial as a teaching aid for students or new graduates and demonstrates the importance of patience in rehabilitation, where it is acceptable to regress elements of exercise prescription in order to progress towards a predetermined outcome.

Exercise prescription and clinical reasoning are two of the core skills that make physiotherapy such a challenging and exciting job. The model presented here may help to provide a more nuanced picture of both the art and skill of what physiotherapists do.

Conflict of interest

None declared.

Ethical approval

None declared.

Funding

None declared.

References

Baker, S., Marshak, H., Rice, G., & Zimmerman, G. (2001). Patient participation in physical therapy goal setting. *Physical Therapy, 81*(5), 1118–1126.

Barclay, L. (2002). Exploring the factors that influence the goal setting process for occupational therapy intervention with an individual with spinal chord injury. *Australian Occupational Therapy Journal, 49*(1), 3–13.

Bleakley, C., Glasgow, P., & Macauley, D. (2012). PRICE needs updating, should we call the POLICE? *British Journal of Sports Medicine, 46*(4), 220–221.

Chad, N. (2010). An approach to the periodization of training during the in season for team sports. *UK Strength & Conditioning Association, 18*(10), 5–10.

Ebert, J., & Edwards, P. (2013). The evolution of progressive, post-operative weight bearing following autologous chrondrocyte implantation in the tibiofemoral joint. *Journal of Sport Rehabilitation* (in press).

Edwards, I., Jones, M., Carr, J., Braunack-Mayer, A., & Jensen, G. (2004). Clinical reasoning strategies in physical therapy. *Physical Therapy, 84*(4), 312–322.

Folland, J., & Williams, A. (2007). The adaptations to strength training: morphological and neurological contributions to increased strength. *Sports Medicine, 37*(2), 145–168.

Gamble, P. (2006). Periodization of training for team sports athletes. *Strength and Conditioning Journal, 28*(5), 56–66.

Gentile, A. M. (1998). Implicit and explicit processes during acquisition of functional skills. *Scandinavian Journal of Occupational Therapy, 5*(1), 7–16.

Guadagnoli, M., & Lee, T. (2004). Challenge point: a framework for conceptualizing the effects of various practice conditions in motor learning. *Journal of Motor Behaviour, 36*(2), 212–224.

Jones, M., Jensen, G., & Edwards, I. (2008). Clinical reasoning in physiotherapy. In J. Higgs, M. Jones, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (pp. 245–254). London: Elsevier.

Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of resistance training: progression and exercise prescription. *Medicine & Science in Sports & Exercise, 36*(4), 674–688.
Laskowski, E., Newcomer-Aney, K., & Smith, J. (1997). Refining rehabilitation with proprioceptive training: expediting return to play. *The Physician and Sports Medicine, 25*(10).
Mendiguchia, J., & Brughelli, M. (2011). A return-to-sport algorithm for acute hamstring injuries. *Physical Therapy in Sport, 12*(1), 2–14.
Moore, G. (2004). The role of exercise prescription in chronic disease. *British Journal of Sports Medicine, 38*, 6–7.
Patel, V. L., Arocha, J. F., Chaudhari, S., Karlin, D. R., & Briedis, D. J. (2005). Knowledge integration and reasoning as a function of instruction in a hybrid medical curriculum. *Journal of Dental Education, 69*(11), 1186–1211.
Seyle, H. (1956). *The stress of life*. New York: McGraw-Hill.
Taylor, N., Dodd, K., Shields, N., & Bruder, A. (2007). therapeutic exercise in physiotherapy practice is beneficial: a summary of systematic reviews 2002–2005. *Australian Journal of Physiotherapy, 53*(1), 7–16.
Wathen, D., Baechle, T. R., & Earle, R. W. (2000). Training variation: periodization. In Baechle, & Earle (Eds.), *Essentials of strength training & conditioning* (2nd ed.) (pp. 513–527). Champaign, IL: Human Kinetics.