CONSTRAINTS-LED APPROACH TO COACHING THE POWER CLEAN

Wesley Verhoeff[1], Sarah-Kate Millar[2] and Tony Oldam[2]

[1]Unitec Institute of Technology, Auckland, New Zealand
[2]Sport Performance Research Institute New Zealand (SPRINZ), Auckland University of Technology, Auckland, New Zealand

The purpose of this study was to apply a constraints-led approach to the acquisition of the power clean. Strength and conditioning coaches need to coach complex motor skills, where the common method involves explicit instruction and task decomposition. However, contemporary skill acquisition theory is in conflict with this explicit and reductionist approach. Through three case studies the examination of individualised task constraints were used to allow a self-organization process to skill development to take place. The constraints employed for the all three case studies achieved movement change in the predicted direction. In two of the three cases, the movement changes resulted in performance improvements measured through 1RM. In conclusion, the constraints-led approach was an effective method for changing movement behaviour in the context of strength and conditioning.

KEYWORDS: Weight lifting, Learning, Skill Acquisition, Coach, Movement

INTRODUCTION: Every strength and conditioning (S & C) coach needs to facilitate movement change either for enhanced sport performance or injury prevention. Being technically aware and able to change movement is critical because movements or exercises that are not performed correctly may result in undesired stress to the body that has the potential to cause injury. A traditional strength and conditioning method to change movement involves the coach using an explicit instructional approach (Dorgo, 2009). This approach, as reported by Rucci and Tomporowski (2010), is one where verbal instructions and feedback are administered to athletes about the performance of a given skill in line with goals specified by the coach. Contemporary evidence has challenged the role of instruction as the best practice route for developing complex movements; as an explicit approach is considered to be an ineffective method for movement change, particularly when considering competitive performance demands (Masters and Poolton, 2012). The negative effects of an explicit approach have been reported to be decreased skill performance under pressure and higher skill deterioration under physiological stress (Lew, Richard, and Graham, 1996). A traditional strength coaching viewpoint reduces the athlete down to their parts to logically train these individual parts. With the assumption that these parts will reassemble logically back to the whole performance, however, nowadays we draw insight from dynamical systems theory, an alternative way of viewing sports training which is emerging (Davids, Button, and Bennett, 2008). A dynamical systems view looks to understand the whole system rather than reducing it down to its parts, and potentially lose sight of the whole system and how the parts of the system interact. In contemporary coaching literature, learning is seen as a non-linear process and needs a matching non-linear pedagogy (Renshaw, Davids, Shuttleworth, and Chow 2009). An example of contemporary non-linear pedagogy is a constraints-led approach which changes the constraints that affect movement. Constraints are categorized as either individual, task or environmental.

METHODS: Three case studied analysed individual participants progress with the acquisition of the skill utilising a constraints-led approach. Each participant needed to demonstrate a minimum score of 14 out of 21 points on the Functional Movement Screen (FMS) and report no body pain. Each participant performed a repetition maximum power clean and this was video analyzed for kinematic data and errors. From this analysis, individualized errors were identified and constraints where assigned to each case. There constraints were: Case study one excessive hipping/ looping of the bar away from the body. The assigned constraint was agility poles in front of the bar (see Fig 1). Case study two error was a straight bar path not having a rearward direction off the floor towards the hip. The constraint assigned was chalk on the bar were the participant needed to leave chalk on their thighs. Case study three error was jumping forward. The constraint assignment was an 8-cm cliff in front of the participant.

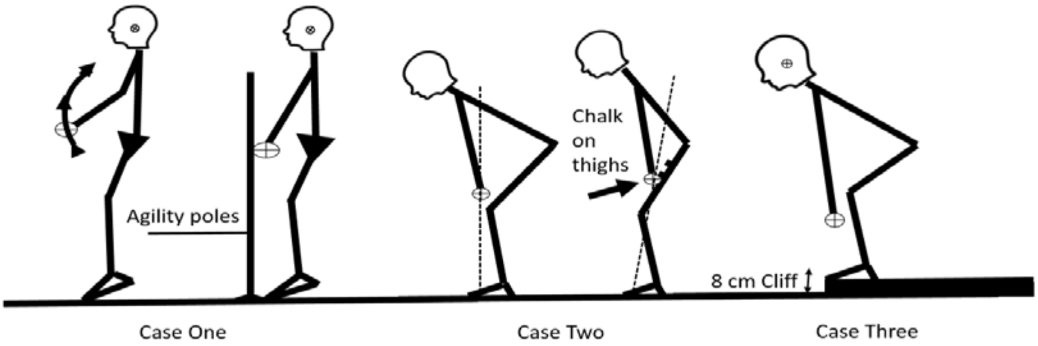

Figure 1: Participants assigned task constraints.

Sessions 2-11 where coaching sessions and participants performed a standardized warm-up. Training sessions and load was adapted from Winchester, Erickson, Blaak and McBride (2005) where the two sessions per week were split into a heavy day and a moderate day. On the heavy session, the participants gradually worked up in weight across a standardised 6 set warmup to 3 sets of 1 repetition at 90% of their 1RM. The task constraint was applied through all warm up sets then removed on training sets to avoid developing a dependency on the task constraint. On the moderate sessions participants again gradually worked up in weight across a standardised 6 set warmup to 4 sets of 3 repetitions at 70% of 1RM. The task constraint was present during 70% sets and gradually removed to avoid the development of dependency. Session 12 was post testing one repetition maximum with video analysis of the heaviest lifts.
RESULTS: Due to the individualised nature of the constraint assignment. An analysis was developed for each individual case study to assess the effectiveness of the constraint on the desired outcome. Barbell variables were adapted from Winchester et al., (2005) for each of the constraints. Root mean squared error (RMSE) was used to determine the amount of within-session variability. Giving an indication of if the new movement pattern had been learnt or was still being explored. Following a phenomenological approach and thus adopting an intra-individual analysis, the results of the three case studies will be presented individually. A summary table of the three case studies is presented in table 1, and presents whether the constraints applied had a positive or negative effect on the outcome measures used to evaluate the effectiveness of a constraints-led method.

Table 1: Overall results on outcome measures

Case	Intended movement change	Performance (1RM)	RMSE (return to baseline)
Case 1	✓	✓	✓
Case 2	✓	✓	X
Case 3	✓	x*	✓

*anecdotal performance improvement 2 weeks following

In Table 1, it can be seen that for each case study, the intended movement change was achieved. In addition, cases 1 and 2 had a performance increase in 1RM from pre-to post-test, with case 3 having a performance increase following this period.
Case study one: Displayed a significant change in the positive direction in horizontal barbell displacement away from the body. Changing from 16.9 cm pre-testing to 5.61 cm post testing. This result was in accordance with the expected change in technique where the bar now travels closer to the participant. There was a gradual change in this measurement until the 4th training session then a flattening off as seen in the graph in table 2 below. In addition, the RMSE post application of constraint of 2.32 cm to 1.24 cm shows a progression from more variability in this measure to more stability. This indicates the new movement behaviour was becoming more engrained.

Table 2: Case study one horizontal barbell displacement away from the body

Session		Pre	1	2	3	4	5	6	7	8	9	10	Post
	90%	16.89		11.9		6.34		3.24		6.13		5.06	5.61
DxF	70%		11.8		7.63		4.27*		9.57		7.77		
	RMSE		2.32	3.33	2.31	3.02	1.48	0.91	2.67	0.98	2.59	1.24	

*Constraint present

Case study two: The change in the rearward direction of the bar off the floor measured through horizontal displacement toward the body is evident in figure 2 where there was a change from 0.82~ cm pre-testing to 7.14~cm post-testing. This change was expected with the chalk constraint where the participant brought the bar closer to their body off the floor.

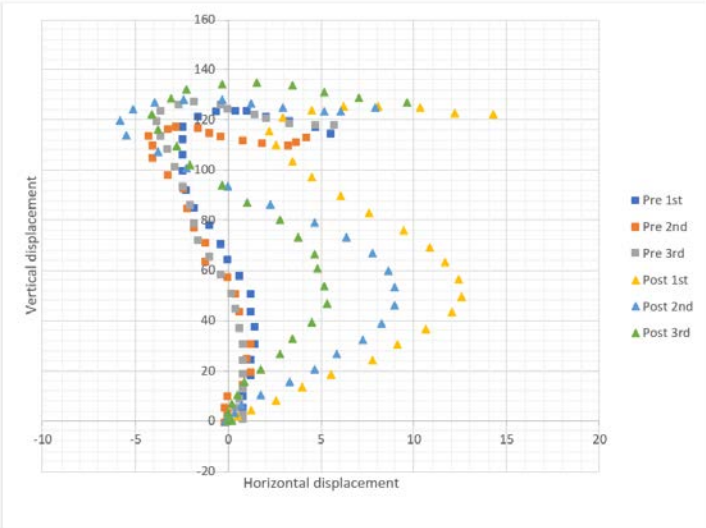

Figure 2: Case study two, changes in horizontal bar displacement

Case study three: The result of the cliff constraint on participant 3's jump forward was an improvement in the left foot from jumping forward -3.29 cm~ to jumping backwards 0.52 cm~ (Fig 3). This gave a combined difference of 3.81 cm from pre-to post testing. There was less variability in jump distances moving from pre-1.93 cm RMSE to 0.9 cm RMSE.

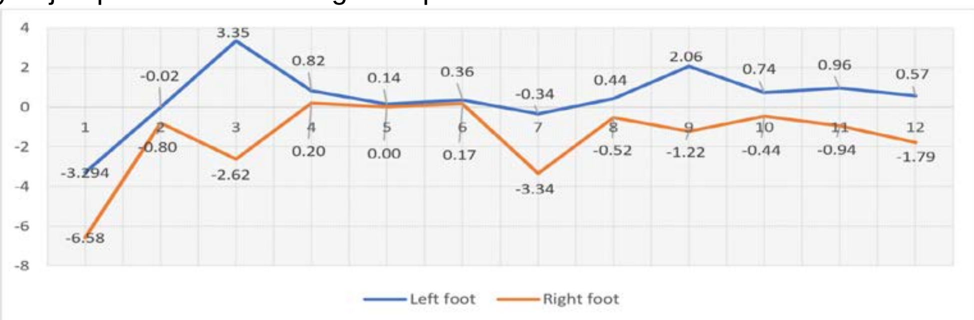

Figure 3: Changes in left and right foot jump distances

DISCUSSION: Case one; the effect of the poles at constraining task space for the bar in order to bring the path closer to the body. The participant changed how far the barbell travelled away from their body during the lift from ~17 cm to ~6 cm. The task constraint of the poles allowed a new movement to emerge where the bar position was closer to the body. The participant showed a shift from a stable movement, through a period of instability and back to a new stable movement again. As described by Newell (2003) skill learning involves ebbs and flows of stability and instability to task demands. This was seen through the root mean squared trending downward for all lifts from 2.32 cm to 1.24 cm in the horizontal barbell direction. These changes in movement resulted in a 15.4% improvement in the power clean performance from 97.5 kg to 112.5 kg. **Case two;** the chalk constraint had a result of changing the bar path to a more rearward direction off the floor and changed the bar to make contact with the upper thigh of the participant. The bar making contact was evident in the results of the most rearward position of the bar from the floor to maximum hip extension changes from 0.82 cm to 7.14 cm. Additionally changes in the deflection point of rearward to forward horizontal bar path from 36.92 cm to 50.17 cm showed where the bar now made contact with the thigh. These results showed the constraint was successful at changing the technique to that described in the research from Winchester, Erickson, Blaak and McBride (2005) where the bar should brush the thigh. Post constraint implementation an increase in the variability was seen by the pre-post testing root mean squared 0.29 cm to 1.81 cm post result. This higher variability showed the stability of the new movement behaviour was still not as stable as the original. This constraint resulted in a performance improvement of 2.5 kg on their power clean. Anecdotally again at the following week post intervention the participant recorded another 2.5 kg increase. The question is then raised; was the intervention long enough considering the degree of variability in their movement still present? **Case three;** the result of the cliff constraint on participant 3 was a change in direction of their jump by ~4 cm on both legs. There was a change in the left from jumping -3.29 cm to jumping backwards 0.52 cm. The overall change on the right foot was greater than the left. However, their foot still moved forward changing from -6.58 cm to -1.79 cm. There was evidence of success of the cliff avoidance reflex (Kretch, and Adolph, 2003) from the constraint used. The result of the stimulus of the cliff on the visual system was evident through the participants more rearward head position after full extension. Indicative of a more rearward pull on the bar the participant changed from 25.17 cm to 31.45 cm. However, the pre-testing result had more variability seen through the RMSE of 4.33 cm whereas the post-test 1.92 cm was indicative of a more stable movement pattern. While this resulted in no performance increase during the testing session anecdotally this participant recorded a 5-kg improvement two weeks post intervention.

CONCLUSION: This study showed how not using any verbal instructions and only a constraints-led approach, and especially the use of task constraints, can be used to reshape movement behaviour. Adapting task constraints encourages performers to explore unique, varied movement solutions in pursuit of good technique. However, the approach leaves performers to do more learning on their own. Coaches coming from a traditional approach could find this shift of method challenging, as providing feedback on every single attempt is common practice. Not giving feedback on every attempt of a movement trades improved short-term performance for better long-term skill earning (Davids, et al., 2003). A constraints-led approach is not based on instant, often verbal feedback, and may take more time. The result can be of greater benefit to the performer. Given the potential benefits associated with using this approach, it seems important that the strength and conditioning coaches investigate this approach to potentially better their practice.

REFERENCES:

Davids, K., Button, C., & Bennett, S. (2008). *Dynamics of skill acquisition: a constraints-led approach*. Champaign, IL: Human Kinetics.

Dorgo, S. (2009). Unfolding the Practical Knowledge of an Expert Strength and Conditioning Coach. *International Journal of Sports Science & Coaching, 4,* 17-30.

Kretch, K.S. & Adolph, K.E. (2013). Cliff or Step? Posture-Specific Learning at the Edge of a Drop-Off. *Child Development*, *84,* 226-240.

Lew, H., Richard, M. & Graham, J. (1996). Knowledge and conscious control of motor actions under stress. *The British Psychological Society, 87,* 621-636.

Masters, R.S.W. & Poolton, J.M. (2012). Advances in implicit motor learning, in: *Skill Acquisition in Sport Research, Theroy and Practice*. N Hodges, J., A Williams, M., eds. New York: Routledge.

Newell, K. M. (2003). Change in Motor Learning: A Coordination and Control Perspective. *Motriz, 9*(1), 1-6.

Renshaw, I., Davids, K., Shuttleworth, R., & Chow, J. (2009). Insights from Ecological Psychology and Dynamical Systems. Theory Can Underpin a Philosophy of Coaching. *International Journal of Sport Psychology, 40*(4), 580-602.

Rucci, J.A. & Tomporowski, P.D (2010). Three types of kinematic feedback and the executionof the Hang Power Clean. *Journal of Strength and Conditioning Research, 24*, 771-778.

Winchester, J.B., Erickson, T.M., Blaak, J.B, & McBride, J.M. (2005). Changes in Bar-Path Kinematics and Kinetics After Power-Clean Training *Journal of Strength and Conditioning Research, 19,* 177-183.