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Comparison of Two Training Programs on Acceleration Out of the Break in American Football

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COMPARISON OF TWO TRAINING PROGRAMS ON ACCELERATION

OUT OF THE BREAK IN AMERICAN FOOTBALL

by

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GRADUATE COMMITTEE APPROVAL

of a thesis submitted by

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This thesis has been read by each member of the following graduate committee and by majority vote has been found to be satisfactory.

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As chair of the candidate's graduate committee, I have read the thesis of Micah A. Alba in its final form and have found that (1) its format, citations, and bibliographical style are consistent and acceptable and fulfill university and department style requirements; (2) its illustrative materials including figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the university library.

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ABSTRACT

COMPARISON OF TWO TRAINING PROGRAMS ON ACCELERATION OUT OF THE BREAK IN AMERICAN FOOTBALL

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Master of Science

Athletes of American football need the ability to stop, start, and reach top speed in an efficient manner. Football players on the defensive side of the ball require the skill of stopping a backward run and accelerating to a forward run. This action is termed the break. Football players receive year-round training in an effort to improve performance. Yet, many times, these athletes may not focus specifically on the muscular systems that are unique to the position they play. The law of specificity states that the more specific the training is for the action required, the more beneficial the outcome. This study utilized seventeen defensive players of a Division IA football team and compared the effect of two training programs on acceleration during the break. The first program was a standard conditioning program (SCP) for football players. The second program was the SCP combined with three ballistic-plyometric drills (BPD) designed to improve the acceleration of the break. The groups were pre tested and divided into either the SCP or the BPD using a matched pair ABBA procedure by position, from fastest to slowest.

After six weeks the BPD group significantly improved their acceleration during a break. The BPD group made a 24.9% ($p<0.05$) improvement from 11.14 ± 0.43 m•sec^2 to 13.78 ± 0.44 m•sec^2. While the SCP group pre tested at 11.9 ± 0.41 m•sec^2 and post tested at 12.42 ± 0.34 m•sec^2 showing no statistically significant improvement. The BPD group significantly improved their ability to accelerate during the break compared to the SCP group.

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Comparison of Two Training Programs on Acceleration out of the Break in American Football

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ABSTRACT

Athletes of American football need the ability to stop, start, and reach top speed in an efficient manner. Football players on the defensive side of the ball require the skill of stopping a backward run and accelerating to a forward run. This action is termed the break. Football players receive year-round training in an effort to improve performance. Yet, many times, these athletes may not focus specifically on the muscular systems that are unique to the position they play. The law of specificity states that the more specific the training is for the action required, the more beneficial the outcome. This study utilized seventeen defensive players of a Division IA football team and compared the effect of two training programs on acceleration during the break. The first program was a standard conditioning program (SCP) for football players. The second program was the SCP combined with three ballistic-plyometric drills (BPD) designed to improve the acceleration of the break. The groups were pre tested and divided into either the SCP or the BPD using a matched pair ABBA procedure by position, from fastest to slowest. After six-weeks of training, the BPD group made a 24.9% ($p<0.05$) improvement in acceleration from 11.14 ± 0.43 m•sec^2 to 13.78 ± 0.44 m•sec^2. While the SCP group pre tested at 11.9 ± 0.41 m•sec^2 and post tested at 12.42 ± 0.34 m•sec^2 for a 6.3% change that was not statistically significant. We conclude that the addition of three specific ballistic-plyometric drills to a SCP will improve acceleration out of a break in American football players.

Key Words: agility, backpedaling, football, strength training

INTRODUCTION

Agility is acknowledged as an important attribute for defensive players in American Football. Agility may be defined as the ability of an athlete to react to a stimulus, start quickly and efficiently, move in the correct direction, and be ready to stop quickly to make a play in a fast, efficient, and repeatable manner [3]. Acceleration, the rate of change in velocity, and agility are distinct qualities [6]. For defensive backs and linebackers the transition from back peddling to a forward acceleration, known as the break, is an excellent example of a movement requiring agility and acceleration. The break can be broken down into two major movements involving the plant leg and the drive leg. The plant leg represents the leg that is used to stop backward momentum following a rapid back peddling maneuver. Once a defender decides to come out of backpedaling, the plant leg externally rotates, abducts, extends, and is driven into the ground to stop their backward momentum. With the plant leg firmly on the ground, defenders must now use their drive leg to shift their momentum in the forward direction. The motion of the drive leg is flexion at the hip. The drive leg movement consists of hip flexion followed by a short six- inch step, driving the leg up and down as quickly as possible, in the direction of the break.

Speed of movement can be improved through participation in a standard resistance training program [1, 10]. Improved speed is known to contribute to improved agility [11]. Increased strength associated with resistance training programs is attributed to adaptations such as muscle hypertrophy and changes in the neuromuscular systems which may affect motor control [4, 7, 9]. Strength gains associated with neuromuscular adaptations usually occur in the first 4 weeks of the training program before any significant muscle hypertrophy occurs. The inclusion of plyometrics in a strength training program increases agility and top running speeds [2, 8, 12]. The review of the literature showed no ballistic-plyometric effect on acceleration during the break. The purpose of this study was to examine the effects of two training programs on acceleration during the break of Division IA football players.

METHODS

Experimental Approach to the Problem

The break of a defender is a task that involves coordination of many different joints and muscles. Currently defensive players at Brigham Young University are trained in many areas of agility. The ballistic-plyometric drills were designed to target the specific systems that are utilized during a break.

Plyometrics, rapid storage and release of strained energy, mimic many of the skills required to accelerate during the break. The defensive back and linebacker positions are extremely hard to play. During any given play these athletes must break several times. The numerous breaks of football players do not allow them to reach top speeds. Thus, acceleration becomes a more valuable skill than top speed. As football players master accelerating during the break, they have the opportunity of being more productive on the field. While the defensive back position is one of great importance, not many studies have been conducted to find out specific ways to improve the break. The faster the defenders get in and out of their break, the more opportunities they will have to make a play.

Subjects

Seventeen members of the Brigham Young University (BYU) NCAA Division IA football team were recruited to participate in this study. All subjects received a clear explanation of their participation in this study and provided informed consent. All testing and training procedures were approved by the BYU Institutional Review Board. All testing and training were performed at the BYU athletic facilities between May and July of 2008.

Procedure

Training Programs

The standard conditioning program (SCP) consisted of weight training (Figure 1) and speed and endurance training (Figure 2) four times a week. While the exercises may have differed from week to week the examples given represent the SCP that the football players completed during the six-week period. The normal week routine consisted of weight training the major muscle groups of the upper body along with speed and agility training on Mondays and Thursdays. On Tuesdays and Fridays the SCP focused the weight training on the major muscle groups of the lower body with an emphasis on speed endurance. Major muscle groups were conditioned with exercises such as the bench press, hang clean, and squat. Accessory lifts were also alternated as shown in Figure 1. The SCP included both plyometrics and agility drills performed by all players regardless of the position they played.

The second program involved the standard conditioning program combined with three ballistic-plyometric agility drills (BPD). The BPD exercises were designed to mimic different aspects of the break that require a rapid storage and release of strained energy. It is important to note both groups performed plyometric and agility drills, but the BPD group combined these three specialized drills, for acceleration during the break, to the standard conditioning program. The ballistic-plyometric training consisted of linear periodized training program with two work-outs per week for six-weeks. The training began with low repetitions and increased progressively over time (Table 1). In addition, once the subject could perform all the repetitions without feeling fatigued, a weighted vest was added. Players were asked to perform all BPD drills at a high intensity.

The first BPD involved the plant leg and consisted of box jumping (Figure 3). Two boxes, with the inner face cut at a 45 degree angle, are placed three feet apart. Subjects performed three sets of eight repetitions of leg drives in which they use one leg to explode between one box and the other in a skating fashion. The rapid, nature of this drill is intended to strengthen and train the muscle systems of the drive leg.

The second BPD involved the plant foot (Figure 4) and consisted of the subject assuming a proper defender stance and then jumping backward at a high velocity while slightly rotating the foot. This movement simulates the plant leg portion of the break and all repetitions were performed on command.

The third BPD involved a power-step (Figure 5) and was designed to strengthen the first step of both the plant and drive leg. First the subjects had a bungee cord attached to their plant leg at the ankle. In the defensive stance they quickly move their plant leg backward to the position it would be during the break. Subjects performed three sets of 10 repetitions at a high velocity for each leg. Next, the subject assumed the position during the break as if they had already planted their foot. In this position, with the bungee on the drive leg, they took a six inch step forward. Again, subjects performed three sets of 10 repetitions at a high velocity for each leg. The load against which these high velocity steps were taken was determined by the length of the bungee cord. The plant leg power-step was performed with the bungee cord stretched 5.18 meters from its attachment site. As subjects gained strength the distance from the wall was increased to 5.79 meters. The initial step of the drive leg was performed with the bungee cord stretched 5.48 meters from its attachment site. As subjects gained strength, the distance from the wall was increased to 6.09 meters. During the six-week period the subjects progressed from three sets of ten repetitions to three sets of twenty repetitions.

Testing

Subjects were tested two days prior to starting the six-week period and 24 hr following the final week of training. The testing involved monitoring the acceleration of each subject as they transitioned from back pedaling to a forward sprint. The subjects were asked to assume a normal, pre-snap defender stance. On command the subject began backpedaling and at a second command they stopped backpedaling and sprinted forward. The spacing of start and break commands were varied randomly. Horizontal displacement of the subject during the break was measured using a sports Laser (LDM 300C Sport Laser, JENOPTIK Group®, Jena, Germany) directed toward the back of the subject at the level of the lower portion of the sacrum. The sport laser monitored displacement once every 0.01 sec. Subject velocity and acceleration were determined by calculating the first and second derivative of displacement, respectively. Each subject performed 5 tests to determine a mean acceleration value. The velocity-time profile was plotted to verify that the slope of the line (acceleration) provided a stable value during the initial ten yards after the break. The sports laser was calibrated prior to each testing session.

Assignment of Groups

Subjects in each group were matched based upon their initial test acceleration results in an ABBA assignment procedure. First the subjects were divided by position (linebackers versus defensive backs), and then ranked from fastest to slowest, within their respective group. The first subject was placed in group "A" and subjects two and three were placed in group "B." The fourth fastest subject was then placed in group with the first subject in group "A."

Statistical Analysis

Differences between groups for the outcome variables were determined using a 2 x 2 ANOVA (group x time) with time as a repeated measure. Significance was set at a p-value of <0.05. When the ANOVA indicated a significant F statistic a Tukey minimum significant difference post hoc test was used to identify specific differences between groups or time points. Statistical analysis was performed using the SAS statistical software.

RESULTS

Descriptive data for the defensive players are given in Table 2 including their initial measured acceleration during a break. Before adding the ballistic-plyometric training program to the standard condition program the acceleration out of the break showed no statistical difference between the SCP (11.9 ± 0.41 m•sec^2) and BPD (11.14 ± 0.43 m•sec^2) groups (Table 3). After six-weeks the SCP group showed no significant change in their acceleration out of the break, averaging 12.42 ± 0.34 m•sec^2 and increasing acceleration by 6.3%. In contrast, following six-weeks the BPD group showed a 24.9% increase (p<0.05) in acceleration out of the break to a value of 13.78 ± 0.44 m•sec^2. The post training acceleration values were higher in the BCP group compared to the SCP group by 1.37 m•sec^2 (p<0.05).

The coefficient of variation (CV) for the pre training measurements of acceleration averaged 8.26 ± 1.49% and 8.12 ± 1.29% for the SCP and BPD groups, respectively. After the six-week training program the SCP group's CV for acceleration out of the break was similar to that measured prior to training averaging 9.01 ± 1.69%. In contrast, the CV for the measured acceleration out of the break appeared to decrease to 5.95 ±1.03% post test in the BPD group. The level of significance, however, was weak (p = .14).

DISCUSSION

The significant new finding of this study was that the six-week ballistic-plyometric drills, designed to specifically target the muscular systems used by a defensive player to accelerate during the break, significantly improved the acceleration of the break. In addition to an increased ability of the player to accelerate out of the break we also noted a slight improvement in consistency in their performance by a reduction in the variation in performance times during testing. It is clear that training contributes to the development of desired physical attributes of athletes [5]. However, this study demonstrated a ballistic-plyometric training program directed toward improving the ability of a defensive football player to accelerate during the break. More importantly, the benefits of the training program were seen within six-weeks with as little as an additional 15 min per week added to the standard conditioning program. It is also important to note that the ballistic-plyometric drills were effective in a group of athletes that play at the highest level of college football and who were coached specifically to perform the break properly.

The three ballistic-plyometric drills improved acceleration of a break in the same direction as backpedaling. This study was limited to test the break in one direction. Yet, the same systems that are involved in a break in the same direction as backpedaling are the same systems that are required to break in any direction. Thus, the three ballistic-plyometric drills will positively impact the acceleration out of the break regardless of the direction or the sport.

The plyometric nature of the drills is important because acceleration during the break is a plyometric skill. In order to break, both the plant leg and the drive leg undergo a rapid storage and release of strained energy. By training the different muscular systems involved in the specific actions of the break, we produced significant improvements in acceleration during the break. These drills may also help the subjects break faster with more consistency. Additional testing is required to demonstrate a true reduction in the coefficient of variation for repeated tests and thereby support the hypothesis that this training regiment improves performance and consistency of the break.

We do not know which specific drill was most beneficial in the improvement of the break. The box-leg-drive drill simulates the explosive nature of the break and focuses on the plant leg. The plant-foot-agility drill simulates the leg movement as the foot is planted in the ground and then moves forward. The power-step drill focused on both the plant and the drive leg movements during the break. All the movements are performed with velocity and resistance and should have improved break performance. It has also been noted that the additional volume of training could be a factor in the improvements on acceleration. Yet, the added volume to the BPD group was quite low when considering the total volume of work done in a week. Additional research will be needed to better understand which of the three drills had the greatest impact on break performance. At present, the combination of these three drills helped in the development of a quicker break.

PRACTICAL APPLICATION

The addition of three ballistic-plyometric drills to a standard conditioning program will significantly improve the acceleration of the break for football players. Adding these ballistic-plyometric drills to the standard conditioning program will not greatly increase the training time.

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TABLE 1 Ballistic-Plyometric training program

Six-week Agility Training Program			
Week	**Box-leg-drives**	**Plant-foot-agility**	**Power-steps**
1	3 x 8 (.91 m spacing)	2 x 10, each leg	3 x 10, each leg
2	3 x 10 (1.22 m spacing)	2 x 12, each leg	3 x 15, each leg
3	3 x 12 (1.22 m spacing)	2 x 15, each leg	3 x 20, each leg
4	3 x 10 (.91 m spacing) 5%-7.5% of body weight added	2 x 12, each leg + weighted vest	3 x 15, each leg
5	3 x 8 (1.22 m spacing) 10%-12.5% of body weight added	2 x 10, each leg + weighed vest	3 x12, each leg
6	3 x10 (.91 m spacing)	2 x 10, each leg	3 x 12, each leg

TABLE 2 Subject Characterizations

Age	Wt (Kg) Pre-test	Wt (Kg) Post-test	Height (cm)	Position	Group	Pre-test (m•sec-2)
23	99.79	102.1	72	LB	SCP	15.19
21	112.9	115.2	75	LB	SCP	14.16
22	100.2	102.1	74	LB	SCP	10.22
23	99.8	99.8	75	LB	SCP	9.91
21	73.4	77.1	69	DB	SCP	13.26
24	84.8	84.8	71	DB	SCP	11.98
22	80.7	81.7	70	DB	SCP	11.63
19	83	83.9	70	DB	SCP	11.51
24	91.2	94.5	72	DB	SCP	9.26
22	102.5	102.1	75	LB	BPD	15.53
19	95.3	95.3	73	LB	BPD	11.27
23	101.2	101.2	75	LB	BPD	10.74
22	102.5	104.3	73	LB	BPD	9.46
22	91.2	91.2	74	DB	BPD	14.14
23	102.5	98.5	73	DB	BPD	12.62
19	78	78	71	DB	BPD	9.76
24	80.7	80.7	69	DB	BPD	9.89
19	98.9	98.9	74	DB	BPD	8.28
23	83.9	84.8	71	DB	BPD	9.7

Linebacker (LB)
Defensive back (DB)
Standard conditioning program (SCP)
Ballistic-plyometric drills program (BPD)

TABLE 3 Acceleration data SCP vs. BPD

GROUP	PRE	POST
SCP	11.90 ± 0.41	12.42 ± 0.34
BPD	11.14 ± 0.43	13.78 ± 0.44*†

Standard conditioning program (SCP)
Ballistic-plyometric drills program (BPD)
Values are mean ± 1 SD for acceleration out of the break in $m \cdot sec^{-2}$.
* $p<0.05$ different from Pre
† $p<0.05$ different from SCP

EXERCISE	Monday		
DATE:	May 26.		
Bear Crawl Hurdles 1 x 5 (2 Sets) Ball Push Ups 1 x 10 V Front Raise 1 x 10			
BENCH PRESS	1x5	50	
	1x4	60	
	2x3	72.5	77.5
	3x2	80	85
	2x1	87.5	90
	1x2	80	
	1x3	72.5	
	Max	225	
CLOSE GRIP LOCKOUTS	1x5	50	
	1x4	60	
(Add Bands)	5x3	45	57.5
DUMBBELL INCLINE PRESS	5x6		
STANDING BEHIND THE NECK	1x5	35	
	1x4	42.5	
	4x5	47.5	55
TRICEP EXTENSION			
	2x8		
	4x6		
ATOMIC NECK			

EXERCISE	Tuesday		
DATE:	May 27.		
Duck Under / Step over Hurdles 1 x 5 (2 Sets) Backward Lunge / Twists 1 x 10 Stability Ball Curls 1 x 10			
CLEAN PROGRESSION	2x5		
HANG CLEAN	1x3	65	
	1x3	72.5	
	2x2	80	
	2x1	85	
	1x1	90	
	2x2	80	
	1x3	72.5	
SQUAT	1x5	50	
	1x4	60	
	2x3	70	75
	3x2	77.5	80
	2x1	82.5	85
	1x2	75	
	1x3	70	
	1x10	225	
SPLIT SQUATS	4x6		
HAMSTRING / LOW BACK COMBO			
Glute-Ham	3x10	BW	
Single Leg Ball Curls	3x10	BW	
BACK WORK			
CHIN-UPS	3x10	75	
BICEP WORK			
HAMMER CURLS	4x10		
GRIP WORK			

EXERCISE	Thursday		
DATE:	May 29.		
Partner La Duc's 1 x 15 Single Arm Box Walk 1 x 10 @ Arm DB Burpee / Press 1 x 10			
INCLINE PRESS	1x5	50	
	1x4	60	
	2x3	70	75
	3x2	77.5	80
	2x1	82.5	85
	1x2	75	
	1x3	70	
	1x10	225	
DUMBBELL BENCH	5x6	25	30
PUSH PRESS	1x5		
	1x4		
	5x3		
3-WAY SHOULDER 3 x 30			
Front Raise	3x10		
Lateral Raise			
Rear Fly			
TRICEP WORK			
CLOSE GRIP BENCH	2x10	52.5	
	2x8	57.5	
	2x6	62.5	
NECK MACHINE			

EXERCISE	Friday		
DATE:	May 30.		
Forward Lunge / Elbow to Arch 1 x 10 Straight Leg over Hurdles 2 x 10 @ Leg Inverted Toe Touch 1 x 10			
SNATCH SQUATS	3x5		
SNATCH PROGRESSION	2x5		
SNATCH	1x3	35	
	1x3	45	
	1x3	52.5	
	3x2	62.5	
POWER CLEANS	1x3	65	
	1x3	72.5	
Jerk 1st & 2nd	2x3	80	
Reps			
	2x1	85	
	1x1	90	
	2x2	80	
	1x3	72.5	
FRONT SQUAT	1x5	50	
	1x4	60	
	2x3	70	
	5x2	80	
SINGLE LEG BOX SQUAT	4x8		
BACK WORK			
BENT OVER ROWS	3x8		
DUMBBELL ROWS	1x10		
	1x10		
	1x10		
BICEP WORK			
FAT BAR CURLS	4x10		

Figure 1: Example of a week of Weight training

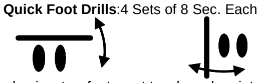
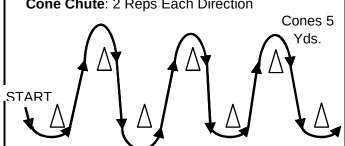
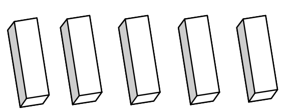
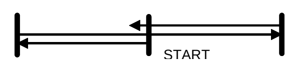
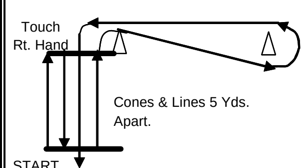
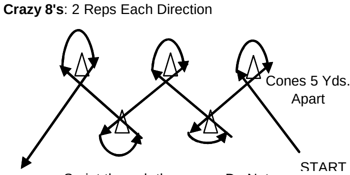
MONDAY *May 26.*	*TUESDAY* *May 27.*	*THURSDAY* *May 29.*	*FRIDAY* *May 30.*
LIFTING: Upper Body Lift RUNNING: Speed & Agility WARM UP: Butt Kicks 2 x 20 Yds. Left over Right / Right over Left Open Up Step 2 x 20 Yds. Left - Right - Ahead Seated Twist - Hip - Butterfly High Knee Crossover 2 x 20 Yds. Seated Twist - Hip Butterfly Lunge - Elbow Straight Leg / Hand Clap 2 x 20 Yds. Leg Swings 2 x 10 @ Sumo Seated Arm Swing Skipping Knee Hugs 2 x 20 Yds. Power Skips 2 x 20 Yds. Bounding 2 x 40 Yds. PLYOMETRICS: Jump Up to Box 3 x 5 Standing Long Jump 3 x 5 Crossover Jumps (Box) 2 x 10 Double leg Lateral V Jumps x2 @ Direction AGILITIES: **Speed Ladder** **Quick Foot Drills**:4 Sets of 8 Sec. Each  Emphasize, two feet must touch each point. The Drill is performed as quickly as possible without stopping. The movement is a step, avoid hopping. **Cone Chute**: 2 Reps Each Direction  Sprint through the cones. Do Not touch cones **Bag Drills:** 2 Reps Each Drill  SPEED ENDURANCE 10 x 110 1:3 Work: Rest Ratio Line: 19 Sec. Combo: 17 Sec, Skill: 15 Sec.	LIFTING: Lower Body Lift RUNNING: Speed Endurance WARM UP: Ankle Flips 2 c 10 Yds. Short Skip / High Knee 2 x 20 Yds. Left over Right Seated Left - Right - Ahead Side Lunge Split Right - Hamstring - Quad Backward Lunge 2 x 20 Yds. Lunge - Elbow Leg Swings 2 x 10 @ Leg Duck Walk Sumo 1 x 20 Yds. POSITION DEVELOPMENT: SPEED ENDURANCE **Hill & Stairs:** Stairs: (40-60 Steps) Run Up x 2 Bound Up x 2 Right Leg Lead x 1 Left Leg lead x 1 Double Leg hop x 2 Right Leg Hop x 1 Left Leg Hop x 1 Bound Up x 3 Hill: (120 Yds.) x 8	LIFTING: Upper Body Lift RUNNING: Speed & Agility WARM UP: Butt Kicks 2 x 20 Yds Left over Right / Right over Left Open Up Step 2 x 20 Yds. Left - Right - Ahead Seated Twist - Hip - Butterfly High Knee Crossover 2 x 20 Yds. Straight Leg / Hand Clap 2 x 20 Yds. Split Right - Hamstring - Quad Backward Lunge 2 x s0 Yds. Sumo Seated Arm Action Skipping Knee Hugs 2 x 20 Yds. Power Skips 2 x 20 Yds. Bounding 2 x 40 Yds. PLYOMETRICS: Double Leg Speed Hop 3 x 10 Double le Leg Lateral Hops 3 x 5 @ Side Jump Up to Box 3 x 5 Double Leg Speed Hop Hurdles 2 x 20 Yds. AGILITIES: **Pro-Agility Drill:** 2-3 Reps Each Direction  From a 3 point stance turn and sprint to the right, touch the line with the right hand, turn and sprint to the left, touch the line with the left hand and sprint past the middle line. **3 Cone Drill**: 3 reps each Direction  **Crazy 8's**: 2 Reps Each Direction  Sprint through the cones. Do Not touch cones	LIFTING: Lower Body Lift RUNNING: Speed Endurance WARM UP: Butt Kick 2 x 20 Yds. Short Skip / High Knee 2 x 20 Yds. Left Over Right Seated Left - Right - Ahead Side Lunge Split Right - Hamstring - Quad Backward High Knee 2 x 20 Yds. Lunge - Elbow Backward Walking Lunge 2 x 20 Yds Duck Walk Sumo 1 x 20 Yds. POSITION DEVELOPMENT: SPEED ENDURANCE **8 x 100 (1:3 Work: Rest Ratio)** Line: 17 Sec. Combo: 15 Sec. Skill: 13 Sec. **6 x 60 (1:3 Work: Rest Ratio)** Line: 9 Sec. Combo: 8 Sec. Skill: 8 Sec. **6 x 40 (1:3 Work: Rest Ratio)** **6 x 20 (1:3 Work: Rest Ratio)** **6 x 10 (1:3 Work: Rest Ratio)**

Figure 2: Example of a week of running

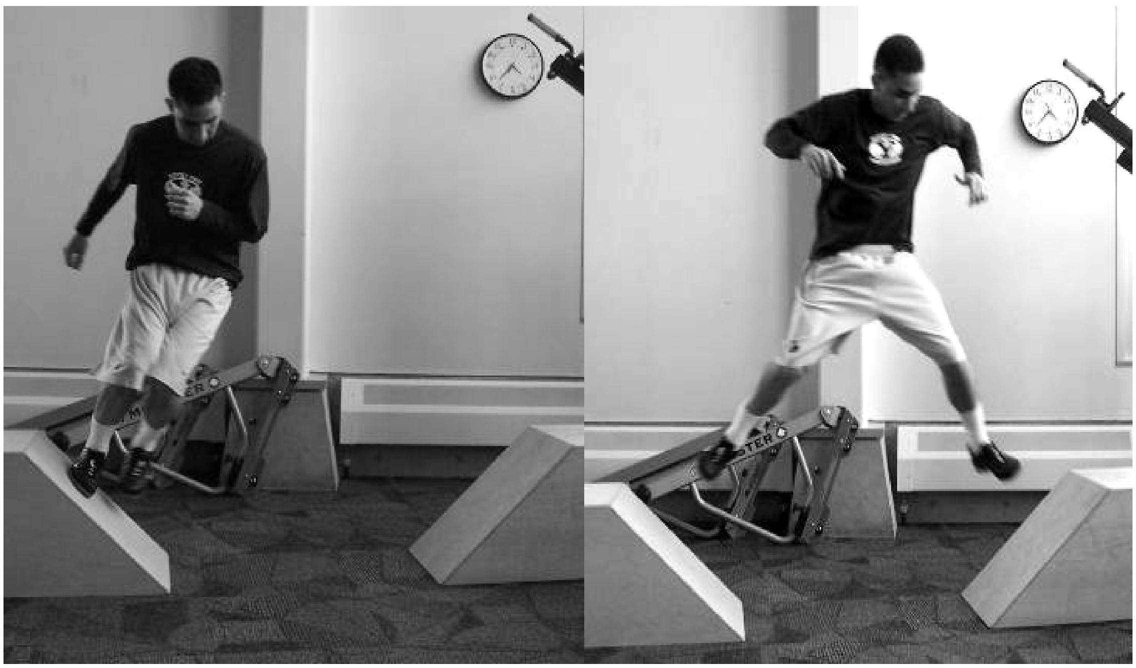


Figure 3: Box-leg drives

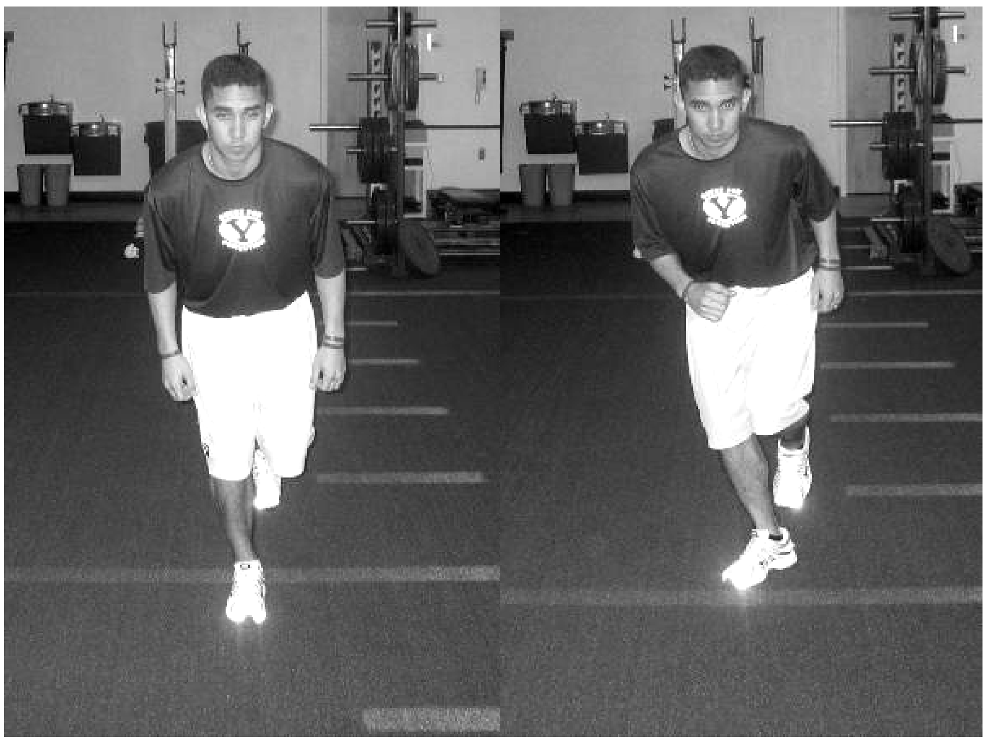


Figure 4: Plant-foot agility

Figure 5: Power steps

Appendix A

Prospectus

Chapter 1

Introduction

From the humble beginnings of American Football in the late 19th century, "the sport which had been able to attract hardly enough men to make up a team, to say nothing of the spectators [27]," has become the most popular sport in America. Football outshines soccer, basketball, baseball, and every other sport based on the number of people that watch it on television. On February 3, 2008, 97.5 million Americans tuned-in to watch Super Bowl XLII. The number of viewers makes it the second, most-watched TV program in United States history [3]. With its rapid growth of recognition and popularity, football also generates a large amount of revenue. The National Football League (NFL), the professional football league in the United States, is the richest sports league in the world. The average team is worth $957 million, with the Dallas Cowboys being the richest sports franchise in the world worth $1.5 billion [11].

Collegiate football is the step before entering the NFL. While the players are not paid, Division 1-A football programs have the ability of bringing millions of dollars to the respective universities. For example, last year bowl games paid out $187 million to universities. Bowl games not only bring millions of dollars to the university, but they also bring positive exposure for the participating universities [1].

With such incredible popularity, American football has become a sport that requires the biggest, the fastest, and the strongest athletes. Over a century ago, the ideal athletic type was much different from today's athletic type [15]. Bill Tobin, General Manager of the Indianapolis Colts said:

"Twenty years ago we never felt we'd have this many big people who could run this fast. It wasn't much further back that 250 lb was big for a lineman. Now it's not big enough to play. With advances in nutrition, weights, kinesiology and development techniques at an early age, we could see the day when 300 lb may be the minimum and 350 lb may be the standard [57].

It is not enough just to be big or just be fast or just be strong. Football athletes must be trained and perform well in all three aspects. Most football players get a lot of help and training in developing stronger and bigger muscles to help them be more physical on the field, but much progress can be made with running faster. For football players, one part of improving speed deals with improving agility.

As popular as American football has become, not many studies have been done in the area of improving agility, in respect to a player's movement and quickness. Agility is a difficult idea to define. Vergstegen and Marcello defined agility as the ability of an athlete to react to a stimulus, start quickly and efficiently, move in the correct direction, and be ready to stop quickly to make a play in a fast, smooth efficient, and repeatable manner [32]. Agility can be improved with proper technique during change of direction (COD) movements, faster straight running speed, stronger leg muscles, and increased perception and decision making [91]. When an athlete improves their agility, they have a better chance of becoming part of an elite group of players involved at the highest level of college football and in the NFL.

In order to understand the stresses put on agility, it is essential to have a basic understanding of American football. American football is a sport that is made up of 11 offensive players and 11 defensive players. Within the offense and defense, specific positions require specialized attributes in order to play that position. For example, on the offensive side of American football, the five different positions are quarterback, running back, wide receiver, tight end, and offensive lineman. The physical attributes required for each position are extremely different. The size of an offensive player can be as small as 5'8 and 186 lbs to as big as 6'8 and 330 lbs, BYU 2008 Spring Roster [2]. Each position not only requires a specific size of an athlete, they also require that athlete to possess a certain amount of speed, agility, and power. Offensive linemen are not required to run the fastest or jump the highest, yet they will be asked to be physically powerful. A wide receiver is not asked to be as physically powerful as an offensive lineman, yet they are required to run faster and jump higher.

These same standards that are found for offensive players are also found for defensive players. On the defensive side of the football the three main positions are defensive lineman, linebacker, and defensive back. They can range from 5'9 and 164 lbs to 6'3 and 343 lbs, BYU 2008 Spring Roster [2]. Defense is different from offense because all the movements performed by defensive players are reactionary. If the offensive player steps right, then the defensive player steps right. Thus, defensive players hold the same qualities as offensive players, yet they must also be extremely agile to keep up with the offense.

The position that must be the fastest and the most agile is the defensive back position. Defensive backs and wide receivers run more than the other positions. Covering a wide receiver man to man is one of the hardest things to do in the game of football. For this reason in the NFL, a subunit of the defensive backs, named corners, average $1.7 million for an annual salary [4]. Along with defensive backs, linebackers are not only asked to be a strong, physical run stopper but to also cover wide receivers and tight ends. Defenders begin covering the receiver by backpedaling, which is running backwards. From backpedaling, defenders must transition to a forward run. A forward run is initiated by opening the hips 180° and running forward in the same direction as the backpedal, opening the hips 90° and running perpendicular to the backpedal. The other option is to stop backpedaling, or break, and transition to a forward run in the opposite direction of backpedaling. The more efficient defenders are in making the transition from backpedaling to a forward run, the more opportunities defenders have of intercepting the ball from the quarterback, called an interception.

From the discussion about defensive back play, agility is an important attribute for defenders. They must react to a stimulus; in this case, the wide receiver. They must go in the right direction and have control of their bodies so that they can make a play by knocking the ball away from the wide receiver or intercepting the ball. Whether a defensive back plans on playing in the NFL or not, improved agility improves their chance of playing in the game and also winning the game.

Currently defensive players at Brigham Young University are trained in many areas of agility. They are given specific drills to improve the ability to break out of backpedaling. They also receive feedback on how they can improve their technique. Defensive players are involved in a strength program, which enables them to increase their leg strength. As part of the strength program, they have the opportunity to be trained in straight sprinting technique. Coaches in the BYU program, teach the defensive players to look for clues that enable them to perceive and make decisions much faster. While the technique and perception being coached is very specific to the defensive back position, the strength and speed training are mostly team wide. Thus, a defensive lineman and a defensive back are asked to lift the same type of lifts and run the same drills. For a sport that is so specialized, it is difficult for players to improve when training is so generalized. Today's athletes are not only highly specialized for their sport but for a particular position within their sport [64].

Statement of Purpose

The purpose of this study is to test the impact of a specific agility training program on the ability of football players to accelerate during a transition from backpedaling to a forward run through training the specific systems that are involved in such a transition.

Hypothesis

Null: There will be a decrease or no difference in the ability of a defensive player to accelerate during a transition from backpedaling to a forward run.

Alternative: There will be an increase in the ability of a defensive player to accelerate during a transition from backpedaling to a forward run.

Definitions of Terms

COD - change of direction. For a defender it is their ability to go from backpedaling to a forward run.

Agility - the efficiency of a defender to perform a COD while controlling the body and making a play.

Straight sprint running – running performed in an efficient manner in a straight line.

Backpedal – running backward in a manner that the athlete can change direction to where ever they are needed.

Breaking – ability of a defender to transition from backpedaling to a forward run in the opposite direction from backpedaling. The defender must stop backpedaling and proceed to run in the direction from where they came.

Agility weight training – training that involves movements similar to those involved in breaking, includes some form of resistance.

Lower Body Strength-training – exercises that athletes do to strengthen leg muscles; these are standard weight training ideas such as the squat or power clean.

LDM 300 C Sport, JENOPTIK Group – laser used to track the speed of a defender from backpedaling to a break.

NFL – National Football League; this is the highest level of American Football. It is made up of 32 teams limited to a 52 man roster.

Delimitations

The study will be delimited to

1. Division-1 collegiate football players who play on the BYU defense.

2. The study will use all available defensive backs and linebackers.
3. Subjects already involved in a strength and conditioning regimen. They will work-out 4 times a week. The work-outs involve lifting weights, speed training, agility training, and position training.
4. Subjects will be first divided into a linebacker and defensive back group. They will then be divided into a control and treatment group based on matched pair ABBA protocol.
5. Data received from the LDM 300 C sport.

Assumptions

1. Subjects will be involved in the strength training regimen on a consistent basis.
2. Subjects will add to their work-outs agility training exercises as set forth by this study.
3. Subjects will perform these agility training exercises twice a week for a six-week period.
4. Subjects will be involved in a pre and post test to determine the acceleration of the COD, and if there has been an improvement due to the training protocol.

Limitations

The possible limitations are

1. The study is looking at a small population. It is looking at a specific position on a collegiate football team.

2. Subjects may do other activities to improve their breaks.
3. Six-weeks may not be a long enough time period to experience a training effect to positively affect the break.

Significance of Study

The defensive back and linebacker positions are extremely hard to play. Yet, if an individual is able to master the position, they have the opportunity to make millions of dollars in the NFL. While the defensive back position is one of great importance, not many studies have been conducted to find out specific ways to improve the break. Testing an improvement in agility is a difficult thing to do. Testing an improvement in the break is even harder. This study will not only give us an accurate and valid test, but it will also help us understand if specifically training the systems that are used in the break will positively impact the break. The faster the defenders get in and out of their break, the more opportunities he will have to make a play. Thus, we will be able to improve the break by adding a short routine that will target the muscles needed to stop the backward momentum and start the body moving forward.

Chapter 2

Review of Literature

The Break

There are a couple of different ways to transition from backpedaling to a forward run [69, 78]. The break consists of two main steps with the feet; the plant leg and the drive leg. The plant leg is considered the leg that is used to stop the backward momentum. Once a defender decides he needs to come out of his backpedal, the leg that is in the air will externally rotate, abduct, and extend. The obliques will work to create as little right and left rotation of the trunk as possible. Once the plant leg externally rotates, abducts and extends, it will be driven into the ground. Defenders should try to put as many cleats in the ground as possible, helping them stop their backward momentum. With the plant leg firmly on the ground, defenders must now use their drive leg to get their momentum going forward. The motion of the drive leg is flexion at the hip. The drive leg should be a six inch step, driving up and down as quickly as possible, in the direction of the break. If the break is at an angle internal or external rotation of the hip will occur with the hip flexion. The drive leg is equally important as the plant leg. For example, if a defender is not able to stop their backward momentum with one powerful plant leg, the drive leg will not be able to take a quick six inch step in the direction of the break. When this occurs, the drive leg acts as a second plant leg and the plant leg now becomes the second drive leg. This is what can be referred to as a bucket step. A bucket step causes the defender to lose ground on the wide receiver. Literally the defender has lost a step in trying to mimic the wide receivers movements.

The break of a defender is a task that involves coordination of many different joints and muscles. The focus of this study is on the muscles that cross the hip joint. The hip joint is an enarthrodial (ball and socket) joint. Along with the glenohumeral joint, it is one of the most mobile joints in the body. Possible ranges of motion for the hip joint are; flexion 0 to 130 degrees, extension 0 to 30 degrees, abduction 0 to 35 degrees, adduction 0 to 30 degrees, internal rotation 0 to 45 degrees, and 0 to 50 degrees of external rotation [83].

The muscles that cause hip flexion as described by Perry include: psoas major, iliacus, rectus femoris, sartorius, and adductor longus [67]. The extensor muscles that cross the hip are the biceps femoris, semimembranosus, semitendinosus, adductor magnus, and gluteus maximus [67]. The gluteus maximus also plays a significant role in abduction along with the gluteus medius and tensor fasciae latae [67]. The adductor muscles include the adductor longus, magnus, and gracilis [67]. Other muscles that are also believed to be involved with hip flexion are psoas minor, pectineus, and tensor fasciae late [83]. The pectineus, adductor brevis, and gluteus maximus are other muscles involved in hip adduction [83]. Muscles that cause the internal rotation are pectineus, gracilis, semitendinosus, semimembranosus, gluteus maximus and minimus, and tensor fasciae late [83]. External rotation includes the following muscles; iliacus, psoas major and minor, sartorius, adductor brevis and magnus, biceps femoris, and gluteus maximus and medius [83]. External rotation is also possible through six deep posterior muscles; piriformis, gemellus superior and inferior, obturator internus and externus, and the quadratus femoris [83].

External and internal obliques are responsible for trunk rotation to the right and left [83]. While breaking, the obliques act as stabilizers. The obliques help turn the trunk toward the direction of the break. If the defender is returning in the same direction from which they were backpedaling, then the obliques keep the trunk as straight as possible while the hips perform their movement to stop from backpedaling and transition to a forward run. The ability to keep the trunk facing the direction of the break allows the defender to assume optimal running form with greater velocity.

Neuromuscular Adaptations

Neural adaptations are an important part during the early stages of training. It has been shown that the early strength gains from resistance training are in fact due to the neural factors involved with muscle recruitment [35, 47, 50, 53, 61, 70, 73, 82]. Limited technology has made it difficult to see the true increases in size of a muscle during a specific period of time. Recently several studies showed that muscle hypertrophy occurred after noted strength increases using magnetic resonance imaging (MRI) [9, 36, 43, 45, 62, 90]. Strength increases before hypertrophy are all part of the neuromuscular adaptations that take place as the resistance training program begins. The neural factors are believed to improve muscle strength in one of two ways. The first is through repeated muscle activation. By activating the muscle through a series of repetitions, the motor system is able to train the neurons to activate more muscles or activate the same muscle but in a synchronized manner. Increased activation and synchronized firing of muscles is one of the reasons for the increase in muscle strength without muscle hypertrophy [30, 50, 52, 56, 72]. Yue and Cole found that the muscle could increase in strength through mental imagery. In their study, a group of subjects only trained through mental imagery. The mental imagery group was able to increase a maximum voluntary contraction. Thus, neuromuscular adaptations have also been found to be derived from the programming/planning levels within the motor system [21, 39, 97].

In a study done by Wojtys et al, neuromuscular adaptations were viewed by testing three different activities; isokinetic, isotonic, and agility training. Their main goal was to determine which exercise regimen could improve the muscle reaction times of the quadriceps, hamstring, and gastrocnemius muscles needed to stabilize the knee. To their surprise, only the agility trained group had significant improvements. These improvements were seen at the spinal cord, intermediate, and voluntary muscle response levels. The voluntary reaction time of all the muscles improved, yet statistically significant changes appeared in three of the muscle groups. Another interesting finding was the fact that the isokinetic trained group actually had significant slowing of the voluntary muscle reaction time in the medial hamstring and medial quadriceps. If weight training is not accompanied by agility training, then it could negatively affect quickness and fine motor skills [88].

Strength Training

Strength, speed, power, and agility are important characteristics of athletes that play American football [16, 17, 34]. Of the four characteristics before mentioned, defenders success lies with speed and agility. During the football off-season, defenders spend hundreds of hours in developing these skills. Many studies have found that strength and power have a positive correlation with speed [13, 18, 19, 48, 54, 79, 93, 96].

These studies have shown a moderate to strong relationship with strength and power to speed. Yet, other studies have demonstrated that straight sprint speed and agility are independent physical qualities [24, 29, 92, 95]. With the understanding that straight sprint speed and agility are distinct qualities, studies were completed to see if strength and power would also positively affect agility. The studies have shown that there is little or no correlation between strength training and agility [28, 55, 63, 92, 94].

A necessary component of strength training must be the involvement of plyometrics. Plyometrics are any activity that rapidly stretch the muscle (eccentric action) then immediately shorten the same muscle (concentric action) [12]. Several studies have shown that plyometrics along with strength training contribute to improvements in vertical jump, acceleration, leg strength, muscular power, increased joint awareness, and total propioception [8, 10, 14, 20, 22, 25, 38, 41, 42, 44, 59, 65, 68, 87]. Plyometics involve movements that contribute to the development of agility [26, 58, 66, 89, 95]. Several studies have shown that a four to six-week plyometric program (twelve training periods) can significantly improve agility [31, 37, 60] Miller et al. conducted a study to demonstrate the correlation between plyometric training and agility. They performed a six-week plyometric training regimen. The subjects trained twice a week. They conducted pre and post test in three different agility drills. The group that was trained using plyometrics improved significantly in all three tests. Miller et al. believe that the improvement was due to either better motor recruitment or neural adaptations [60]. For a defender to gain the full benefit of strength training, they must involve plyometics into their training program.

Technique

Straight sprint running is characterized by a high centre of gravity and an upright stance [33]. In order to run faster, it is also important that a sprinter has a high degree of knee flexion [51]. The more knee flexion, the shorter the lever arm of the leg allowing the runner to increase angular velocity at the hip. Increasing angular velocity at the hip allows the sprinter to decrease the amount of breaking force created by the foot's contact with the ground [86]. The increase angular momentum allows the sprinter to increase their step rate. Both step rate and step length are integral parts of sprint running [46]. These techniques allow the sprinter to be more efficient and run at a higher speed. Studies have shown that running technique for athletes involved in field sports is different than the technique involved for track sprinters [33, 76, 77]. A low centre of gravity and forward lean are essential parts of field sprinters techniques. A higher center of gravity is not optimal for acceleration, deceleration, and stability [33]. A change of direction is completed by lowering the centre of gravity so that the field sprinter can decelerate [76]. Thus, the low center of gravity allows the field sprinter to decelerate, change direction, and accelerate in the new direction with greater efficiency. Because these two techniques are so different, it is essential that football defenders focus the majority of their training to improving the agility component of their technique.

While the lower body has been discussed thoroughly, the arms are also an important component of both straight sprint running and agility. For example, a study was completed that demonstrated a ten percent decrease in 100-m running time while both arms were fixed to the body. They also found that a two to three percent decrease was found when the arm was extended horizontally, as if passing a baton [84]. While scientific information is found on the affect of arms during straight sprint running, little information is found on how arms may affect agility movements. Brown and Vescovi demonstrate the importance of arm coordination with the body during a change of direction movement. For example, when figure skaters want to spin faster, they pull their arms into their body. When the arms are away from the body, angular momentum is decreased and the skater may not generate the angular momentum necessary to complete their jumps. The same is true for agility. If an athlete has their arms away from the body, they put un-wanted stress on other parts of the body [23]. During a critical moment in the game an athlete may find themselves out of position because their arms have not allowed their body to remain in a position that allows them to decelerate, change direction, and accelerate toward making a play.

Cognitive Processes and Decision Making

While the subjects relating defender plays are essential for their success, cognitive processes and decision making can help an average athlete become a play maker. Athletes are asked to perform high velocity actions in response to the movements of their opponents. Athletes must process almost simultaneously many kinds of information [71]. Defenders must process a lot of different information in order to gain a clear picture of the present moment: down and distance, offensive personnel, formation, defensive call, adjustments to the offense, number of wide receivers. This information is processed in the few seconds before the play starts. Once the play has begun, a new set of information is processed so that the defender can use his athletic ability to be in position to make a play.

Helsen and Starkes examined this idea by looking at the expertise in soccer. They wanted to know if the expertise came from the efficiency of the visual/central nervous system, or if it came from cognitive domain-specific skills. The only significant predictors of sports performance were the cognitive domain-specific skills [40, 81]. Research has shown that high-performance athletes are able to anticipate the movements of their opponent from cues that they perceive [6, 7, 76, 80]. Abernethy and Russell suggested that elite performers differ from non-elite performers in their ability to decipher the cues of their opponent and react to those cues [6]. Studies have been completed in tennis, hockey, badminton, squash, and soccer [5, 49, 74, 75].

Defenders have the opportunity to respond to the cues given by their opponent. Two defenders with similar physical ability can be perceived very different if one of the defenders has a higher developed skill of perception and decision making. The defender that is able to perceive the purpose of their opponent is able to make up for a lack of speed, strength, power, and agility. Cognitive processes and decision making are an integral part of agility and aid defenders in their struggle to cover the wide receiver.

The break is a skill that involves all components of agility. Technique training allows the body to learn the break. Continually working the actions required for an effective break, through training the technique, allow the neuromuscular system to function at its highest level. Leg strength is also essential to stop backpedaling and transition to a forward run. Insufficient leg strength does not allow the defender to stop and start at a high enough level to make a play on the ball. Weight training, along with plyometric training, has been found to produce the best results to improve agility. The subjects of this study have been and will be involved in strength and conditioning programs that involve both weight training and agility training. This study will add to the subjects program, an agility protocol that targets the systems used to perform an effective break. The training is designed to improve the neuromuscular aspects of the movement, along with the strength of muscles not targeted during the weight and agility training. Lastly, cognitive processes and decision making can separate the great defender from the average defender. Cognitive processes and decision making for defenders are the ability to understand the movement of your opponent. The ability to perceive when the receiver is going to make a change of direction and in what direction the change of direction will take place is an invaluable quality for defenders. Defense is all based on reaction. If the offense moves this way then the defender moves with the offense. High cognitive processes and fast decision making improves the ability of the defender to make a play.

Chapter 3

Methods

Subjects

24 members of the Brigham Young University football team will be recruited to participate in this study. The subjects will be recruited because they all play defense for the BYU football team. Players will be taken from the two positions that most utilize the break in their play, linebackers and defensive backs. This study wishes to look at the affects of the training protocol on a group of athletes that have played the position. It is also important to determine if the agility training protocol has positive effects on the break among athletes that have previous experience and coaching in the testing procedures. This study specifically examines the impact of an agility training program on a defenders ability to stop backpedaling and transition to a forward run. The agility training program will train the movements needed to perform the responsibilities of a defender in the game of American football.

The subjects will be divided into two groups. One group will be the control and the other will be the group passing through the agility protocol. Both groups will be involved in an extensive strength and conditioning program. This strength and conditioning program will be consistent of all subjects. The control group will not have any exercises added to the program. The treatment group will be asked to arrive fifteen minutes early to perform the agility protocol. Since the agility protocol is comprised of ballistic/plyometric movements, it will be best that the protocol is performed when the subjects are not fatigued. The agility training protocol will occur twice a week for a six-week period.

Equipment

LDM 300C Sport Laser, JENOPTIK Group, will be used to test the effectiveness of the break of each subject. The sport laser determines velocity by the measuring the displacement in the position of the subjects. The rate at which the laser measures velocity is every one hundredth of a second. The laser will be placed on a tripod and aimed at the back of the subject. The laser will provide horizontal velocity of backpedaling, time needed to change from backpedal to a forward run, and the time and speed needed to run 10m from the point that the forward run began. The laser provides the velocity, both positive and negative, of the entire trail. It also provides the time and distance of each trial. The data that will be collected will be used to determine the acceleration of the break.

Testing Procedures

Prior to each collection, the sports laser will be calibrated to ensure accuracy. Body weight will be collected prior to pre and post-tests. Each subject will wear their own football cleats. The test will be completed on Field Turf ®. Subjects will be given 5 minutes to warm-up in any manner that they see fit. The subjects will be asked to assume a normal, pre-snap defender stance. The laser will be leveled to ensure accuracy. The laser height will then be changed to point at the lower portion of the sacrum when the subject is in a defensive stance. They will be given a command to begin backpedaling and another command to stop backpedaling and sprint forward in the direction from which they traveled. The commands given to the defender will be given randomly, within a five yard range. Random commands better assimilates the variability of the break. In a game, reaction to the offensive player is part of having an effective break, and this test will include the reactionary part of the break. Subjects will be asked to perform the tests at their perceived maximal velocity. Data from the LDM 300C Sport laser will be collected and viewed. If the subjects vary from the course they are running, they will break contact with the laser and data will be insufficient. Insufficient tests will be asked to be repeated. Due to the variability of the break taken from preliminary data, subjects will be asked to perform five maximal effort tests. Two minutes of rest will be given between each test. The rest time will stay consistent and is to insure that fatigue will not affect the subject.

Outcome Variables

The LDM 300C Sport laser collects displacement at one hundredth of a second. After the displacement data are collected with the sport laser, velocity will be calculated by taking a first derivative. The change of velocity divided by the time taken to break will represent the break. One tenth of a second before and after the point of zero horizontal velocity will be plotted vs. time. A trend line will be used to determine the slope through this time period. The slope of the graph, acceleration, will be the outcome variable used to determine the effectiveness of the agility protocol.

Recommendations and guidelines as set forth by the American College of Sports Medicine (ACSM) will be followed for all testing phases of this study [85]. Testing and agility protocol will be performed at Brigham Young University Football Facilities (Indoor Practice Facility, and Student Athlete Building weight room).

Agility Protocol

The three agility drills were designed to mimic the different aspects of a break. The agility protocol was designed by the principal investigator along with two of the three drills. All three of the drills are plyometric in nature. They require an eccentric loading phase followed by a rapid concentric contraction.

The agility protocol for this study will entail two work-outs a week for six-weeks. It will be linear periodized training because it will start with low repetitions and build up to higher repetitions (Table 2). Once the subjects can perform all the repetitions without feeling fatigued, a weighted vest will be added to the agility drills. All drills will be trained at a high intensity. Sufficient time will be given between sets (2-3 minutes) so that the legs can recover and perform the rapid nature of the tasks.

The first drill that will be performed will be an agility box jump drill (Figure 1). It will be called box-leg-drives. It will focus on the forces that are place on the plant leg. Two boxes with a 45 degree angle will be placed three feet apart. Subjects will begin the agility protocol by performing three sets of eight of box-leg-drives. They will use one leg and explode between one box and the other as quickly as they can. Each contact will be viewed as one repetition. As the subjects become accustomed to the agility protocol, the repetitions will increase to three sets of ten. As the subjects continue to improve the box will be widened out to four feet. The last phase will be to add a weighted vest. The weighted vest will begin at 5% of the subject's body weight and increased up to 12.5%.

During this time of the training, the number of repetitions will be reduced to three sets of eight for the lighter weight and eventually to 3 sets of six with the heavier weight. If at any time subjects become fatigued to the point that the drill is not performed rapidly the subject will be asked to do fewer repetitions or take weight out of the vest. The rapid, ballistic nature of this drill will develop the systems involved with the plant leg of the defender that is making a break. It will also increase the efficiency of the hip flexors and therefore strengthen the systems required to move the drive leg.

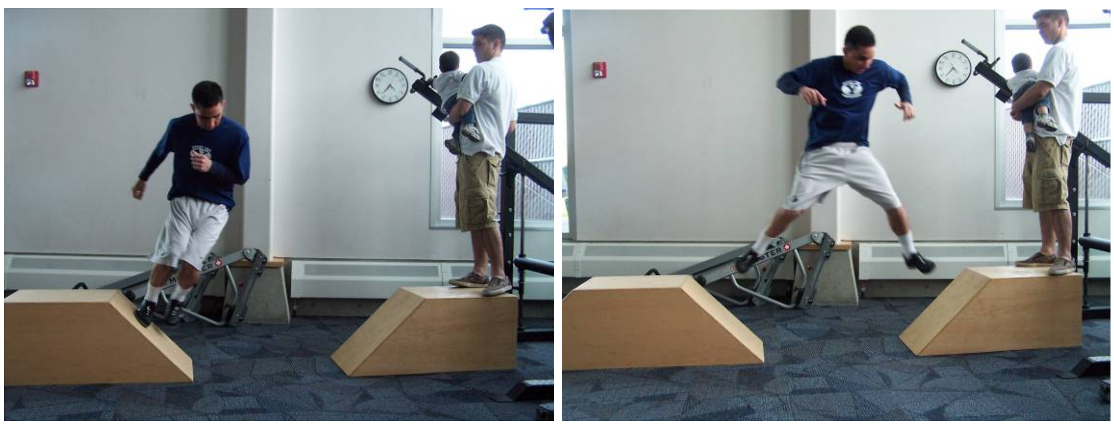


Figure 1

The second drill will be called plant-foot-agility (Figure 2). The subject will assume a proper defensive stance and with one leg jump backward over a line. The subject will perform this drill by externally rotating the foot used to hop over the line. The foot will rotate between approximately 70-80 degrees. This will simulate the plant leg portion of the break. They will perform each repetition of the plant-foot-agility on command. It is vital to the success of this drill that the subject returns to the starting position and is set before performing the next repetition. The speed of getting through the entire drill is not as important as the speed at which each repetition is performed.

This drill assimilates the position of the plant leg in the break. Subjects will be required to perform the plant leg drill at their perceived highest velocity. The drill will begin with ten repetitions per set. The subjects will perform two sets on each leg. One set will be completed after both legs have performed the drill. As with the box-leg-drive drill, subjects will progress to a higher number of repetitions and eventually a weighted vest. Subjects will eventually perform 2 sets of twenty on each leg. They will then add the weighted vest starting at 5% of the body weight and increase that weight to 12.5%. Again, it is essential that each repetition is completed with high velocity. These training protocols are ballistic in nature and need to mimic the explosive nature of the break.

Figure 2

The last drill will be a power-step drill (Figure 3). This drill will focus on both the plant and drive legs. The subjects will have bungee cord attached to their leg; at the ankle. They will assume a defensive stance, facing the wall, and will quickly move their plant leg to the position in which it will be during the break. The plant leg power-step will be performed 17 feet from the wall. As subjects gain greater strength and better coordination of the task, the distance from the wall will be moved to 19 feet. Subjects will perform each repetition at a high velocity for three sets of ten on each leg. Subjects will also turn around, back to the wall, and perform a drill that focuses on the drive leg. They will stand as if they have already planted their foot during a break, and with the bungee on the drive leg take a six inch step forward. Subjects will start this task 18 feet from the wall and move to 20 feet. The six inch step will be used against the resistance of the bungee cord and will be picked up and placed down as quickly as possible. Again, subjects will perform these drills at three sets of ten and progress to three sets of fifteen.

Figure 3

Statistical Analysis

Differences between the groups will be tested using a 2 x 2 repeated measure ANOVA with a Tukey post hoc test. Alpha will initially be set at .05. The test will look to better understand the differences between the treatment and control groups. If differences are found, the treatment and control groups will be divided into subgroups by position. Differences will be noted between the linebackers and the defensive backs. Analysis will be performed using SAS statistical software.

Table 1 Six-Week Agility Protocol

Week	**Box-leg-drives**	**Plant-foot-agility**	**Power-steps**
1	3-8 (3 ft between boxes) each leg	2-10 each leg	3-10 each leg
2	3-10 (4ft between boxes) each leg	2-12 each leg	3-15 each leg
3	3-12 (4ft between boxes) each leg	2-15 each leg	3-20 each leg
4	3-10 (4ft between boxes) each leg 5%-7.5% of body weight added	2-12 each leg + weighted vest	3-15 each leg
5	3-8 (3ft between boxes) each leg 10%-12.5% of body weight added	2-10 each leg + weighed vest	3-12 each leg
6	3-10 (3ft between boxes) each leg	2-10 each leg	3-12 each leg

Matched pairs ABBA will be the assignment procedure used according to the velocity of the break obtained from the pretest. First the subjects will be place by sub-groups, linebackers and defensive backs. Then the subjects will be placed in order from fastest to slowest, within their respective group. The first subject will be place in group "A" and subjects two and three will be place in group "B." The fourth fastest subject will then be placed in group "A." This format will continue until all subjects are placed in either group "A" or "B."

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