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Reducing Performance of Unsafe Weight Lifting Techniques Using Positive Practice

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REDUCING PERFORMANCE OF UNSAFE WEIGHT LIFTING
TECHNIQUES USING POSITIVE PRACTICE

by

Leslie Shier

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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REDUCING PERFORMANCE OF UNSAFE WEIGHT LIFTING TECHNIQUES USING POSITIVE PRACTICE

Leslie Shier, M.A.

Western Michigan University, 2003

The prevalence of injuries resulting from improper weight training technique among recreational lifters is of serious concern. Recreational lifters often receive limited instruction regarding safe practices. Four exercises, the latissimus dorsi pulldown, the bench press, the squat and the knee extension, were identified as commonly performed at risk. Writers of the sports medicine literature have suggested that these exercises have potential physiological benefit, but may cause injury when performed incorrectly. The current study employed positive practice in order to increase safe weight lifting among 10 recreational lifters. A multiple baseline design across the four exercises was utilized to illustrate the effects of positive practice on safe weight lifting. Positive practice resulted in an average increase of 46% safe for the latissimus dorsi pulldown, 70% safe for the bench press, 56% safe for the squat, and 60% safe for the knee extension. Social validity measures indicated that positive practice was an acceptable intervention.

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Leslie Shier

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TABLE OF CONTENTS

ACKNOWLEDGMENTS	ii
LIST OF TABLES	vii
LIST OF FIGURES	viii
INTRODUCTION	1
Injuries in Weight Lifting	1
Prevention	3
Specific exercises	5
Applied Behavior Analysis in Sports	7
Performance feedback	9
Overcorrection	11
Purpose	13
METHOD	14
Participants and Setting	14
Dependent Variables	15
Data Collection Procedure	17
Follow-up Sessions	17
Independent Variables	18
Procedure	20
Experimental design	20
Baseline	21

Table of Contents—continued

Information	22
Positive practice	22
Passive observation	23
Debriefing	23
Observer training and interobserver agreement	24
Treatment integrity	25
RESULTS	27
Group Performance	27
Baseline	27
Information	27
Positive practice	28
Individual Performance	28
Participant 1	28
Participant 2	32
Participant 3	34
Participant 4	37
Participant 6	39
Participant 7	42
Participant 8	47
Participant 9	47
Participant 10.....	51

Table of Contents—continued

Participant 11	56
Lifting Components	59
Follow up	59
Debriefing.....	60
Symptoms survey.....	60
Evaluation.....	63
DISCUSSION	67
Summary of Results	67
Information	67
Positive Practice.....	71
Behavioral Mechanisms of Positive Practice.....	72
Punishment.....	73
Evocative effect.....	76
Other considerations.....	78
Passive Observation	78
Discussion of Individual Performance.....	80
Exercises	80
Confounds.....	81
Weight	83
Variability	84
Alternative visual representation of data.....	85

Table of Contents—continued

Limitations.....	86
Strengths of the Study	91
Implications.....	93
APPENDICES	94
A. Observation Checklist	94
B. Observer Script.....	96
C. Symptoms Inventory	100
D. Consent Form	103
E. Weight Training Form.....	108
F. Debriefing Questionnaire.....	110
G. Intervention Integrity Checklist.....	113
H. HSIRB Approval	115
BIBLIOGRAPHY.....	117

LIST OF TABLES

1. Symptoms Survey	65
2. Debriefing Evaluation Questions.....	66

LIST OF FIGURES

1. Data for Participant 1. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	29
2. Data for Participant 1. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	31
3. Data for Participant 2. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	33
4. Data for Participant 2. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	35
5. Data for Participant 3. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	36
6. Data for Participant 3. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	38
7. Data for Participant 4. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	40
8. Data for Participant 4. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	41
9. Data for Participant 6. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	43
10. Data for Participant 6. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	44

List of Figures—continued

11. Data for Participant 7. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	46
12. Data for Participant 7. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	48
13. Data for Participant 8. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	49
14. Data for Participant 8. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	50
15. Data for Participant 9. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	52
16. Data for Participant 9. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	53
17. Data for Participant 10. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	55
18. Data for Participant 10. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	57
19. Data for Participant 11. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises	58
20. Data for Participant 11. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.....	61
21. Data Averaged Across All Participants and Session During Baseline, By Lifting Components. Each Panel Represents the Percentage of Repetitions Per Set, Across All Participants for the Specified Exercise.	62

List of Figures—continued

22. Sample of data for Participant 3. The Figure Represents the Percentage of Repetitions Performed Safely Per Set Across the Four Exercises..... 87

INTRODUCTION

Injuries in Weight Lifting

According to a survey conducted by the Centers for Disease Control and Prevention, among a representative sample of a civilian, noninstitutionalized population including 17,705 adults, 13.4% reported that they had participated in weight lifting during the previous month and 8.7% reported participating in weight lifting at least twice per week during the previous month. The majority of the adults indicating involvement in a regular weight lifting regimen were between the ages of 17 and 29 years of age (Galuska, Earle, & Fulton, 2002). Adult lifters who engage in recreational lifting on a regular basis are at-risk for injuries resulting from improper weight lifting practices.

The prevalence of injuries resulting from improper weight training technique is of serious concern. Weight lifting injuries accounted for approximately 56,400 emergency room visits in the United States during 1995 (National Electronic Injury Surveillance System, 1997). Risser (1990) presented data on specific musculoskeletal injuries related to weight training. According to the article, nearly 4,000 adolescents older than 14 years of age participate in power lifting and weight lifting tournaments, and more than 8,000 teenagers compete in body building events annually. Nerve damage, joint dislocations, and bone fractures are

reported to be among some of the serious injuries resulting from these activities. However, aggressive over-use of heavy weights has most commonly resulted in more serious injuries such as hip fractures and damage to knee cartilage. A second article by Risser (1991) identified the body parts most commonly injured during weight lifting. Injuries to the lower back were found to be most common, followed by injuries to the knees, chest, shoulders and elbows. Whereas the types of injuries vary, the author stated that muscle strains account for approximately 60% to 75% of all injuries during weight training.

Specific weight lifting related injuries have been reported in the literature such as: medial and lateral collateral knee ligament sprains resulting from squats, leg presses, and lunges with high loads or improper lower-extremity placement (Freeman & Rooker, 1995); medial meniscus cartilage tears associated with knee flexion exercises (Brady, Cahill, & Bodnar, 1982); pelvic avulsions caused by excessive tension (Brady et al., 1982); ruptures in the pectoralis muscle due to hyperextension in the final 30 degrees of humeral extension (Wolfe, Wickiewicz, Cavanaugh, & Shirley, 1992); and scaphoid wrist fracture related to the degree of dorsiflexion of the wrist (Reider, Yurkofsky, & Mass, 1993). In addition, several studies have reported that weight lifters experienced acute medical conditions such as high blood pressure (MacDougall, McKelvie,

Moroz, Sale, McCartney, & Buick, 1992; MacDougall, Tuxen, & Sale, 1985) and retinal hemorrhages (Pitta, Steinert, Gragoudas, & Regan, 1980).

Prevention

There have been a number of attempts to identify possible factors that cause risk taking while weight training. For example, a one-year study was conducted to examine factors potentially related to athletic-induced injuries among freshman physical education majors. The results indicated a variety of physical characteristics such as great upper-body strength, fast limb speed and flexibility that were associated with the injury-prone male. Accident-prone females were likely to have greater upper body strength, functional strength and heavier body weight than their male counterparts. Psychological traits, irrespective of gender, identified as potential factors in risk taking included lack of caution, low anxiety resulting in high risk-taking behavior, domination, and extraversion (Lysens, Ostyn, Auweele, Lefevre, Vuylsteke, & Renson, 1989).

Though there are likely multiple causes of injury, including physical and psychological characteristics, many studies suggest alternative reasons for the high rate of injuries involved in weight training. Risser, Risser, and Preston (1990) and Zemper (1990) speculated

that a lack of supervision for proper technique was the number one contributor to injuries resulting from improper weight lifting. Studies in which supervision was continuous report lower rates of injuries (Risser et al., 1990). As a result, Risser (1990) presented a prevention strategy consisting of a pre-program physical examination, proper training, and ongoing supervision by a trained individual.

In many cases lifters may have received incorrect instruction on safe lifting techniques. Several articles have addressed the issue of staying up-to-date on the most recent findings regarding the specific benefits and risks of each exercise. As stated by Vogel (2002), many times lifters use techniques that may have some advantage but ultimately compromise performance and safety. A number of exercises were targeted by Vogel as commonly misused. The lat pull down and the overhead press (in which the bar is lowered behind the neck) were identified as risky exercises. The author provided alternative techniques in which, during the same exercise, the bar was lowered in front of the head.

Standard practice for the dissemination of information on weight lifting practices consists of either web-based or printed journals and magazines. The following are the primary sources of information provided by experts to inform the recreational lifter; the American College of Sports Medicine (ACSM), American Council on Exercise (ACE), International

Federation of Sports Medicine (FIMS), Centers for Disease Control (CDC), Office of the Surgeon General, and World Health Organization (WHO). As a result, readers are limited to written descriptions of correct practices.

Unfortunately it is likely that, people who lift weight recreationally do not initiate contact with the latest information in order to insure safe lifting practices. Oftentimes, it is likely left up to trainers or coaches to provide corrective instruction regarding safe lifting. This heightens the risk for those individuals not associated with a team or under the supervision of a trainer, but who instead lift privately. There is a great need to identify and provide alternative means for the dissemination of information on the safe techniques in weight lifting to ensure the safety of all lifters.

Specific exercises. A recent article in *The Physician and Sportsmedicine* recommended safe techniques across 5 exercises to reduce injuries incurred during lifting (Reeves, Laskowski, & Smith, 1998).

These techniques were selected based on lifting-related injuries most commonly reported to physicians. The authors provided first the problem, or commonly occurring incorrect technique, followed by the correct form.

The first technique, the latissimus dorsi pull-down, also mentioned by Vogel (2002), when done incorrectly has been associated with rotator cuff damage and shoulder instability. When the weight is lowered behind the neck this excessively flexes the cervical spine, and can generate

potentially damaging forces across the glenohumeral joint. To reduce the likelihood of injury the authors recommend sitting, leaning back at the hips, gripping the bar slightly wider than shoulder width, and pulling the bar down in front of the head. The second technique, the knee extension, may result in hyperextension during the last 5 to 10 degrees of the movement, causing increased patellar compression. As a solution, the authors suggested shortening the range of movement to prevent hyperextension and extreme knee flexion. The third group of exercises, the bench press and the chest fly, can hyperextend the shoulders whenever the elbow is below or behind the lifter's frontal plane and place the pectoralis muscles at a mechanical disadvantage when done incorrectly. Often glenohumeral instability can result from either repetitive shoulder capsule damage or excessive traction on the acromioclavicular joints. To reduce the risk of injury the authors suggested that the lifter adjust the exercise machine or starting position so that his or her elbows are even with the frontal plane at the beginning of and during the exercise. The fourth technique, the military press, can cause extreme shoulder rotation, stress on the shoulder capsule, and stress on the inferior glenohumeral ligament, resulting in anterior shoulder instability and the risk of spinous process fracture or neck strains. A simple solution suggested was to lift the weight in front of the

neck. The fifth and final technique, the squat, is problematic when the squat is too deep, any time the thighs are parallel to the floor or lower. As a result, there can be an excessive amount of shear load on the knee where the articular cartilage is the thinnest. To prevent the occurrence of injury, the authors recommend avoiding a) deep squats, b) extreme hyperflexion/hyperextension, and c) maintaining lumbar spine stability during lifts.

Applied Behavior Analysis in Sports

Applied behavior analysis has been used to benefit athletic performance across a variety of sports, including: football (Komaki & Barnett, 1977; Ward & Carnes, 2002), swimming (McKenzie & Rushall, 1974), speed skating (Anderson & Kirkpatrick, 2002), basketball (Kladopoulos & McComas, 2001), track and field (Scott, Scott, & Goldwater, 1997) and soccer (Brobst & Ward, 2002; Ziegler, 1994). The variety of behavior analysis techniques used to increase athletic performance in the sports literature includes self-recording; frequent and contingent reinforcement; a package intervention of verbal praise, visual feedback and instruction; goal setting; training; prompting; and shaping.

As an example of behavior analytic approaches to improving athletic performance, Brobst and Ward (2002) evaluated the effects of public posting, goal setting and oral feedback on the skills of 3 high school

soccer players during practice. The authors monitored improvement on 3 categories of performance identified as most critical to the success of the team. Players were observed keeping and maintaining possession of the ball, moving to an open position during a game restart, and moving to an open position after passing the ball. The intervention was found to be effective across the three categories during practice but the effects did not generalize to the game setting. Additional methods were suggested to support transference of the improved performance to settings other than practice.

Allison and Ayllon (1980) proposed a behavioral coaching model as a strategy to facilitate the acquisition of motor skills. The coaching method combined 1) positive and negative reinforcement, 2) systematic use of verbal instructions and feedback, 3) positive practice, and 4) a time out procedure. The method was implemented across three sports: football, gymnastics, and tennis. A number of behavioral dimensions were selected in each area: blocking in football; backward walkovers, front hand springs and reverse skips in gymnastics; and the forehand, backhand, and the serve in tennis. The results indicated significant improvement following the introduction of the behavioral coaching method. Improvements were demonstrated across each sport. There was an increase over baseline of 46.3% in football, 49.9% in gymnastics and 49% in tennis.

Performance feedback. Performance feedback has been reported to be an effective intervention across a variety of performance areas, ranging from achievement in sports to compliance with occupational safety regulations. For example, Alavosius and Sulzer-Azaroff (1990) conducted a study to evaluate the acquisition and maintenance of health care routines as a function of feedback density. The study compared the effects of written instructions with continuous, intermittent, or no-feedback schedules on performance. The results suggested a small increase in acquisition after written instructions alone, whereas more rapid acquisition was observed when written instructions were combined with continuous feedback. In another study, Babcock, Sulzer-Azaroff, Sanderson, and Sciback (1992) documented the effects of training in addition to conducting a process group on safe practices. Results indicated that the combination of training and the process group contributed to an increase in safe practices. However, even greater improvement resulted from the addition of graphic feedback. Similar conclusions were discussed in a review of the literature on performance feedback by Alvero, Bucklin, and Austin (2001). Devries, Burnette, and Redmon (1991) found that performance feedback led to increases from 28% to 49% in nurses' compliance with glove wearing.

These represent only a few of the many studies that have used feedback to improve safety performance. In their review of performance feedback, Balcazar, Hopkins, and Suarez (1985) conducted a systematic evaluation of the consistency of the effects of feedback in 126 applications reported in published studies. The authors discussed the differential effects of feedback presented alone and in combination with rewards or with goal setting. The authors concluded that feedback alone did not improve performance uniformly across applications. However, feedback had more consistent effects when supplemented with contingent rewards and/or with goal setting. The authors suggested that the effects of feedback resulted primarily from a relationship with functionally differential consequences.

One type of feedback, corrective feedback, combines explicit suggestions for improving performance with standard performance feedback. For example, Wilson, Boni, and Hogg (1997) examined the effects of task clarification, positive reinforcement and corrective feedback on the courtesy exhibited by police staff. During the feedback phase the observers randomly selected one or two of the target behaviors monitored on a behavioral checklist during the observation session to discuss with the officer. Performance improvement was apparent immediately

following the introduction of corrective feedback and positive reinforcement.

Corrective feedback has also been used to improve safe performance. Reber and Wallin (1994) used performance management techniques to improve offshore oilfield diving safety. An intervention package of task clarification, goal setting and corrective feedback was implemented. Employees participated in a training session in which they received clarification of safety responsibilities and set a performance goal of 100%. Following training, safety inspectors conducted random observations an average of three times a week and were instructed to provide corrective feedback if they witnessed an unsafe act. The results indicated a significant reduction in injuries and saved the program an estimated \$283,510 in the first year.

Overcorrection. Overcorrection, “a contingency on inappropriate behavior requiring the person to engage in an effortful response that more than corrects the effects of the inappropriate behavior” has proven to be effective at reducing problem behaviors exhibited by children in academic settings (Malott, Malott, & Trojan, 2000, p.66). Overcorrection involves both feedback and a related consequence. Epstein, Doke, Sajwaj, Sorrell, and Rimmer (1974) examined the effects of overcorrection on several inappropriate behaviors of children. In this study, inappropriate hand

movements (i.e., hand contact with the nose, mouth, or eyes) were followed by an overcorrection technique that required that the child place his/her hands at his/her side within 2 s and remain in that position for a total of 15 s. Results for both children in the study suggested that the “hand” overcorrection procedure reduced inappropriate hand movements.

One type of overcorrection, positive practice, requires that a person practice engaging in the appropriate behavior. Positive practice combines both corrective feedback and the consequent response of repeating an appropriate behavior after the occurrence of each inappropriate behavior. Carey and Bucher (1983) studied the effects of long and short durations of positive practice overcorrection to reduce off-task behavior after instruction to perform an object-placement task. When off-task behavior occurred, the therapist started a stopwatch and used hand-over-hand guidance to assist the child in placing the objects in the correct hole. The therapist was instructed to ensure correct responding at a rate of at least one every 5 s for either 30 s during the short practice phase or for 3 min during the long practice phase. Results suggested that both the short and long practice conditions led to a rapid reduction in off-task behavior and acquisition of correct object placement. Negative side effects, such as aggression and disruption were observed as a result of the long positive practice condition. In conclusion, the authors recommended the use of

short positive practice to reduce inappropriate behavior and to increase desired alternative behavior. Positive practice could be instrumental in improving lifting techniques in which the participant is forced to “feel” the difference between lifting techniques. Ideally, during positive practice the participant would come in contact with the appropriate proprioceptive stimuli related to the correct technique. However, a literature review conducted for the purposes of this study found no studies evaluating positive practice techniques in weight training situations.

Purpose

The current study examined the effects of corrective feedback and positive practice on body position during targeted weight lifting exercises. Specific unsafe techniques suggested in the literature were targeted for improvement using a low cost and minimally intrusive intervention.

METHOD

Participants and Setting

Ten participants were selected for the study. The participants consisted of 7 male and 3 female college students attending a midwestern university. Participants were undergraduate students between the ages of 18 and 25 who were currently lifting weights regularly or who had lifted weights regularly in the past. The participants' characteristics for inclusion in the study were chosen based on the prevalence of injuries occurring in young adults as reported in the literature. Participants were eligible for membership or must have been current members of the Western Michigan University Recreation Center. Participants selected for the introductory meeting were asked to provide a course schedule. Participants were selected based on their performance of the four exercises targeted in the study and on their availability to attend two sessions a week for approximately 12 weeks.

Recruitment took place in the entrance of the university recreation center. Students interested in personalized instruction in weight training exercises were provided the opportunity to sign up to participate in an initial screening process in which they were observed lifting weights without instruction. Students scoring 67% safe or lower on 2 or more of

the 4 targeted exercises for 2 sets of 10 repetitions were selected as participants for the study as long as they met all other requirements.

Initially, 11 participants were selected, however, participant 5 terminated sessions during the first week of observation sessions due to time conflicts. The remaining 10 participants completed the study.

The study took place in the weight lifting room of a student recreation center at a large midwestern university. The weight room consisted of 88 pieces targeting both cardio and weight lifting workouts. Approximately 80 students per hour used the weight room, on average, between 6:00am and 10:00pm. Personal exercise trainers, employed by the university, were available at an additional cost. Otherwise, supervision was usually limited to untrained undergraduate floor staff who were primarily responsible for monitoring compliance with rules and performing basic equipment maintenance. The location was selected based on informal observations of high rates of unsafe techniques practiced by members using the weight room.

Dependent Variables

The study evaluated the effects of an intervention designed to increase the correct performance of four exercises reported in the literature as commonly at-risk among weight lifters (Reeves, Laskowski, & Smith, 1998). The four exercises included the latissimus dorsi

pulldown, the bench press and chest fly, the knee extension and the squat. During the course of the study, participants had the liberty to choose to perform either the chest fly or bench press. The participants were asked to commit to either the chest fly or the bench press for the duration of the study. For the purposes of the study the two exercises were interchangeable. None of the participants selected the chest fly. The four target exercises were selected because they are likely to be used to some extent by most weight lifters across age groups and levels of experience.

The following operational definitions of the four exercises were contained in the observation checklist used by experimental observers (see Appendix A). The squat and bench press were performed using free weights, whereas the latissimus dorsi pulldown and the knee extension were performed using machines. Correct technique using the latissimus dorsi pulldown was evidenced by the lifter leaning back at the hips, maintaining a straight back, gripping the bar slightly wider than shoulder width, and pulling the bar down slightly in front of his or her head. During the bench press, lifters were to adjust the exercise machine or starting position so that their elbows were even or above the frontal plane at the start of and during each repetition. In addition, during the bench press, the lifter was to maintain a straight back with minimal lifting of the stomach. During performance of the knee extension, lifters were to avoid

hyperextension at the completion of knee extension by decreasing the range of motion starting in a bent position of 45 degrees and extending no more than 170 degrees (just less than straight). While performing the squat, lifters were to keep thighs above parallel while maintaining a straight back.

Data Collection Procedure

A checklist specifying the correct components within each of the four exercises was used to calculate a percentage safe score for each set of 10 repetitions for each exercise performed per session observed. Three observers were each assigned two or more participants for the entire study. During observation sessions the observer watched only one participant at a time. Participants were observed twice per week for 30 minutes. Each participant was asked to complete 3 sets of 10 repetitions during each observation session. Observation sessions were separated by at least one day of rest. Once each week, reliability sessions were conducted whereby a second (i.e., reliability) observer joined the primary observer to conduct simultaneous but independent observations of the participant's behavior.

Follow-up Sessions

Two follow-up sessions were conducted four weeks after participants 1 and 2 completed primary observation sessions. The follow-

up sessions repeated baseline conditions in which neither participant received any information regarding safe lifting and did not perform practice sets. Follow-up sessions were conducted to demonstrate maintenance of safe performance without the administration of either intervention.

Independent Variables

Positive practice was employed independently across the 4 exercises. Positive practice was comprised of corrective feedback and practice. Corrective feedback occurred at the end of each set and consisted of explicit verbal summaries of the participant's performance on the relevant components of the targeted exercises and suggestions for improvement. For example, the observer might have said, "I noticed that you lifted the bar behind your head. Next time, you might want to lift the bar in front of your head to prevent injury" (see Appendix B for a copy of the script that was used by the observers). Before each session during positive practice the observer would remind the participant of the contingency, "if any of the repetitions within a set are performed at-risk you will be asked to practice the lift safely five times."

The second component, practice, consisted of the observer instructing the participant after each set to correct and repeat the techniques that were originally performed incorrectly. The observer

explained the correct form and, if needed, physically guided the participant so that the participant was able to practice the correct technique five times without weight. If at any point during the five practice trials the participant began to use incorrect technique the observer immediately guided the participant into the safe position. This was repeated for all targeted exercises that were observed as at-risk during one or more repetition. Participants did not exceed three practice sessions (i.e., one for each set) of five repetitions for each of the four exercises during a single session. In case participants questioned the suggestions offered, observers were equipped with a specific script specifying the empirical support and rationale behind each of the corrections.

A second independent variable was employed for three participants, or in other words, one participant observed by each research assistant. Participants were randomly selected to receive verbal instructions on safe lifting techniques after baseline and prior to receiving positive practice. See Appendix B for a copy of the observer script for the information phase.

A third independent variable, passive observation, was utilized across the performance of one participant. The participant performed each of the four exercises immediately following another participant receiving positive practice. No direct intervention was provided.

Procedure

During recruitment, research assistants were stationed across from the card swipe area in the entrance of the recreation center. A sign was posted soliciting voluntary participation in a study regarding weight lifting practices. Students interested in individualized weight lifting instruction were provided a card with screening session dates, times and location. Volunteers were instructed on the purpose and procedures of the screening session. During the screening session volunteers were observed engaging in the four exercises. Those volunteers who qualified (those who scored 67% or lower on two or more of the four exercises for 2 sets of 10 repetitions) received a second card specifying the date, location and time of the introductory meeting. The volunteers who qualified were asked to provide contact information at this time. Volunteers who were not selected were debriefed by an observer. The observer reviewed the volunteer's performance based on the checklist and encouraged the volunteer to continue to lift safely in the future.

Experimental design. An ABC multiple-baseline design across exercises was utilized to evaluate the effects of information and positive practice on safe lifting techniques. The interventions were introduced to 2 exercises at a time across all participants.

Baseline. During the introductory meeting, each participant completed a symptoms inventory to document reports of previous injuries that might have been related to improper lifting techniques. The inventory was completed a second time at the end of the study to examine changes in reported symptoms potentially resulting from the intervention (see Appendix C for a copy of the symptoms inventory). Before completing the preliminary inventory, and prior to data collection, participants were asked to sign a consent form during an informational meeting (see Appendix D for a copy of the consent form). The consent form primarily discussed the observation procedures, any risk related to participation in the study, the importance of consistent attendance during scheduled sessions, the four required exercises and the optional exercises prescribed by an exercise physiologist in case participants were interested in continuing their workout following the observation session. Participants recorded a beginning weight for each of the four exercises, and their preferred sequence of exercises in the designated areas located on the consent form. Participants were instructed to maintain the sequence selected throughout the study. Participants were given the option of increasing or decreasing the amount of weight lifted and they were encouraged to record the weight amount lifted for each set throughout the study. The program was summarized on a form indicating the number of

repetitions, sets and amount of weight used in the sessions (see Appendix E for a copy of the weight training form). Participants were informed that an observer would monitor compliance with completing the form. Finally, participants were asked to provide a copy of their course schedule and were paired with an observer to work out a schedule of observation sessions. Participants were asked and encouraged to attend scheduled sessions throughout the study.

During baseline the observer monitored the percentage of safe components per set per set during each of the 10 repetitions and 3 sets for all 4 exercises using the observation checklist. The observer withheld feedback and suggestions during this phase. Participants were asked to work out as they would under normal circumstances.

Information. One participant observed by each of the three research assistants was exposed to an information phase in which he or she was provided a brief verbal description of the correct way to perform each of the exercises. Following the brief information phase, and once the data stabilized, the participants began positive practice.

Positive practice. All participants engaged in positive practice following either baseline or instruction conditions, for each of the 4 exercises, staggered over time. At the end of each set, the observer identified any of the components of the targeted exercises that were

performed incorrectly. The observer described the correct technique and prompted the participant to practice the correct technique five times without weight. During this time, the observer physically guided the participant into the correct posture and if necessary assisted the participant for the remaining practice repetitions. The participant performed 5 practice trials (i.e., reps) without weight after each set in which one or more components were performed incorrectly.

Passive observation. One participant did not receive information or positive practice. Participant 10 performed the four exercises during the same observation sessions as participant 11. Participant 11 performed each of the four exercises first under baseline and positive practice conditions. Participant 10 was scored using the checklist however, no direct intervention was provided.

Debriefing. Participants were debriefed on the rationale behind the observations immediately following the introduction of the first intervention. However, additional information was provided after the final observation session. During the debriefing session each participant received feedback regarding his or her performance over the course of the study. Participants were given the option of reviewing their performance graphs. Participants were asked to complete a questionnaire and a second symptoms inventory to provide feedback to the principle investigator

regarding participation in the study (see Appendix F for a copy of the debriefing questionnaire).

Observer Training and Interobserver Agreement

All observers were trained using video footage modeling a sample observation session. In addition, observers practiced scoring lifting techniques shown on videos until all observers reached 90% agreement for five or more consecutive sets. To standardize observer training, observers were instructed using the observer script (Appendix B), which described the prescribed procedures for each phase. Before conducting actual observations with participants, all observers were required to demonstrate proficient use of the checklist (i.e., 90% agreement or better).

Interobserver agreement checks were conducted by secondary observers for 49% of all sessions and these checks were distributed evenly across phases. Interobserver agreement checks were conducted approximately once a week for each participant, and were calculated based on the percentage of safe components per set reported by each observer per observation. Point-by-point agreement was obtained when independent observers marked corresponding boxes on the observation checklist as either safe or unsafe. Percent agreement was calculated using the formula, the number of agreements divided by the number of total agreements and disagreements observed multiplied by 100.

A total of 135 observations took place over the duration of the study. Two independent observers collected data simultaneously for 66 sessions (49% of total sessions). The average agreement percentage across all four exercises was 97% (range: 87%- 100%; SD: 3%). Interobserver agreement (IOA) was calculated for each exercise. Mean IOA scores were 98% (range: 92%-100%; SD: 3%) for the latissimus dorsi pulldown, 97% (range: 93%-100%; SD: 3%) for the bench press, 96% (range: 87%- 100%; SD: 5%) for the squat and 99% (range: 96%-100%; SD: 2%) for the knee extension.

Treatment integrity. The extent to which the independent variables were implemented according to prescribed methods was assessed by both the primary and secondary observers. The primary observer recorded a small narrative on the bottom of the performance checklist describing a summary of the intervention delivered after each set. During interobserver reliability sessions the secondary observer recorded the percentage of completed components on an additional checklist comprised of the necessary steps within both interventions. The observer first collected reliability data on the participant's performance across the four exercises, followed by an assessment of the primary observer's delivery of the selected intervention using the appropriate intervention integrity

checklist (see Appendix G for a copy of the intervention integrity checklists).

Independent variable integrity was collected during normal reliability sessions for a total of 37 sessions (28% of all observation sessions) across participants and exercises in order to measure the accuracy of the implementation of the independent variables planned in the study. Independent variable integrity was also collected during baseline conditions in order to ensure that no additional information was provided at that time. An average of 100% compliance was calculated for the accurate use of baseline procedures, information, and positive practice.

RESULTS

Minimal effects on safe performance across the four exercises were demonstrated by all participants exposed to information. Alternatively, positive practice had substantial effects on the safe performance of all exercises, for all participants.

Group Performance

Baseline. During baseline conditions, the mean percentage of safe performance across the four exercises was 38% (range: 0%- 100%; SD: 23%). Safe performance of the latissimus dorsi pulldown averaged 43% (range: 0%- 100%; SD: 27%), the bench press was 30% (range: 0%- 100%; SD: 19%), the squat was 45% (range: 0%- 100%; SD: 30%), and the knee extension was 35% (range: 0%- 90%; SD: 20%).

Information. Three participants were exposed to information prior to positive practice, participants 1, 4 and 7. During the information phase, the mean percentage of safe performance across the four exercises for these three participants was 47% safe (range: 3%- 73%; SD: 17%). Safe performance of the latissimus dorsi pulldown averaged 61% (range: 50%- 74%; SD: 12%), the bench press was 43% (range: 30%- 51%; SD: 12%), the squat was 30% (range: 3%- 50%; SD: 24%), and the knee extension was 52% (range: 50%- 54%; SD: 2%).

Positive practice. All participants were exposed to positive practice. During positive practice, average safe lifting performance for all participants across the four exercises was 99% (range: 96%- 100%; SD:1%). Group performance of the latissimus dorsi pulldown was 99% safe (range: 96%- 100%; SD: 1%), the bench press was 99% safe (range: 98%- 100%; SD: 1%), the squat was 99% safe (range: 96%- 100%; SD: 1%), and the knee extension was 100% safe (range: 99%- 100%; SD: 1%).

Individual Performance

Participant 1. Figure 1 displays participant 1's performance across the four exercises. For participant 1, mean performance of the latissimus dorsi pulldown was 0% safe (range: 0%- 0%; SD: 0%) during baseline, 50% safe (range: 50%- 50%; SD: 0%) during information, and 99% safe (range: 75%-100%; SD: 5%) during positive practice. Mean performance of the bench press was 50% safe (range: 0%- 50%; SD: 20%) during baseline, 50% safe (range: 50%- 55%; SD: 1%) during information, and 99% safe (range: 85%- 100%; SD: 4%) during positive practice. Mean performance of the squat was 50% safe (range: 50%- 60%; SD: 3%) during baseline, 50% safe (range: 50%- 50%; SD: 0%) during information, and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of knee extension was 0% safe (range: 0 %- 0%; SD: 0%) during baseline, 53% safe

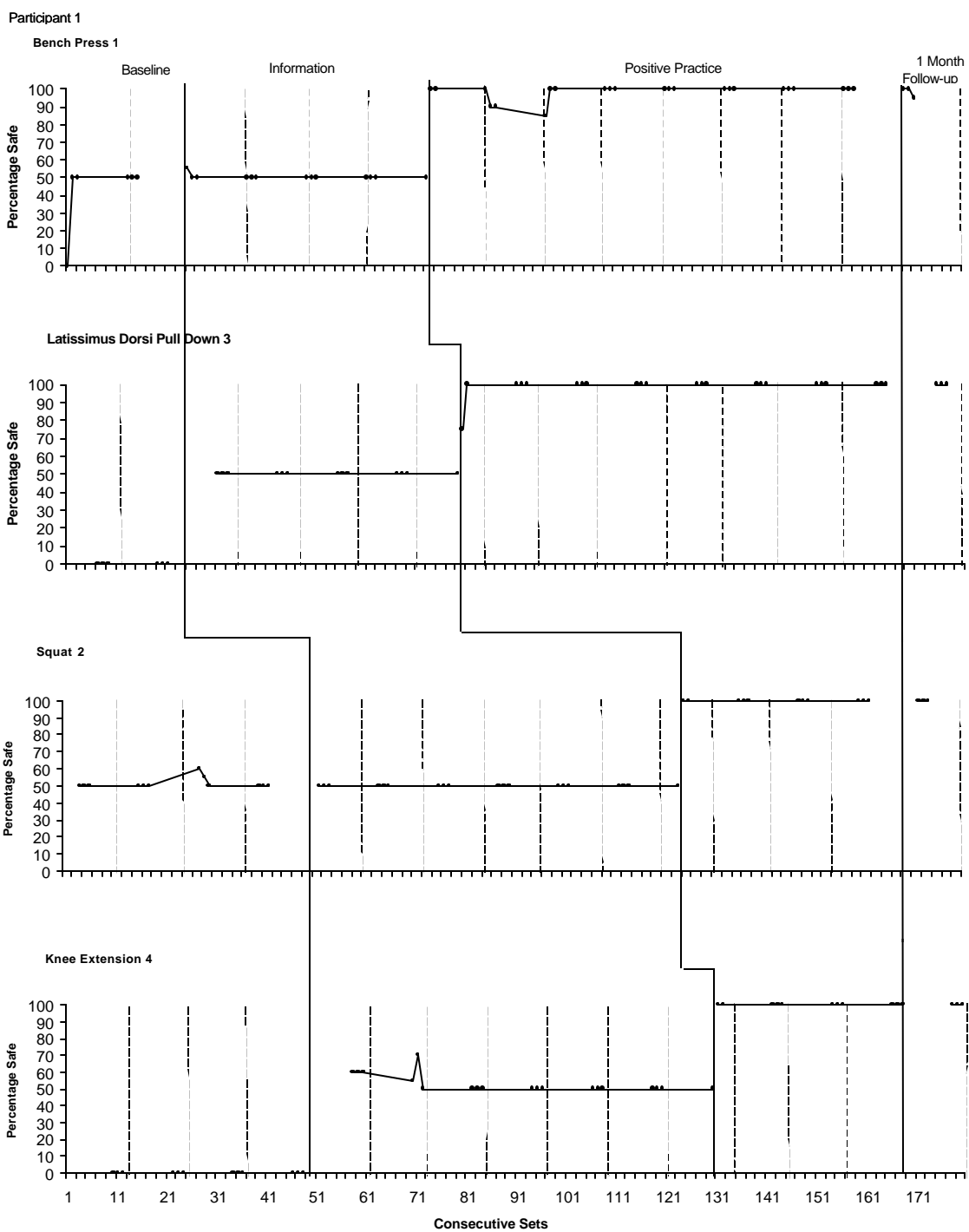


Figure 1. Data for Participant 1. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

(range: 50%- 70%; SD: 6%) during information, and 100% safe (range: 100%- 100%; SD: 0%) during positive practice.

Figure 2 displays the weight lifted by participant 1 across each of the four exercises. For participant 1, mean weight lifted for the latissimus dorsi pulldown was 110 pounds (range: 100-100; SD: 0) during baseline, 100 pounds (range: 100- 100; SD: 0) during information, 102 pounds (range: 100-112; SD: 5) during positive practice, and 100 pounds (range: 100-100; SD: 0) during follow-up. Mean weight lifted for the bench press was 135 pounds (range: 135-135; SD: 0) during baseline, 135 pounds (range: 135-135; SD: 0) during information, 135 pounds (range: 135-135; SD: 0) during positive practice, and 135 pounds (range: 135-135; SD: 0) during follow-up. Mean weight lifted for the squat was 135 pounds (range: 135- 135; SD: 0) during baseline, 135 pounds (range: 135- 135; SD: 0) during information, 167 pounds (range: 135- 185; SD: 25) during positive practice, and 135 pounds (range: 135-135; SD: 0) during follow-up. Mean weight lifted for knee extension was 50 pounds (range: 50- 50; SD: 0) during baseline, 66 pounds (range: 50-75; SD: 9) during information, 75 pounds (range: 75- 75; SD: 0) during positive practice, and 75 pounds (range: 75-75; SD: 0) during follow-up.

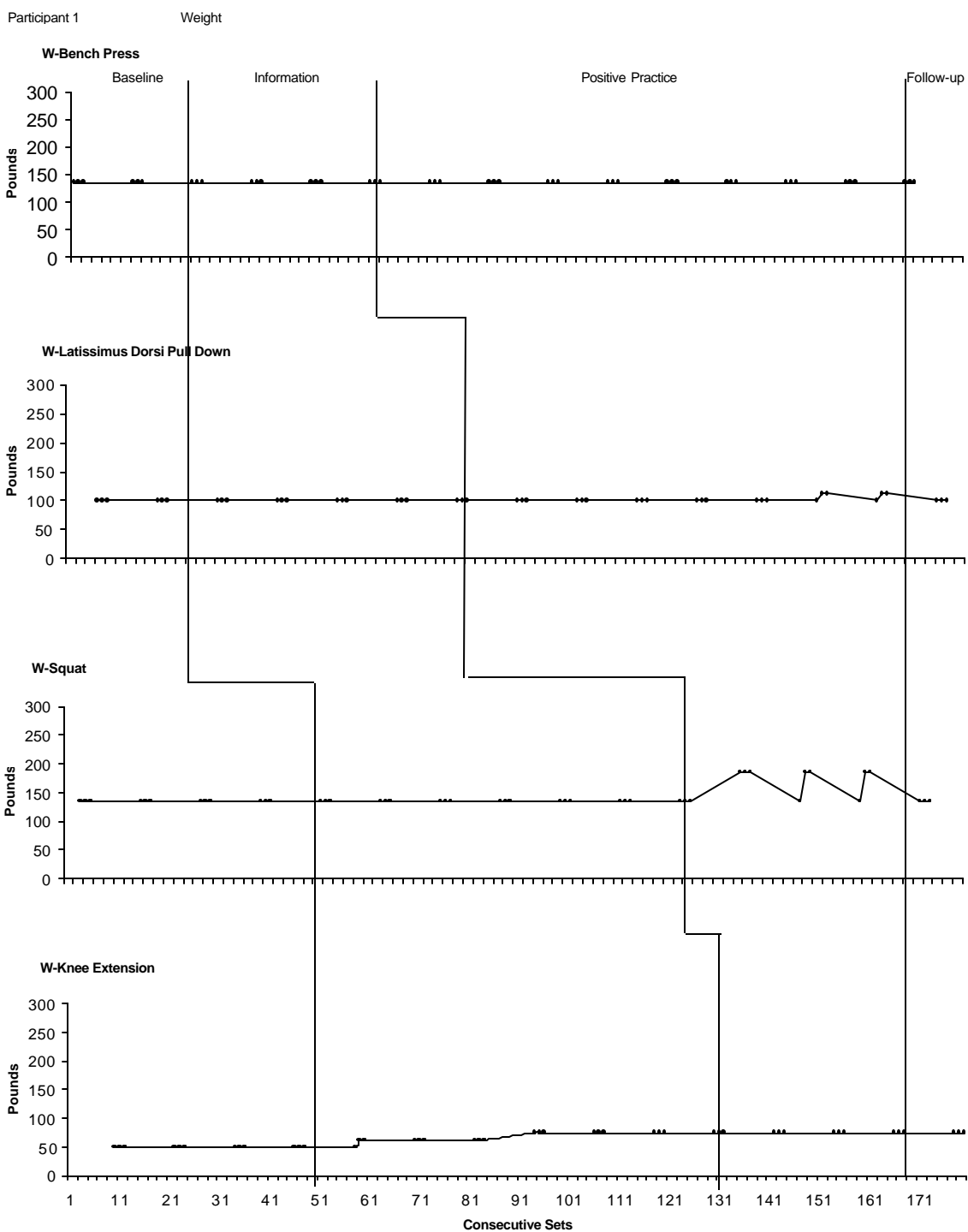


Figure 2. Data for Participant 1. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

Participant 2. Figure 3 displays participant 2's performance across the four exercises. For participant 2, mean performance of the latissimus dorsi pulldown was 50% safe (range: 50%- 50%; SD: 0%) during baseline and 100% safe (range: 100%-100%; SD: 0 %) during positive practice. Mean performance of the bench press was 8% safe (range: 0%- 50%; SD: 17%) during baseline and 100% safe (range: 100%-100%; SD: 0%) during positive practice. Mean performance of the squat was 50% safe (range: 45%- 50%; SD: 1%) during baseline and 99% safe (range: 85%-100%; SD: 3%) during positive practice. Mean performance of the knee extension was 38% safe (range: 0%- 50%; SD: 22%) during baseline and 100% safe (range: 100%-100%; SD: 0%) during positive practice.

Figure 4 displays the weight lifted by participant 2 across each of the four exercises. For participant 2, mean weight lifted for the latissimus dorsi pulldown was 88 pounds (range: 87-90; SD: 1) during baseline, 97 pounds (range: 87-100; SD: 5) during positive practice, and 125 pounds (range: 125-125; SD: 0) during follow-up. Mean weight lifted for the bench press was 95 pounds (range: 95-95; SD: 0) during baseline, 95 pounds (range: 95- 95; SD: 0) during positive practice, and 135 pounds (range: 135-135; SD: 0) during follow up. Mean weight lifted for the squat was 110 pounds (range: 95- 115; SD: 9) during baseline, 115 pounds (range:

Participant 2

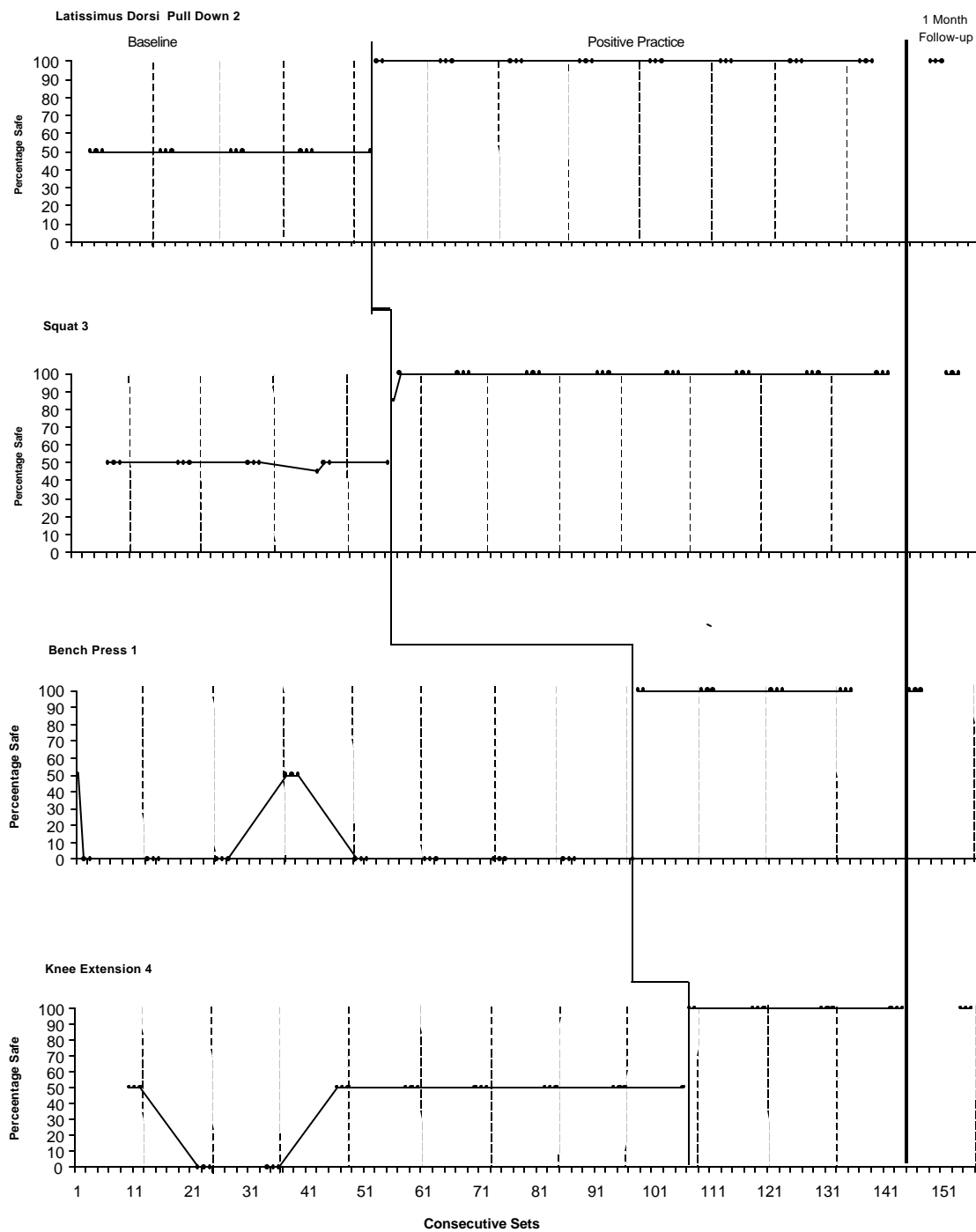


Figure 3. Data for Participant 2. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

115- 115; SD: 0) during positive practice, and 155 pounds (range: 155-155; SD: 0) during follow up. Mean weight lifted for knee extension was 96 pounds (range: 80- 100; SD: 8) during baseline, 100 pounds (range: 100-100; SD: 0) during positive practice, and 160 pounds (range: 160-160; SD: 0) during follow-up.

Participant 3. Figure 5 displays participant 3's performance across each of the four exercises. For participant 3, mean performance of the latissimus dorsi pulldown was 80% safe (range: 50%- 100%; SD: 12%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the bench press was 26% safe (range: 0%- 50%; SD: 12%) during baseline and 100% safe (range: 100%-100%; SD: 0%) during positive practice. Mean performance of the squat was 26% safe (range: 0%- 50%; SD: 22%) during baseline and 95% safe (range: 50%-100%; SD: 13%) during positive practice. Mean performance of the knee extension was 18% safe (range: 0%- 50%; SD: 24%) during baseline and 98% safe (range: 60%- 100%; SD: 8%) during positive practice.

Figure 6 displays the weight lifted by participant 3 across each of the four exercises. For participant 3, mean weight lifted for the latissimus dorsi pulldown was 114 pounds (range: 100-125; SD: 10) during baseline and 105 pounds (range: 110-112; SD: 6) during positive practice.

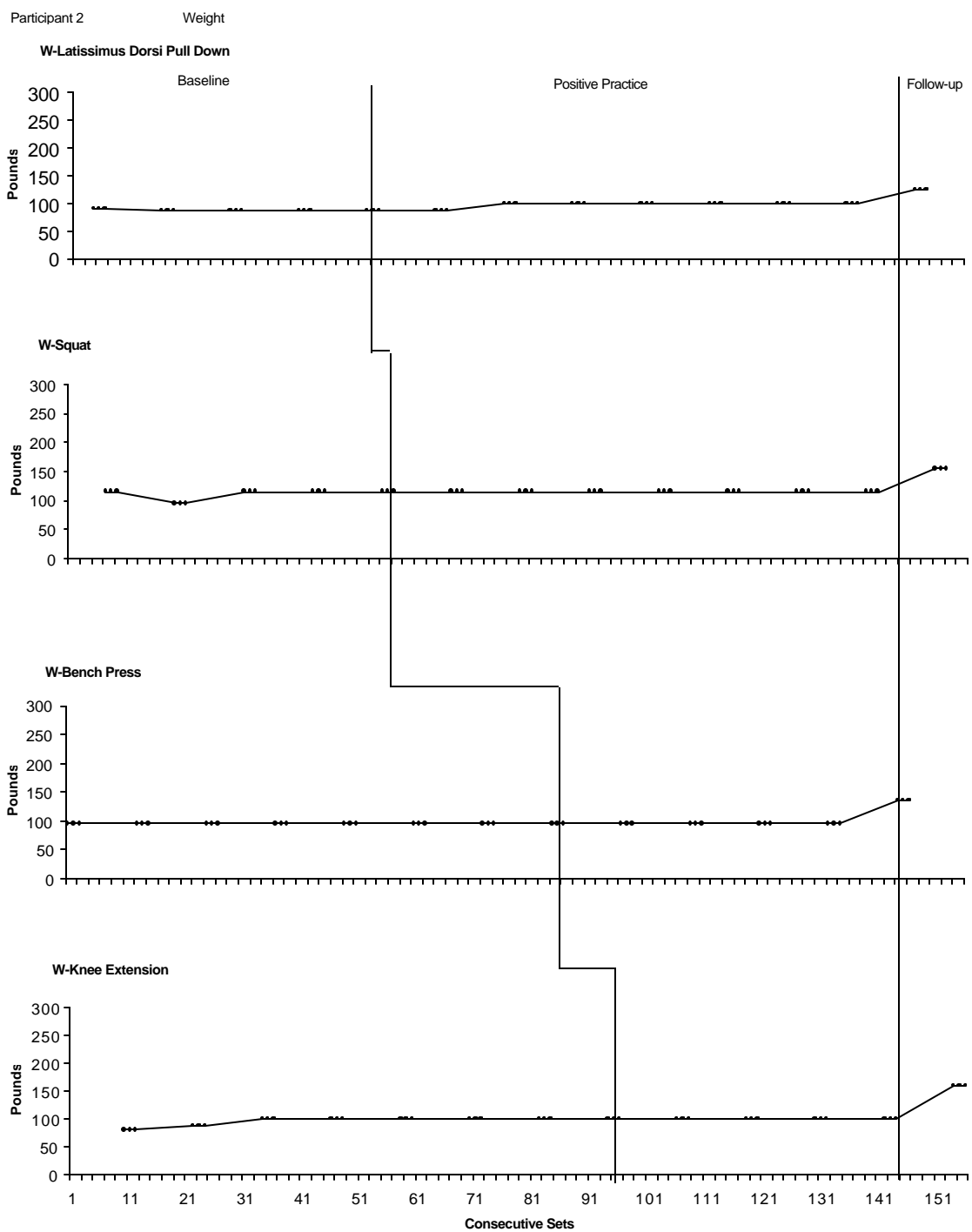


Figure 4. Data for Participant 2. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

Participant 3

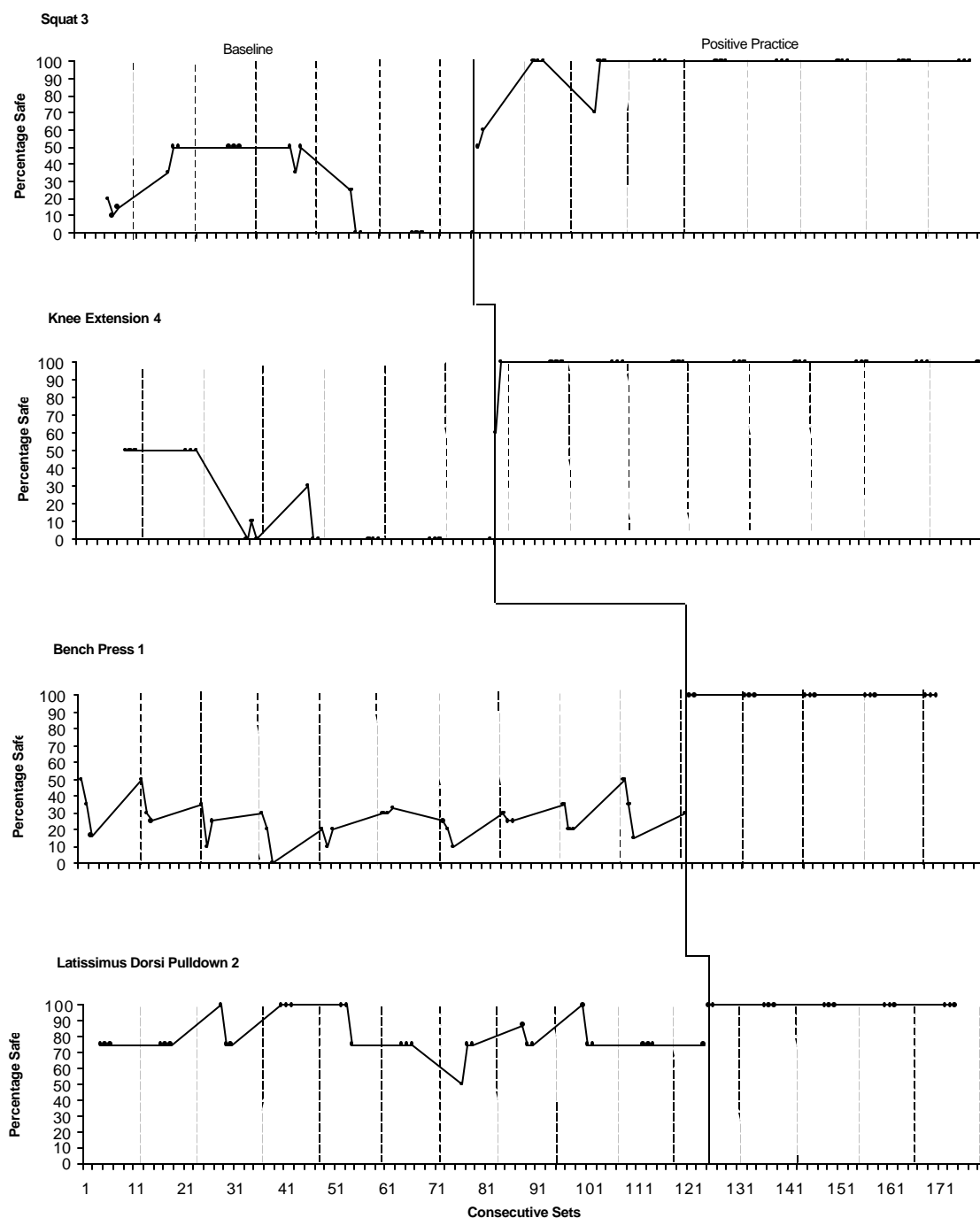


Figure 5. Data for Participant 3. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

Mean weight lifted for the bench press was 141 pounds (range: 135-145; SD: 5) during baseline and 162 pounds (range: 155- 165; SD: 5) during positive practice. Mean weight lifted for the squat was 167 pounds (range: 155- 185; SD: 17) during baseline and 193 pounds (range: 185- 205; SD: 9) during positive practice. Mean weight lifted for knee extension was 177 pounds (range: 175- 187; SD: 5) during baseline and 175 pounds (range: 170- 175; SD: 1) during positive practice.

Participant 4. Figure 7 displays participant 4's performance across each of the four exercises. For participant 4, mean performance of the latissimus dorsi pulldown was 62% safe (range: 50%- 75%; SD: 12%) during baseline, 60% safe (range: 50%- 75%; SD: 10%) during information, and 96% safe (range: 90%- 100%; SD: 3 %) during positive practice. Mean performance of the bench press was 40% safe (range: 10%- 50%; SD: 13%) during baseline, 30% safe (range: 0%-90%; SD: 21%) during information, and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the squat was 0% safe (range: 0%- 50%; SD: 22%) during baseline, 3% safe (range: 0%- 30%; SD: 9%) during information, and 99% safe (range: 90%- 100%; SD: 3%) during positive practice. Mean performance of the knee extension was 50% safe (range: 50%- 50%; SD: 0%) during baseline, 54% safe (range: 50%- 85%; SD: 10%) during

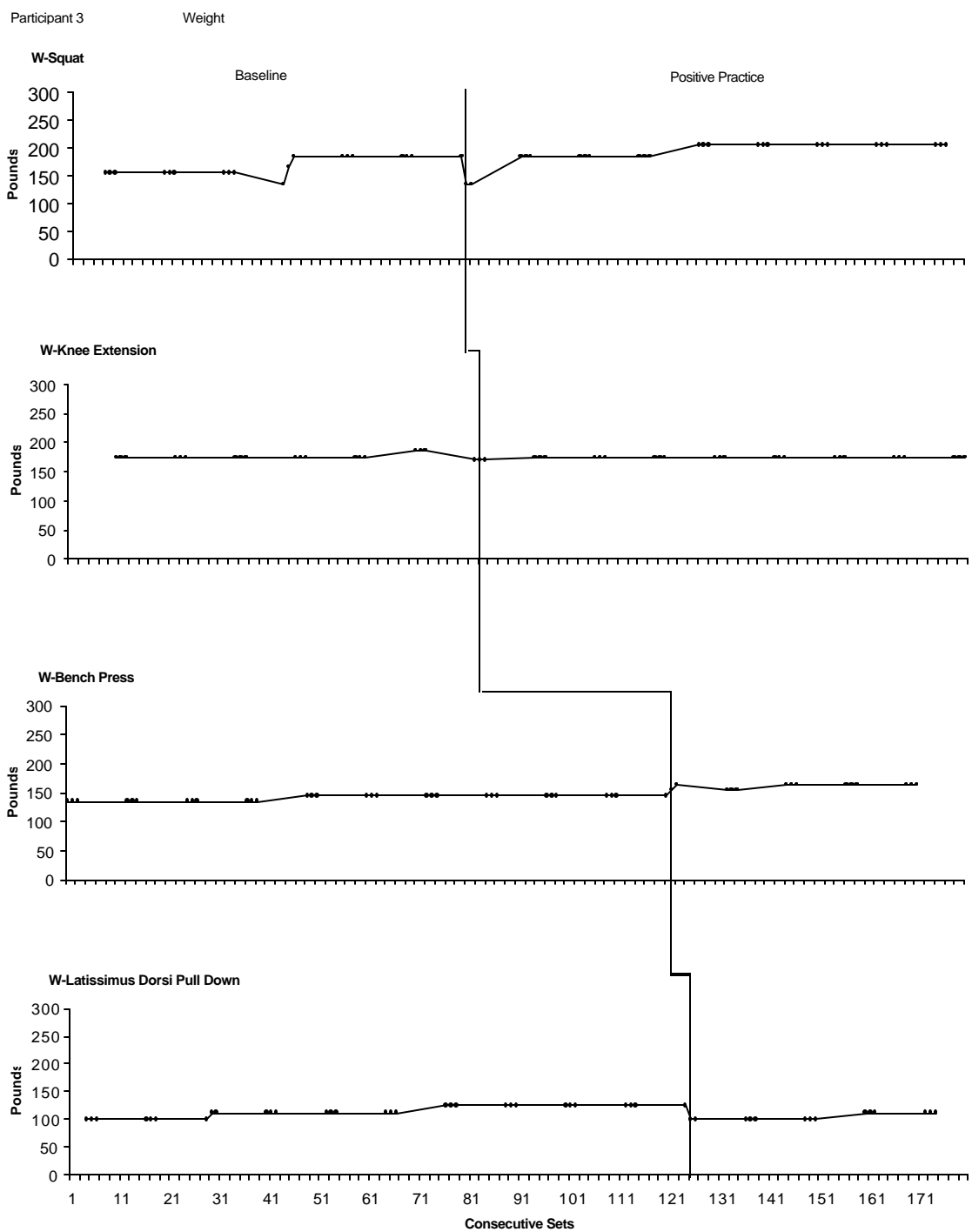


Figure 6. Data for Participant 3. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

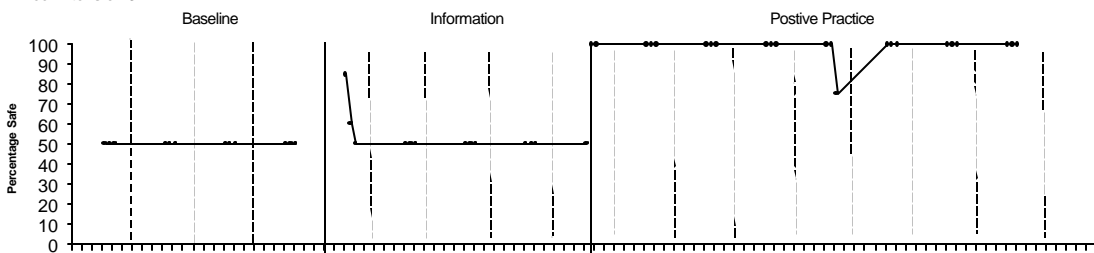
information, and 99% safe (range: 75%- 100%; SD: 5%) during positive practice.

Figure 8 displays the weight lifted by participant 4 across each of the four exercises. For participant 4, mean weight lifted for the latissimus dorsi pulldown was 66 pounds (range: 62-75; SD: 4) during baseline, 65 pounds (range: 62- 75; SD: 4) during information, and 66 pounds (range: 62-75; SD: 4) during positive practice. Mean weight lifted for the bench press was 72 pounds (range: 70-75; SD: 2) during baseline, 74 pounds (range: 70-75; SD: 2) during information, and 71 pounds (range: 62-75; SD: 6) during positive practice. Mean weight lifted for the squat was 68 pounds (range: 65- 75; SD: 5) during baseline, 77 pounds (range: 75- 85; SD: 4) during information, and 93 pounds (range: 85- 95; SD: 6) during positive practice. Mean weight lifted for knee extension was 56 pounds (range: 50- 75; SD: 11) during baseline, 53 pounds (range: 50-62; SD: 5) during information, and 54 pounds (range: 50- 62; SD: 6) during positive practice.

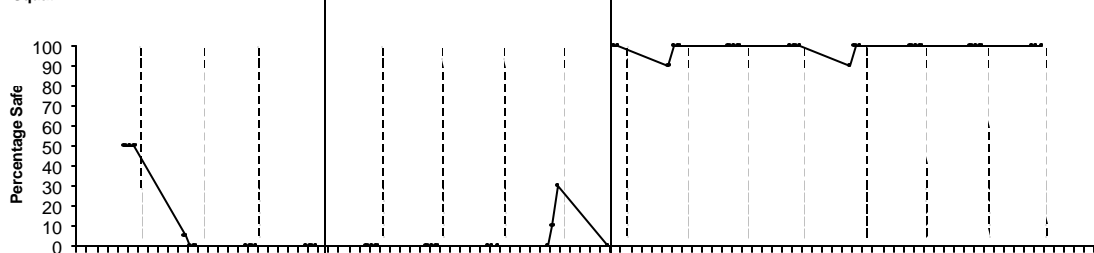
Participant 6. Figure 9 displays participant 6's performance across each of the four exercises. For participant 6, mean performance of the latissimus dorsi pulldown was 50% safe (range: 50%- 55%; SD: 1%) during baseline and 100% safe (range: 95%- 100%; SD: 1%) during positive practice. Mean performance of the bench press was 58% safe (range: 50%-

Participant 4

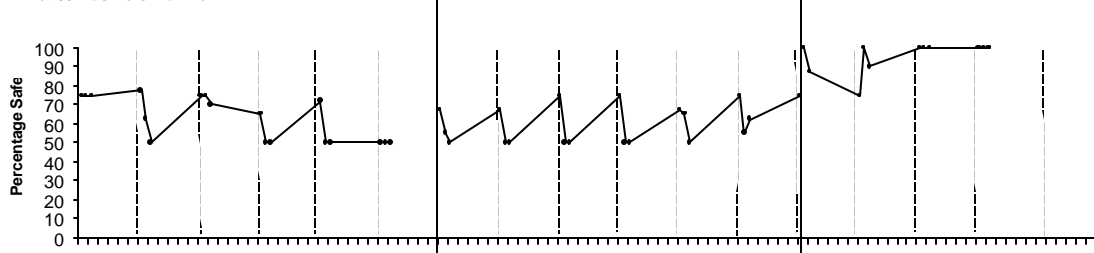
Knee Extension 3



Squat 4



Latissimus Dorsi Pull Down 1



Bench Press 2

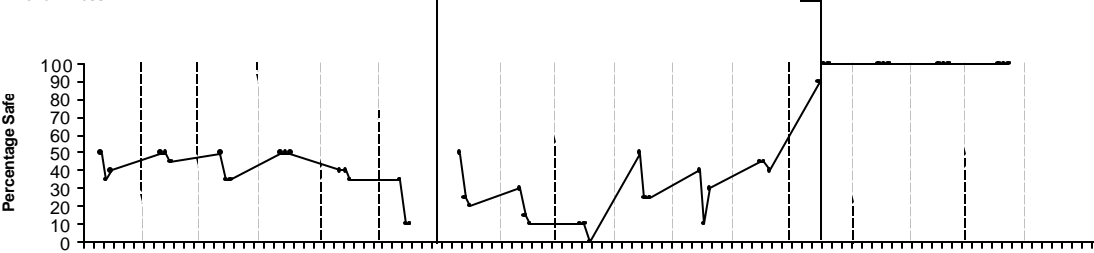


Figure 7. Data for Participant 4. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

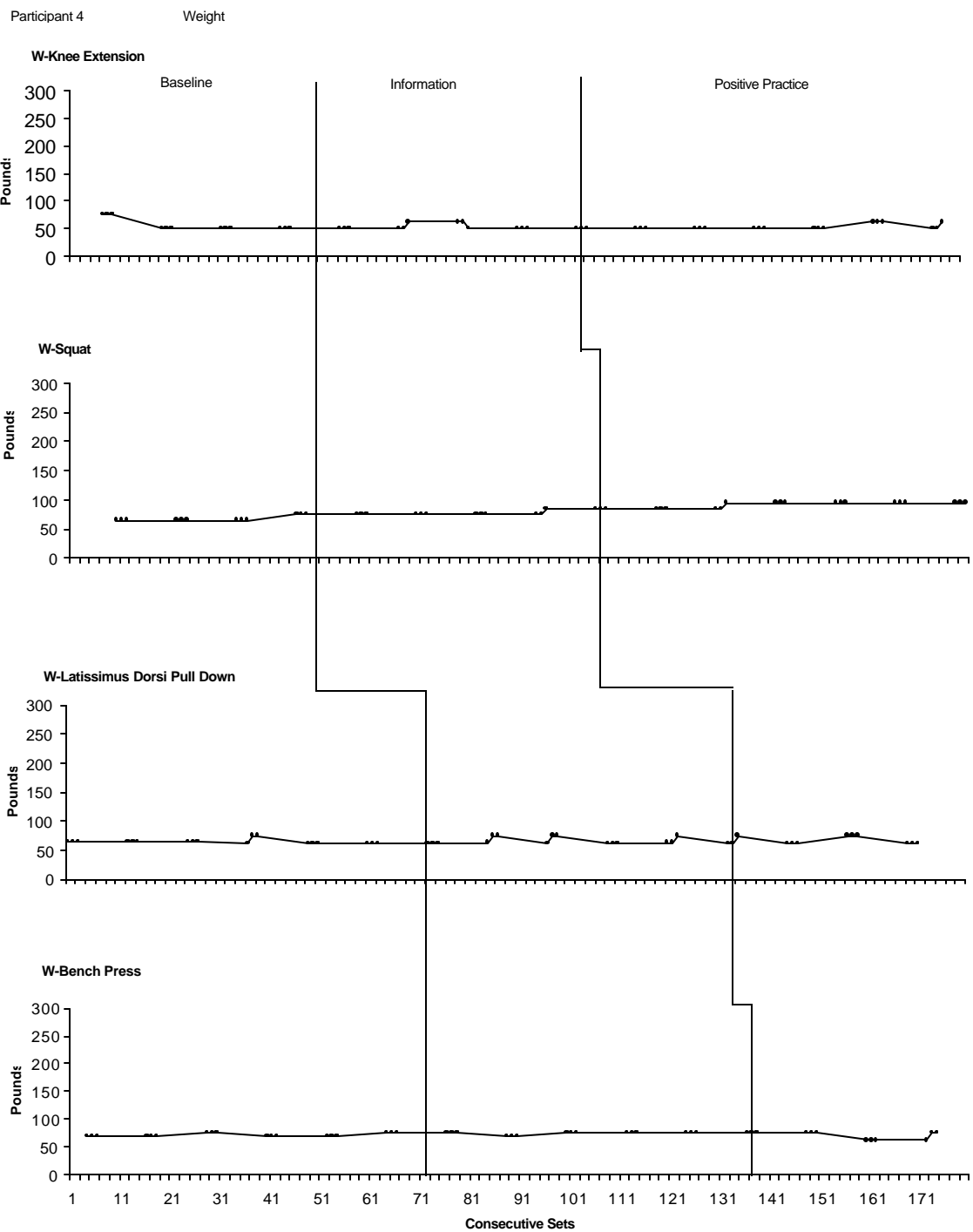


Figure 8. Data for Participant 4. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

100%; SD: 18%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the squat was 63% safe (range: 50%- 100%; SD: 23%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the knee extension was 40% safe (range: 0%- 90%; SD: 27%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice.

Figure 10 displays the weight lifted by participant 6 across each of the four exercises. For participant 6, mean weight lifted for the latissimus dorsi pulldown was 131 pounds (range: 125-138; SD: 7) during baseline, and 125 pounds (range: 125- 125; SD: 0) during positive practice. Mean weight lifted for the bench press was 139 pounds (range: 135-145; SD: 5) during baseline and 135 pounds (range: 135-135; SD: 0) during positive practice. Mean weight lifted for the squat was 104 pounds (range: 45- 145; SD: 44) during baseline and 123 pounds (range: 45- 135; SD: 31) during positive practice. Mean weight lifted for knee extension was 100 pounds (range: 87- 112; SD: 6) during baseline and 100 pounds (range: 100-100; SD: 0) during positive practice.

Participant 7. Figure 11 displays participant 7's performance across each of the four exercises. For participant 7, mean performance of the latissimus dorsi pulldown was 25% safe (range: 0%- 25%; SD: 12%) during baseline, 74% safe (range: 50%- 75%; SD: 6%) during information,

Participant 6

Latissimus Dorsi Pull Down 2

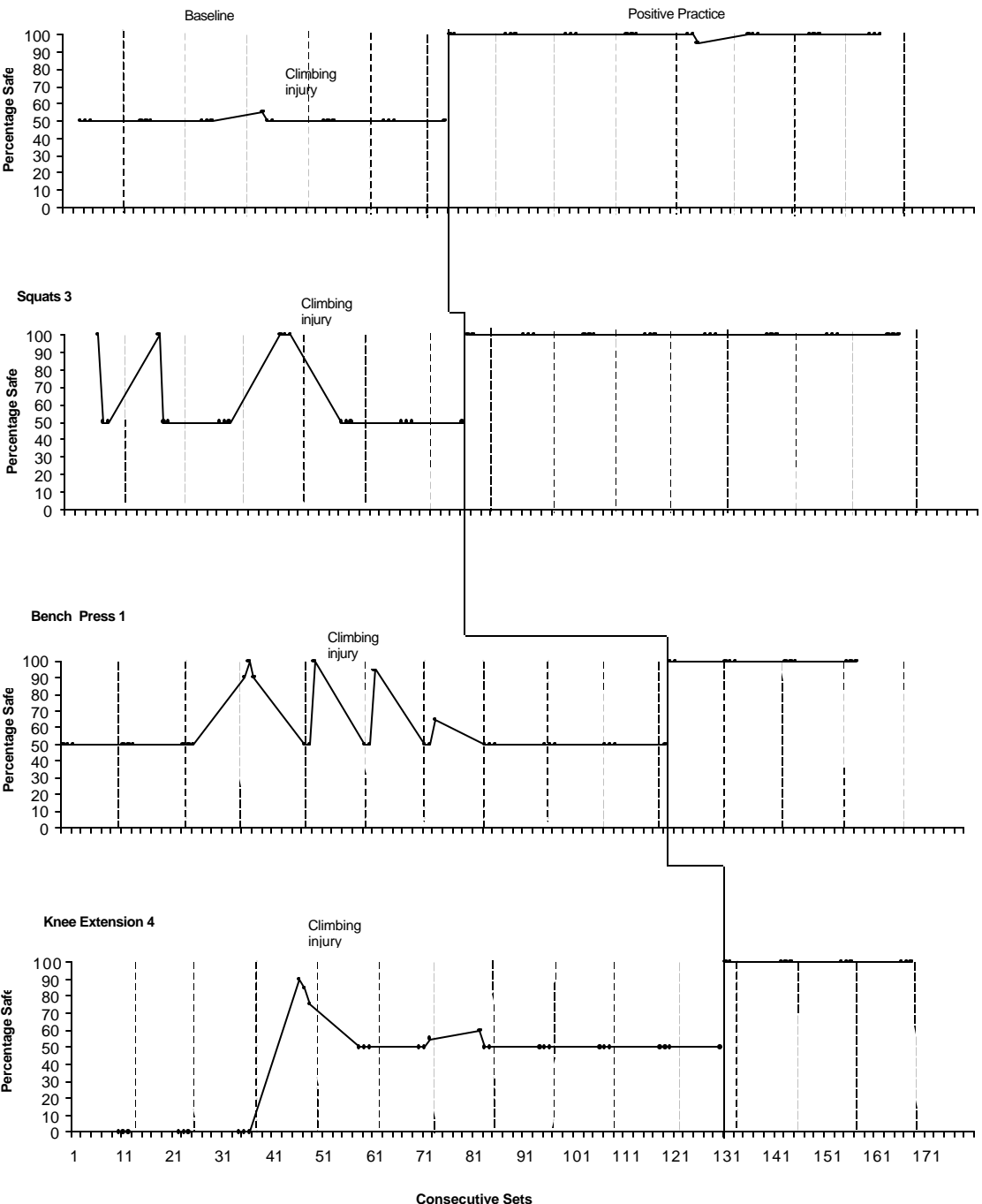


Figure 9. Data for Participant 6. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

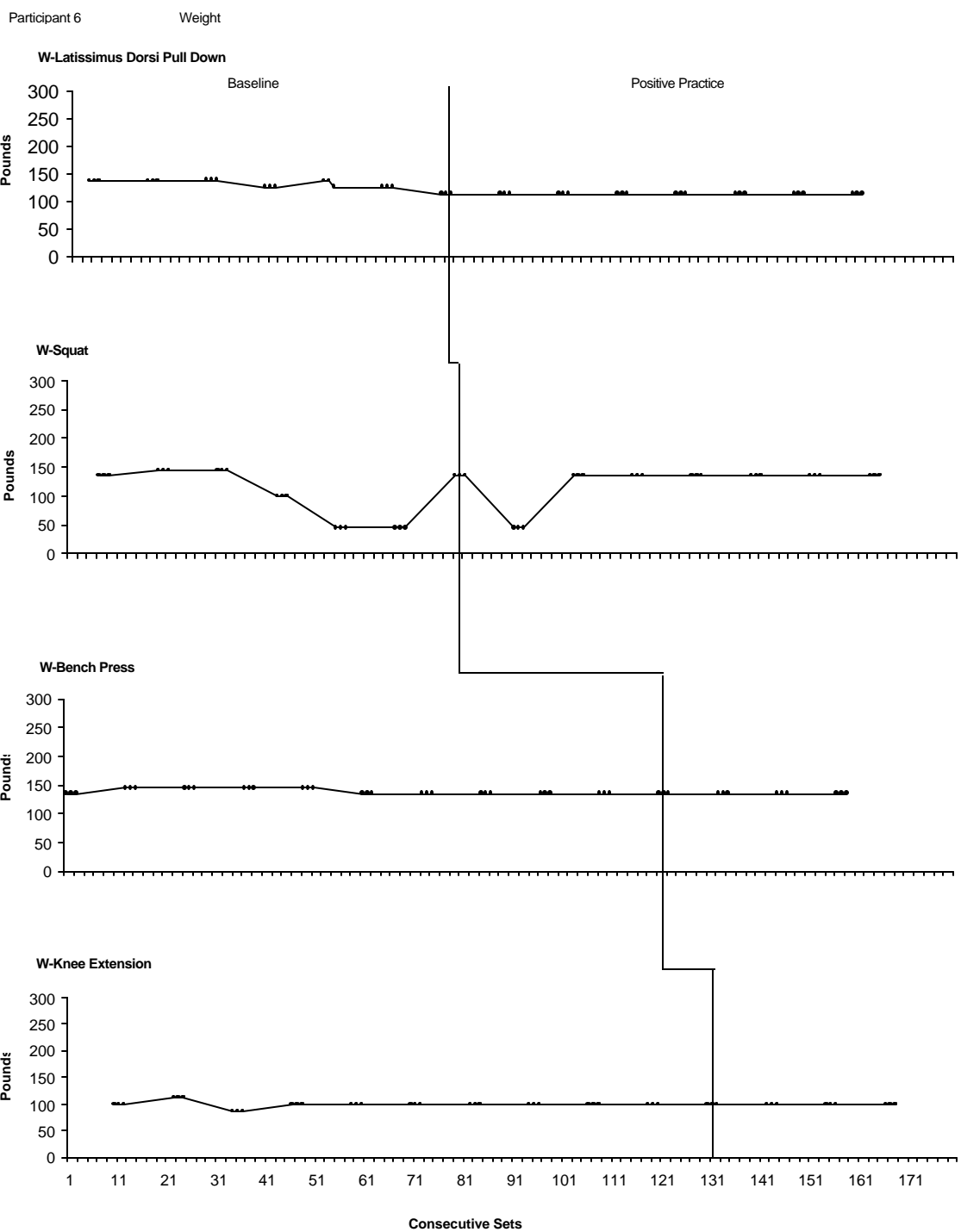


Figure 10. Data for Participant 6. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the bench press was 50% safe (range: 0%- 50%; SD: 19%) during baseline, 50% safe (range: 50%- 50%; SD: 0%) during information, and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the squat was 50% safe (range: 50%- 50%; SD: 0%) during baseline, 39% safe (range: 0%- 50%; SD: 22%) during information, and 98% safe (range: 50%- 100%; SD: 10%) during positive practice. Mean performance of the knee extension was 50% safe (range: 50%- 50%; SD: 0%) during baseline, 50% safe (range: 50%- 50%; SD: 0%) during information, and 100% safe (range: 100%- 100%; SD: 0 %) during positive practice.

Figure 12 displays the weight lifted by participant 7 across each of the four exercises. For participant 7, mean weight lifted for the latissimus dorsi pulldown was 54 pounds (range: 50-63; SD: 6) during baseline, 63 pounds (range: 63- 63; SD: 0) during information, and 63 pounds (range: 63-65; SD: 4) during positive practice. Mean weight lifted for the bench press was 45 pounds (range: 45-45; SD: 0) during baseline, 45 pounds (range: 45-45; SD: 0) during information, and 50 pounds (range: 45-50; SD: 1) during positive practice. Mean weight lifted for the squat was 45 pounds (range: 45- 45; SD: 0) during baseline, 53 pounds (range: 45- 55; SD: 4) during information, and 61 pounds (range: 55- 65; SD: 5) during

Participant 7

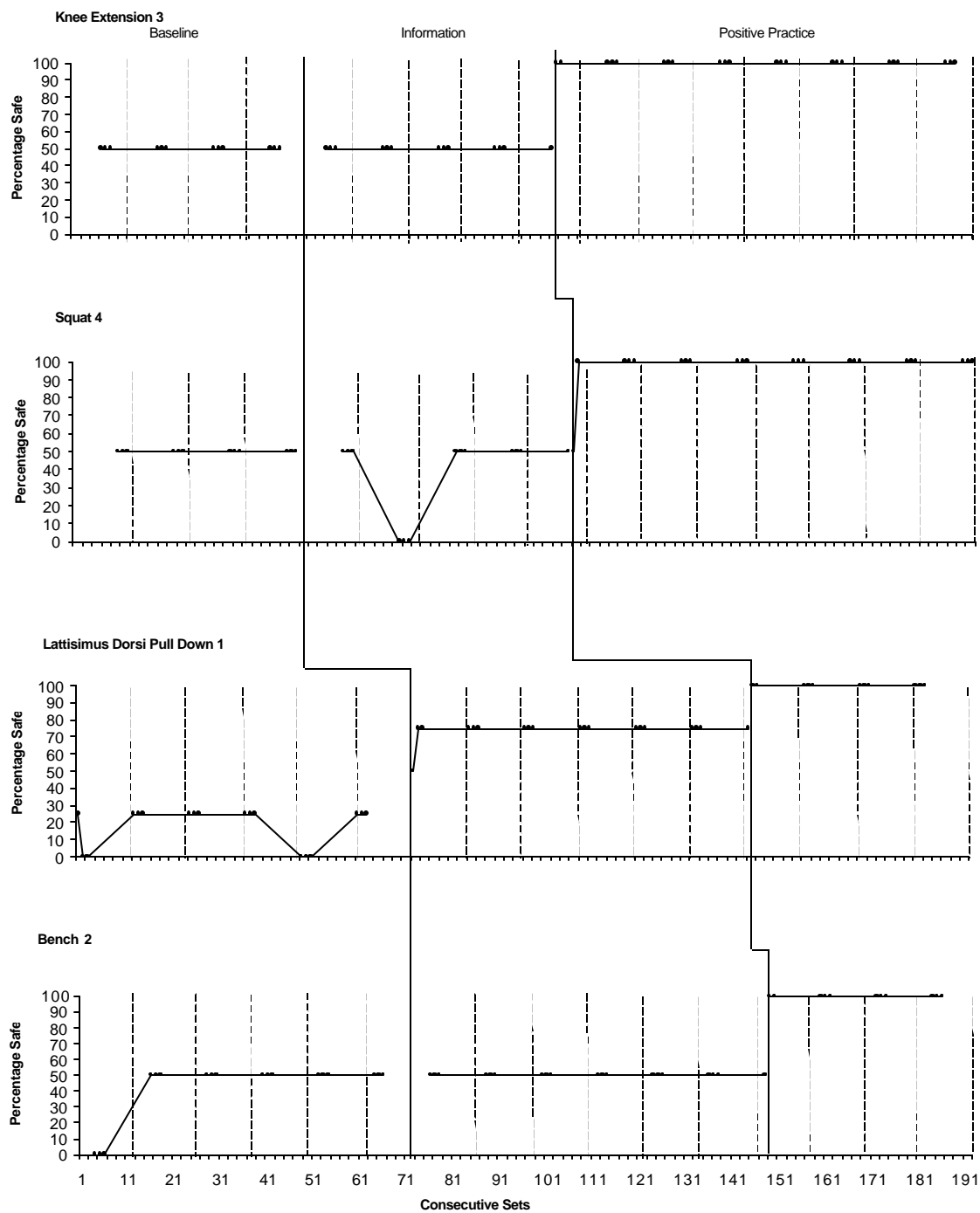


Figure 11. Data for Participant 7. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

positive practice. Mean weight lifted for knee extension was 37 pounds (range: 36- 38; SD: 1) during baseline, 38 pounds (range: 38-38; SD: 0) during information, and 43 pounds (range: 38- 63; SD: 9) during positive practice.

Participant 8. Figure 13 displays participant 8's performance across each of the four exercises. For participant 8, mean performance of the latissimus dorsi pulldown was 0% safe (range: 0%- 0%; SD: 0%) during baseline and 98% safe (range: 75%- 100%; SD: 6%) during positive practice. Mean performance of the bench press was 0% safe (range: 0%- 0%; SD: 0%) during baseline and 98% safe (range: 60%- 100%; SD: 9%) during positive practice. Mean performance of the squat was 56% safe (range: 0%- 100%; SD: 21%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the knee extension was 49% safe (range: 40%- 50%; SD: 2%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice.

Participant 9. Figure 15 displays participant 9's performance across each of the four exercises. For participant 9, mean performance of the latissimus dorsi pulldown was 38% safe (range: 0%- 50%; SD: 19%) during baseline and 98% safe (range: 75%- 100%; SD: 7%) during positive practice. Mean performance of the bench press was 37% safe (range: 0%-

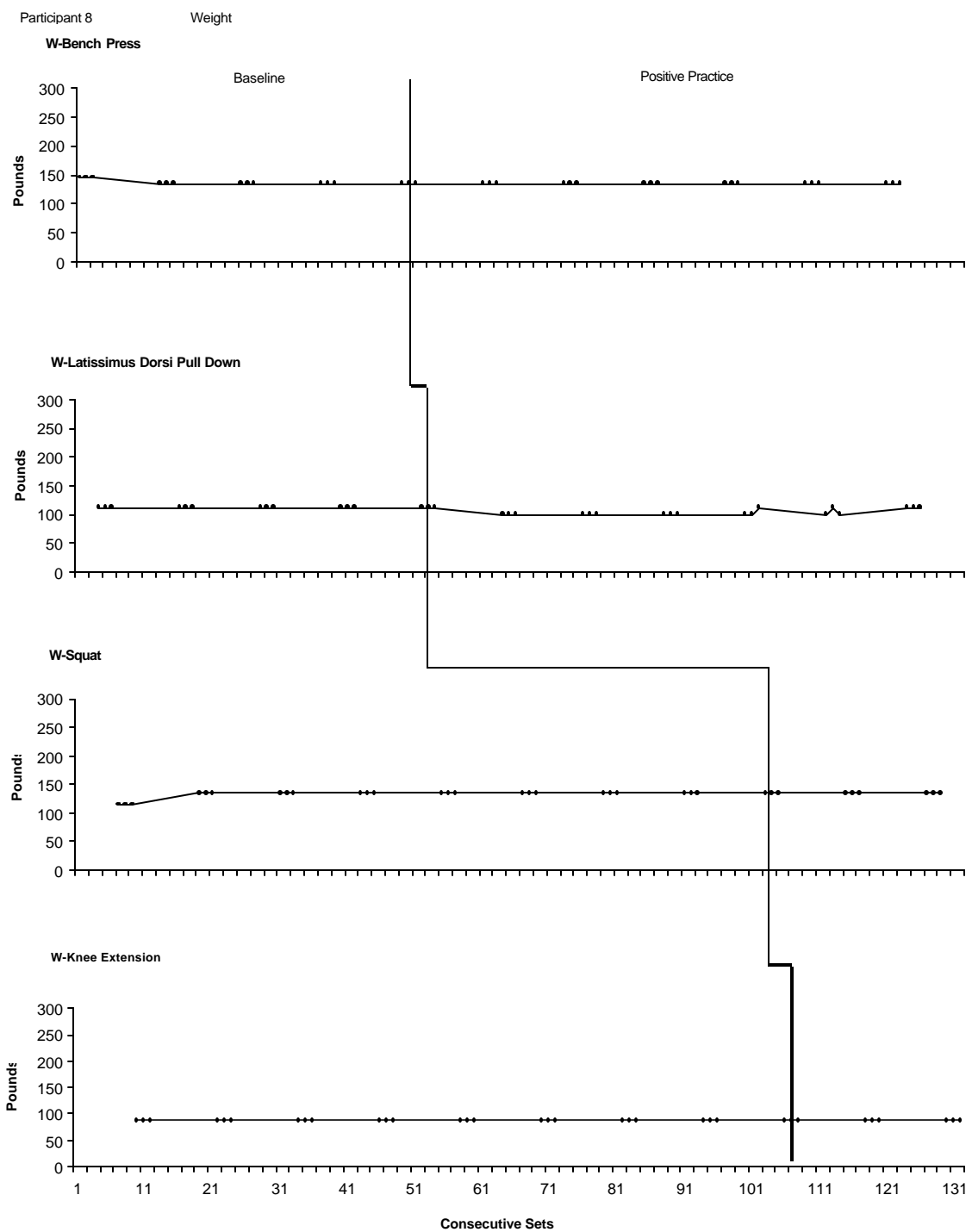


Figure 12. Data for Participant 8. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

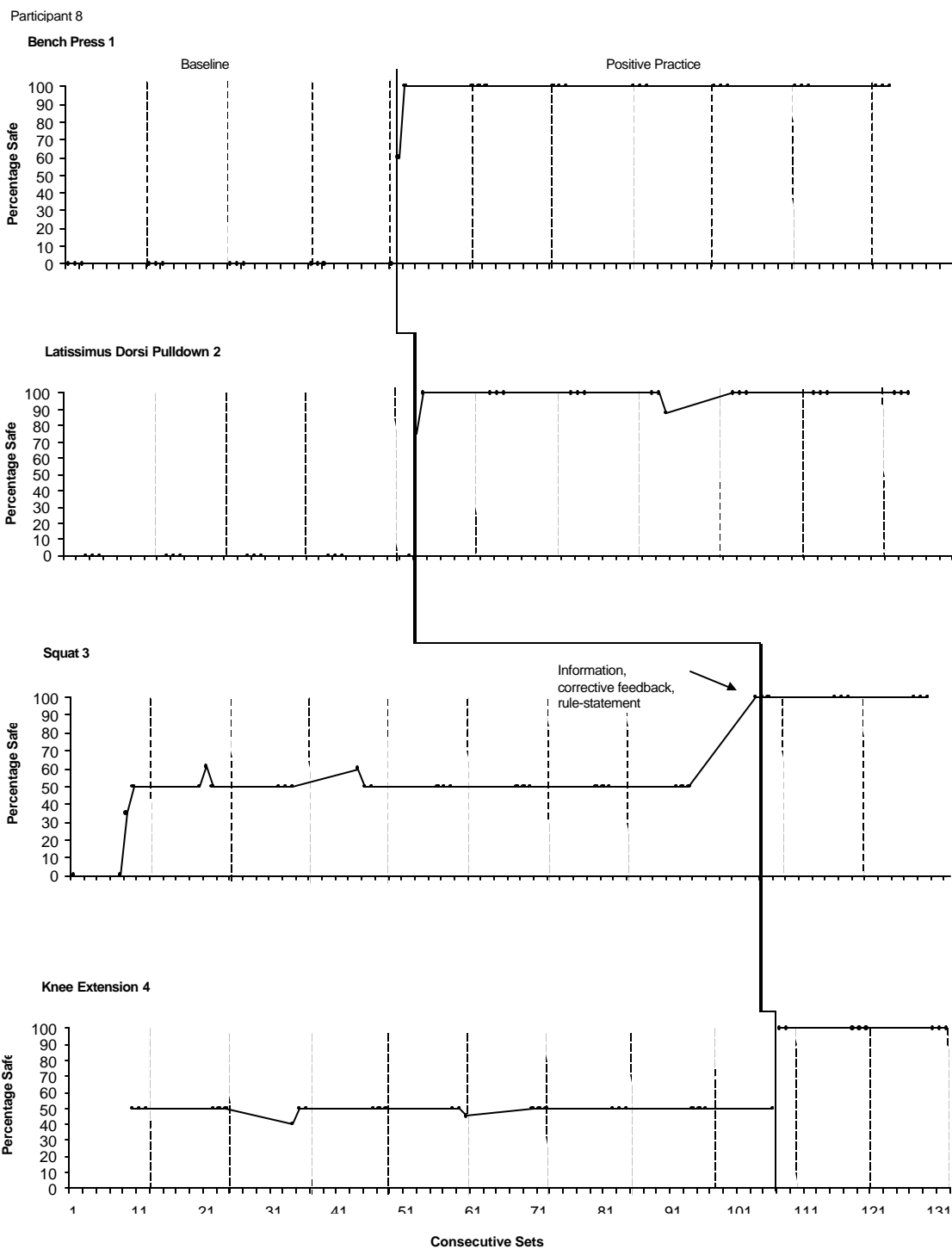


Figure 13. Data for Participant 8. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

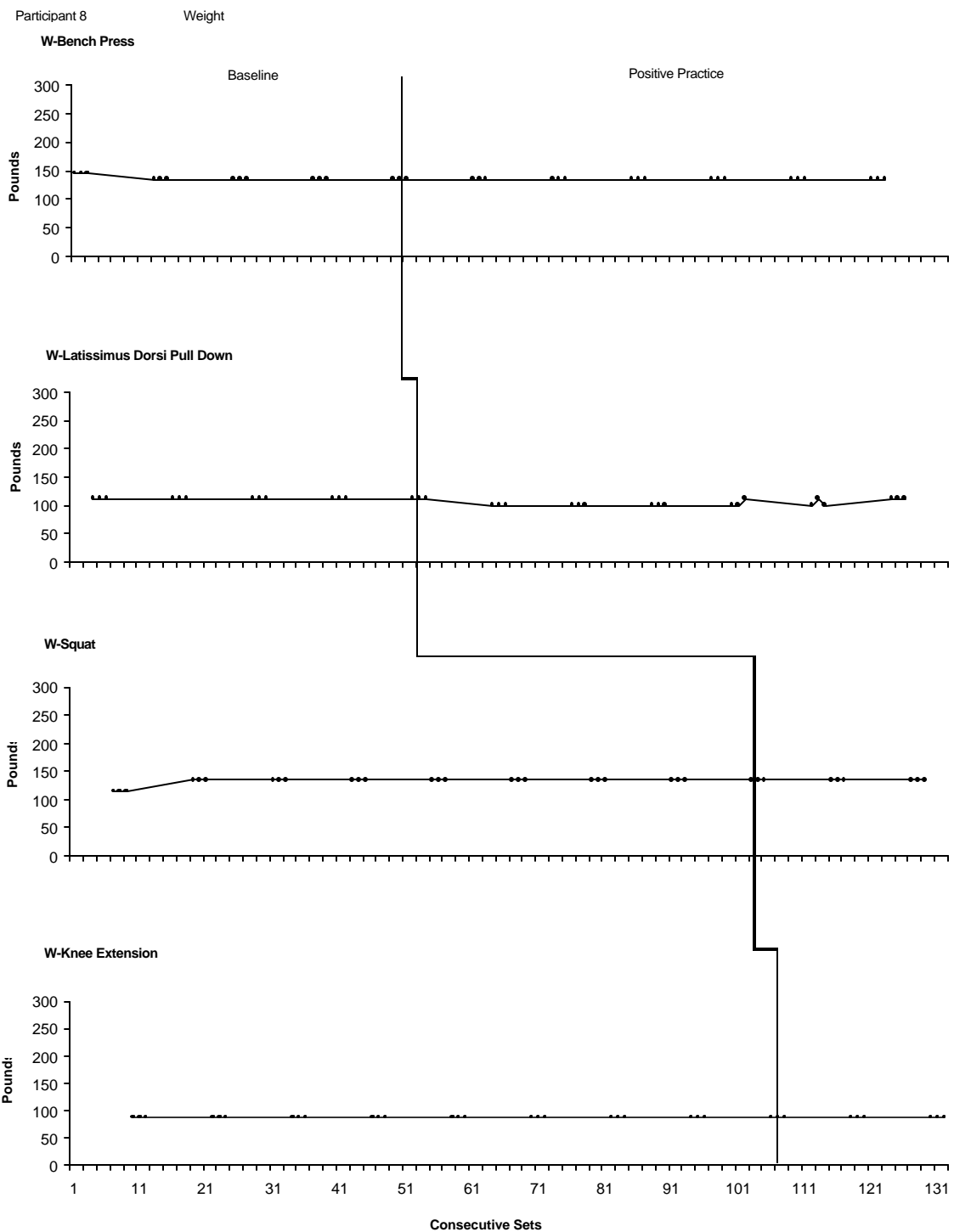


Figure 14. Data for Participant 8. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

50%; SD: 16%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the squat was 1% safe (range: 0%- 10%; SD: 3%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the knee extension was 53% safe (range: 50%- 80%; SD: 9%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice.

Figure 16 displays the weight lifted by participant 9 across each of the four exercises. For participant 9, mean weight lifted for the latissimus dorsi pulldown was 63 pounds (range: 63-63; SD: 0) during baseline and 50 pounds (range: 50- 63; SD: 1) during positive practice. Mean weight lifted for the bench press was 48 pounds (range: 45-50; SD: 2) during baseline and 50 pounds (range: 50-50; SD: 0) during positive practice. Mean weight lifted for the squat was 51 pounds (range: 45- 55; SD: 5) during baseline and 62 pounds (range: 55- 65; SD: 4) during positive practice. Mean weight lifted for knee extension was 63 pounds (range: 63- 63; SD: 0) during baseline and 63 pounds (range: 63-63; SD: 0) during positive practice.

Participant 10. Figure 17 displays participant 10's performance across each of the four exercises. For participant 10, mean performance of the latissimus dorsi pulldown was 71% safe (range: 50%- 75%; SD: 12%)

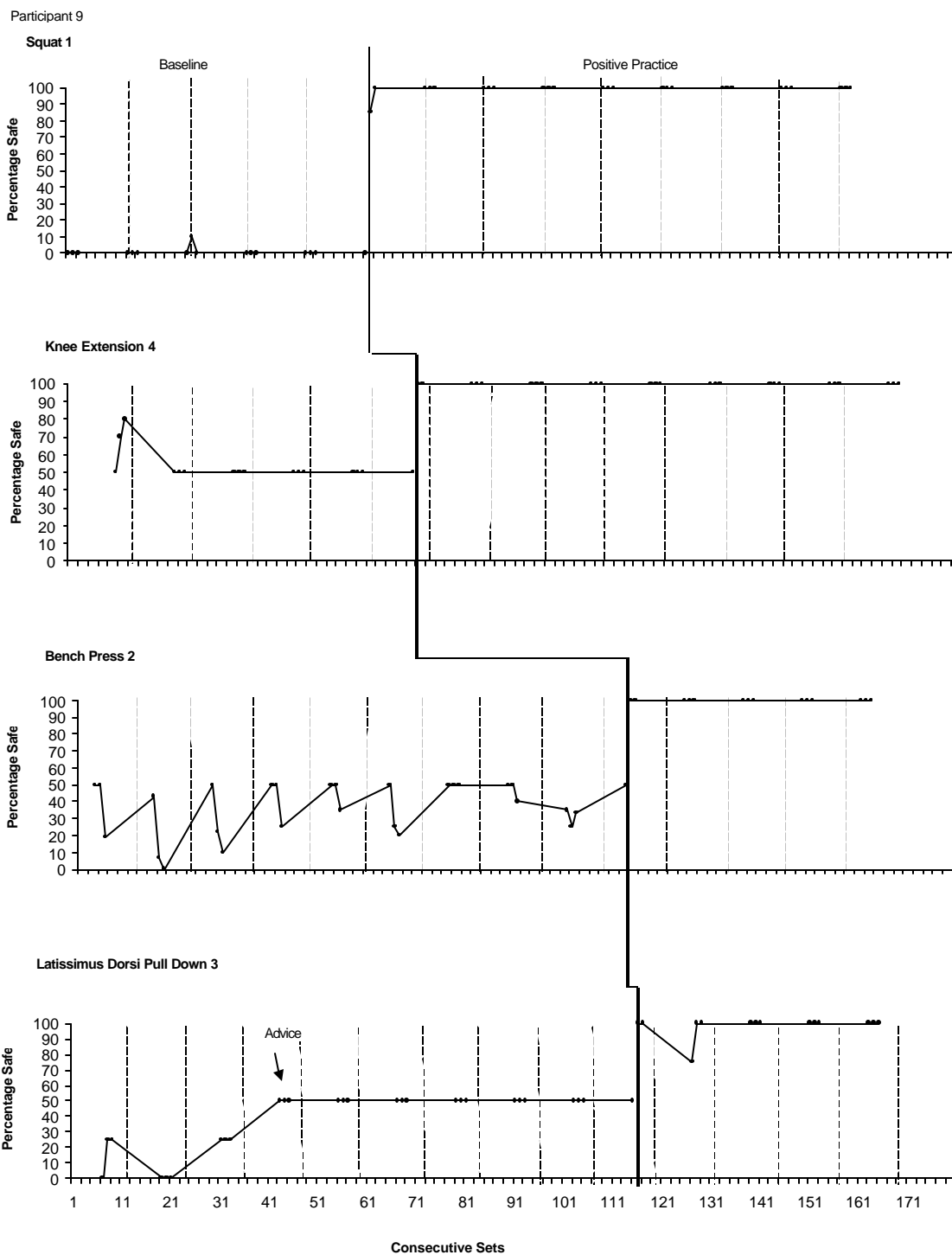


Figure 15. Data for Participant 9. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

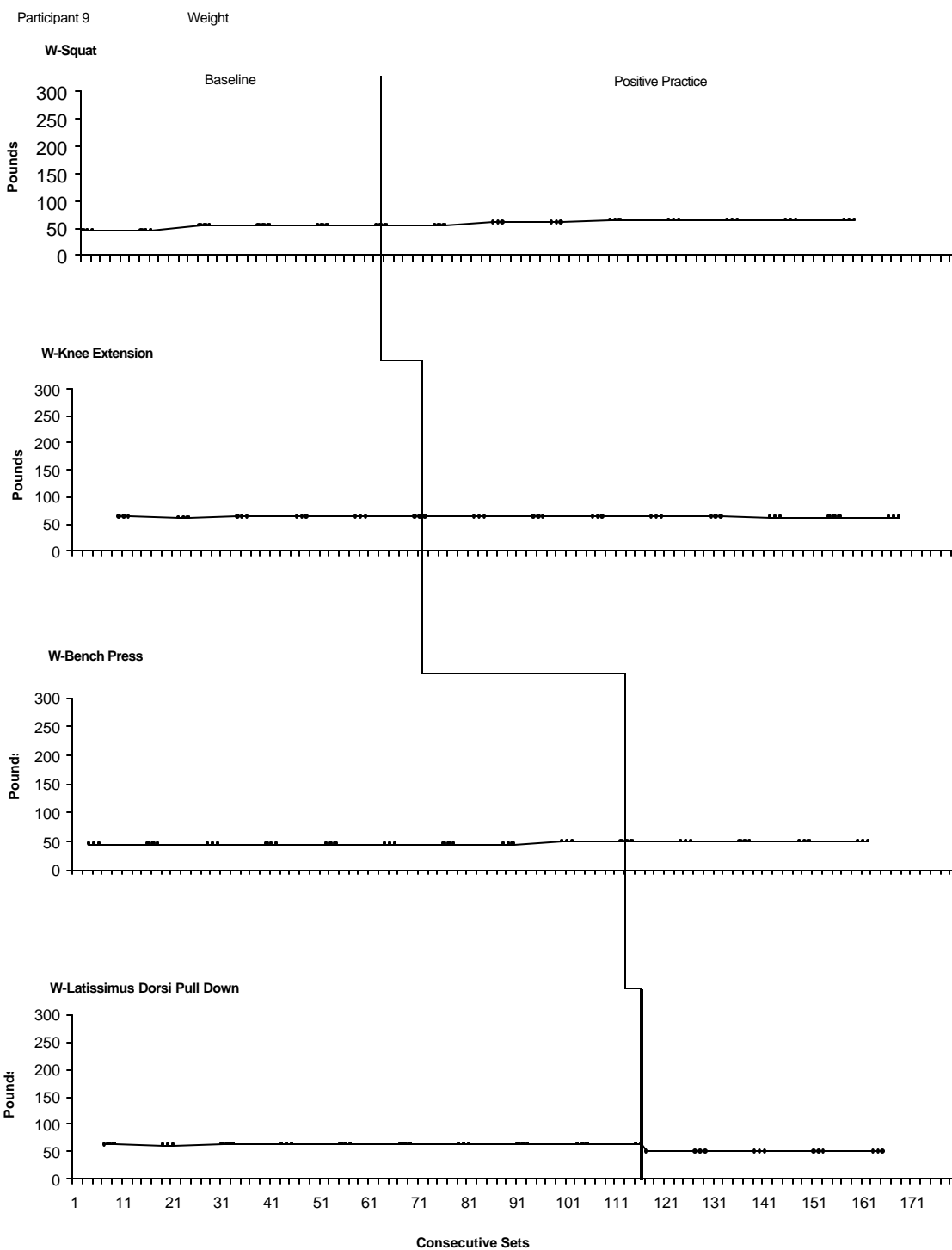


Figure 16. Data for Participant 9. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

during baseline and 97% safe (range: 75%- 100%; SD: 8%) during passive observation. Mean performance of the bench press was 22% safe (range:0%- 50%; SD: 25%) during baseline and 99% safe (range: 90%- 100%; SD: 2%) during passive observation. Mean performance of the squat averaged 100% safe (range: 60%- 100%; SD: 10%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during passive observation. Mean performance of the knee extension was 50% safe (range: 50%- 50%; SD: 0%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during passive observation.

Figure 18 displays the weight lifted by participant 10 across each of the four exercises. For participant 10, mean weight lifted for the latissimus dorsi pulldown was 92 pounds (range: 75-137; SD: 25) during baseline and 88 pounds (range: 50- 100; SD: 22) during passive observation. Mean weight lifted for the bench press was 100 pounds (range: 95-115; SD: 9) during baseline and 102 pounds (range: 95-135; SD: 15) during positive practice. Mean weight lifted for the squat was 95 pounds (range: 95- 95; SD: 0) during baseline and 130 pounds (range: 95- 180; SD: 29) during positive practice. Mean weight lifted for knee extension was 106 pounds (range: 100- 125; SD: 11) during baseline and 108 pounds (range: 75-175; SD: 30) during positive practice.

Participant 10

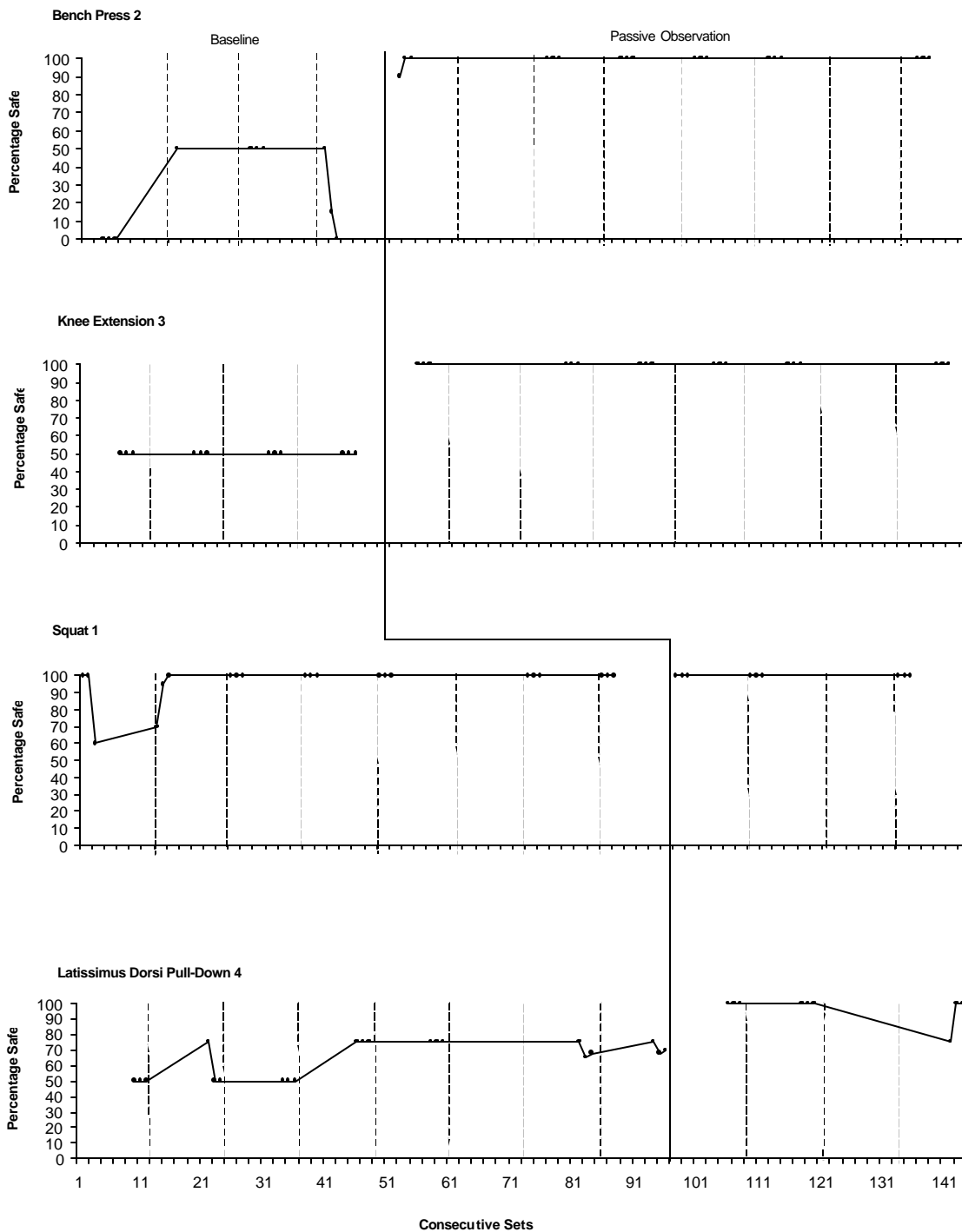


Figure 17. Data for Participant 10. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

Participant 11. Figure 19 displays participant 11's performance across each of the four exercises. For participant 11, mean performance of the latissimus dorsi pulldown was 51% safe (range: 50%- 60%; SD: 2%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the bench press was 27% safe (range: 0%- 50%; SD: 26%) during baseline and 99% safe (range: 90%- 100%; SD: 2%) during positive practice. Mean performance of the squat was 50% safe (range: 50%- 50%; SD: 0%) during baseline and 100% safe (range: 100%- 100%; SD: 0%) during positive practice. Mean performance of the knee extension was 4% safe (range: 0%- 50%; SD: 14%) during baseline and 100% safe (range: 95%- 100%; SD: 1%) during positive practice.

Figure 20 displays the weight lifted by participant 11 across each of the four exercises. For participant 11, mean weight lifted for the latissimus dorsi pulldown was 90 pounds (range: 75-113; SD: 14) during baseline and 100 pounds (range: 100- 100; SD: 0) during positive practice. Mean weight lifted for the bench press was 109 pounds (range: 95-135; SD: 17) during baseline and 105 pounds (range: 95-135; SD: 15) during positive practice. Mean weight lifted for the squat was 95 pounds (range: 95- 95; SD: 0) during baseline and 128 pounds (range: 95- 180; SD: 25) during positive practice. Mean weight lifted for knee extension was 113

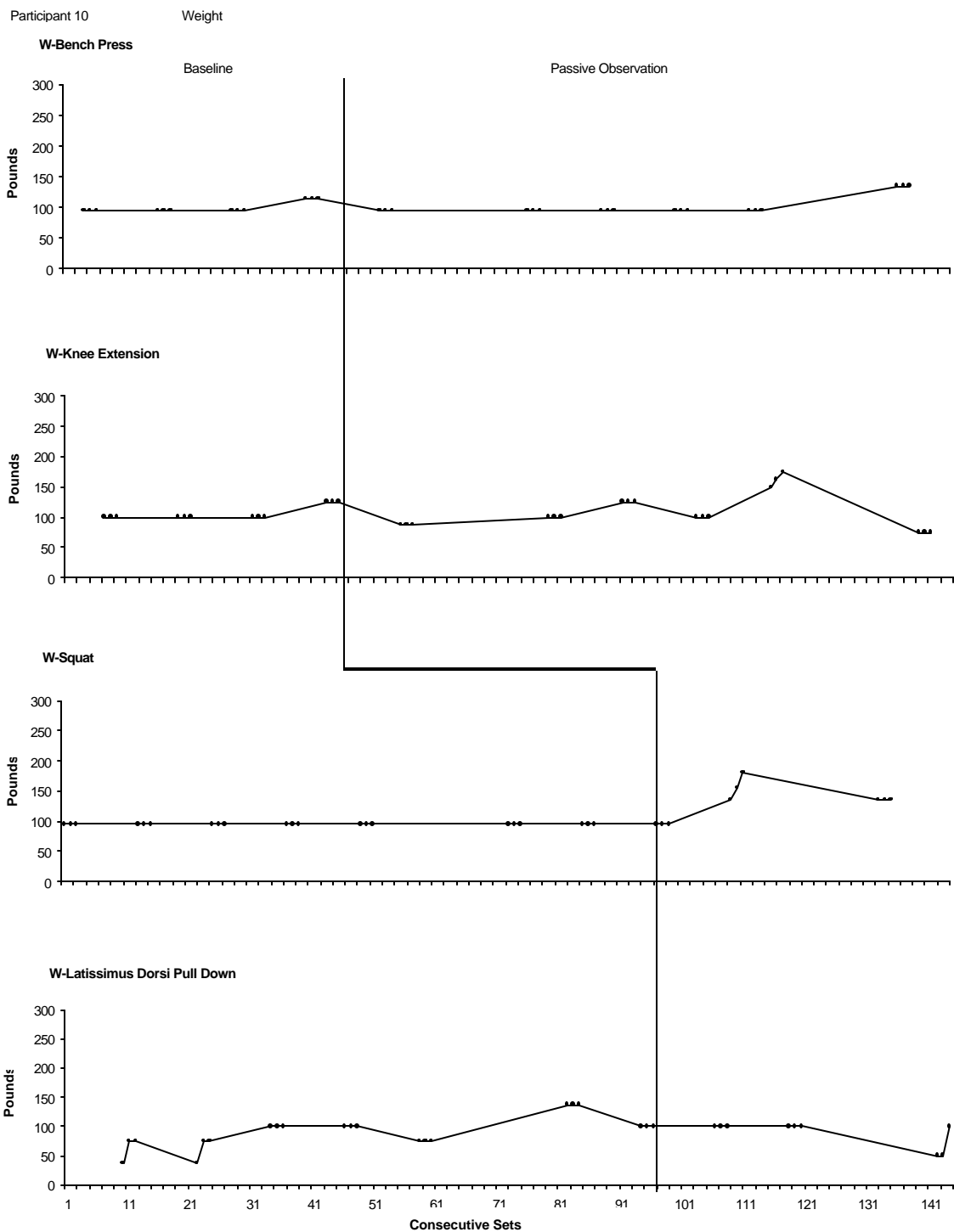


Figure 18. Data for Participant 10. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

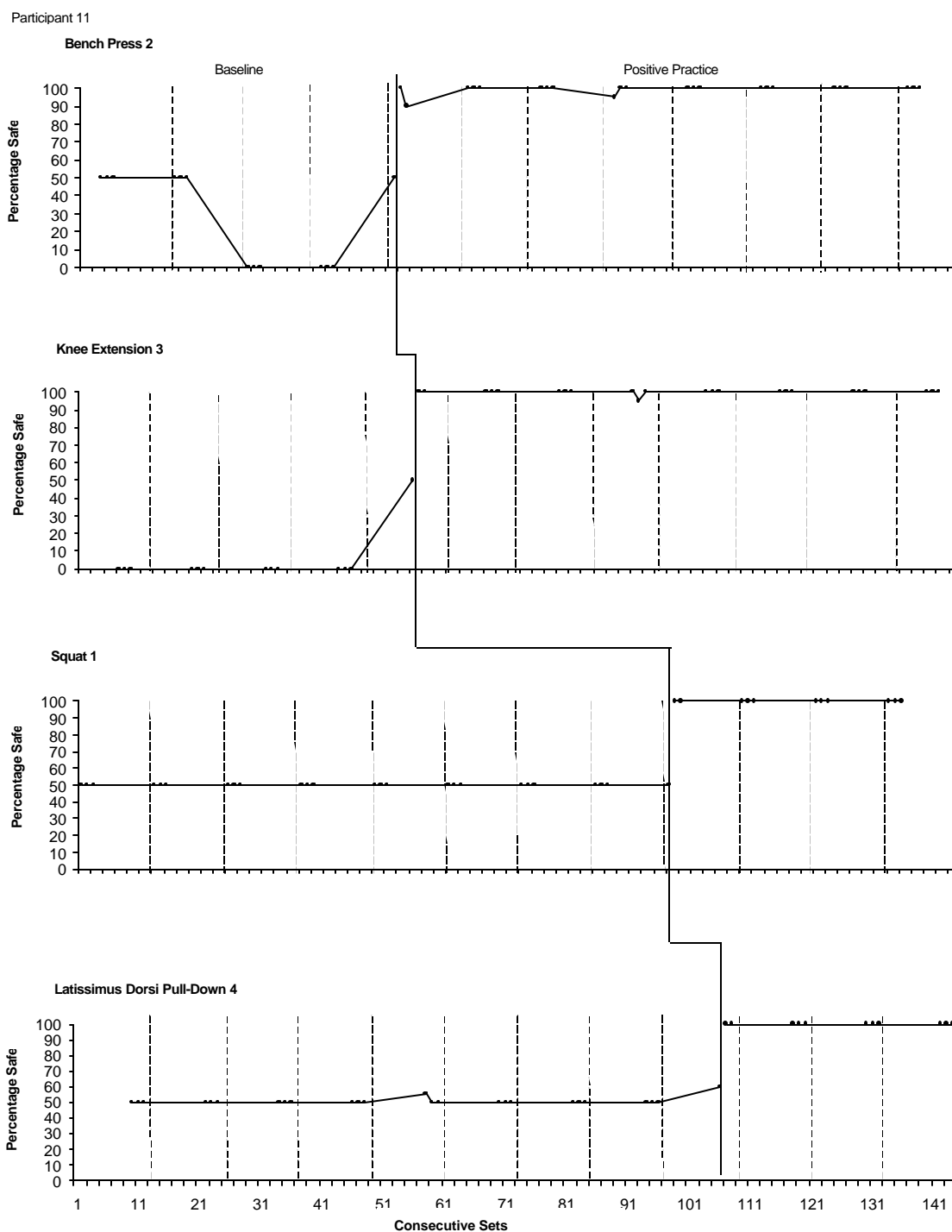


Figure 19. Data for Participant 11. The Figure Represents the Percentage of Components Performed Safely Per Set Across the Four Exercises.

pounds (range: 85- 135; SD: 17) during baseline and 115 pounds (range: 88-162; SD: 19) during positive practice.

Lifting Components

An analysis of the safe performance of the individual components across all participants during baseline conditions was conducted to identify potential trends among the components of the four exercises. During the bench press average performance of the elbow was 7% safe (range: 1-100; SD: 24) and the back 58% safe (range: 1-100; SD: 44). During the squat average performance of the thigh was 20% safe (range: 1-100; SD: 39) and the back 75% safe (range: 1-100; SD: 43). During the latissimus dorsi pulldown performance of the hips was 22% safe (range: 1-100; SD: 40), the hands 16% safe (range: 1-100; SD: 37), the chest 76% (range: 1-100; SD: 43), and the head 74% safe (range: 1-100; SD: 44). During the knee extension performance of the legs was 4% safe (range: 1-100; SD: 18) and the back 66% safe (range: 1-100; SD: 47).

Follow-up

Participants 1 and 2 were observed for one session four weeks after completing primary observation sessions. Participant 1 averaged 100% (range: 95%-100%; SD: 1) safe across the four exercises. Mean performance of the latissimus dorsi pulldown was 100% (range: 100%-100%; SD: 0%), the bench was 98% (range: 95-100; SD: 3), the squat was

100% (range: 100%-100%; SD: 0%), and the knee extension was 100% (range: 100%-100%; SD: 0%). Participant 2 averaged 100% safe (range: 100%-100%; SD: 0) across the four exercises. Mean performance of the latissimus dorsi pulldown was 100% (range: 100%-100%; SD: 0%), the bench was 100% (range: 100%-100%; SD: 3%), the squat was 100% (range: 100%-100%; SD: 0%), and the knee extension was 100% (range: 100%-100%; SD: 0%).

Debriefing

At the conclusion of each participant's final observation session the observer reviewed the participant's data, answered questions regarding the data, and asked the participant to complete both a symptoms survey and an evaluation of the study.

Symptoms survey. A symptoms survey was administered for the first time during participant orientation and a second time during debriefing to examine any reported changes in physical symptoms related to common injuries incurred during the targeted exercises. The overall results of the survey suggest that many of the participants experience discomfort or pain in the areas identified as related to unsafe weight lifting across the 4 targeted exercises but no changes were found in participant reports across the first and second inventory. For example, 5 participants reported shoulder pain during lifting prior to participating in

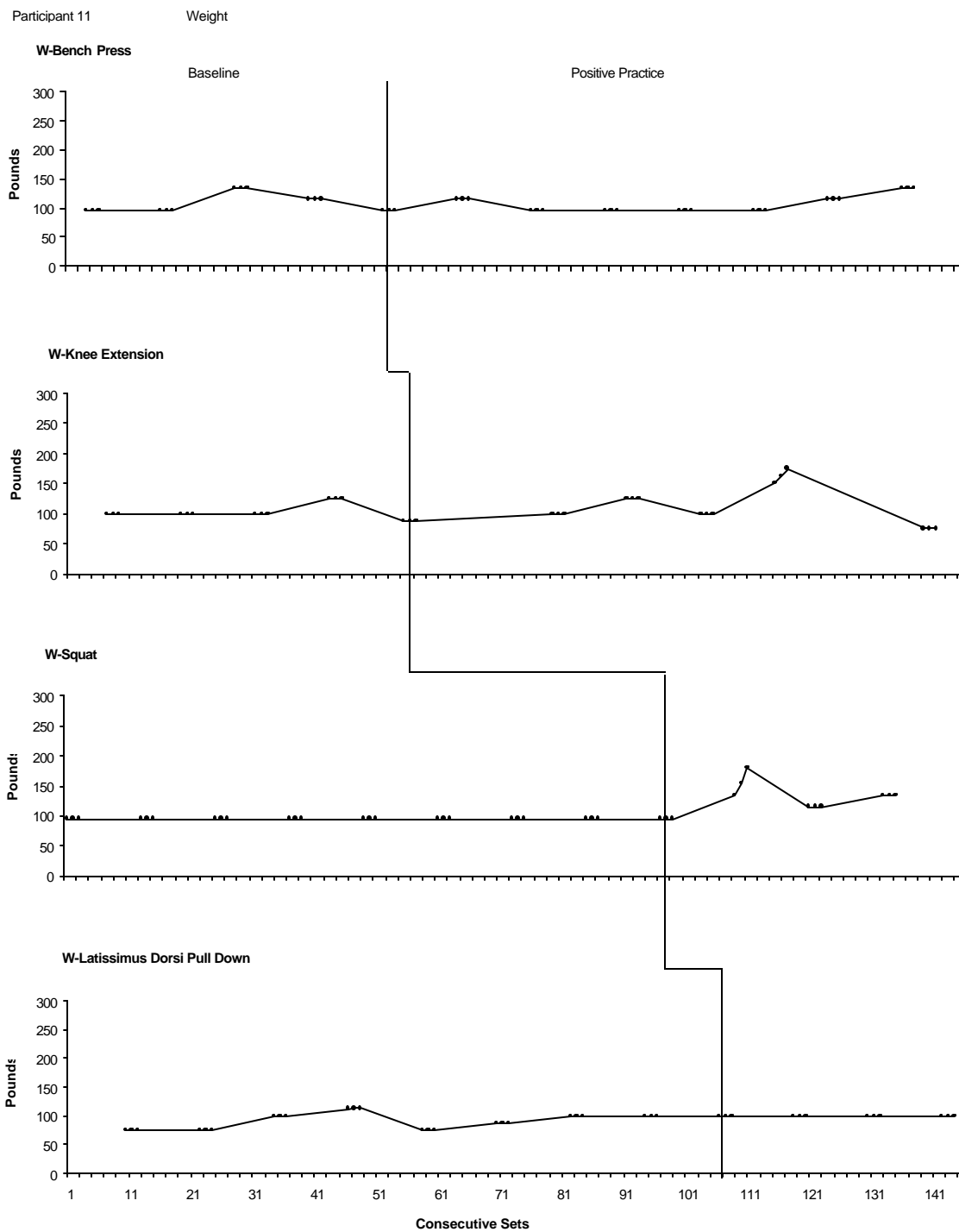


Figure 20. Data for Participant 11. The Figure Represents the Pounds Lifted Per Set Across the Four Exercises.

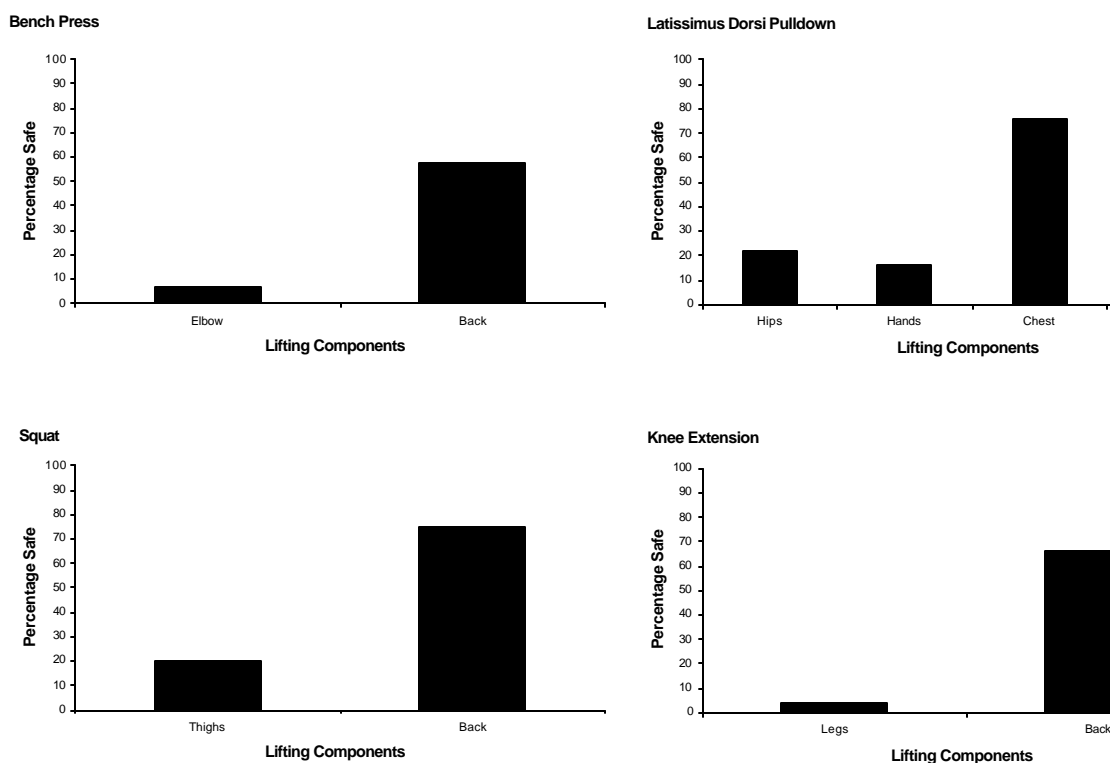


Figure 21. Data Averaged Across All Participants and Session During Baseline, By Lifting Components. Each Panel Represents the Percentage of Repetitions Per Set, Across All Participants for the Specified Exercise.

the study. Shoulder pain was noted by researchers as a symptom of performing the bench press unsafely. Two participants reported one additional symptom following their participation in the study. However, both participants were involved in intramural sports for the duration of the study. The reported symptoms may have resulted from physical exercise outside of the study. Five participants reported one or more symptom on the first survey that were not reported again on the second

survey. The decrease in reported symptoms may be related to the practice of safer lifting techniques. All participants reported having contacted information on weight lifting prior to and during the study. See Table 1 for the results from both symptoms inventories.

Evaluation. An evaluation was administered to survey anecdotal reports concerning the social validity of the study. The participants' perspective on the benefits of being a part of the study were examined. The evaluations suggest that participants shared a positive view of the study. Questions were rated using a Likert scale ranging from 1 (the most negative rating) to 5 (the most positive rating). Participants scored all positive questions an average of 4.5, while negative questions were scored an average of 1.9. Positive questions consisted of positive statements regarding the study and negative questions consisted of negative statements regarding the study. In summary, the answers to the questionnaire indicated that participants felt that; their safety performance improved over the course of the study; the study was helpful; they would continue to use the suggestions received during the study; there were few objections to receiving feedback; positive practice was useful; sessions were not difficult to attend regularly; they were able to get an adequate workout during the lifting sessions; performance graphs were similar to perceptions of lifting performance; and overall experiences

were positive. No improvements to the study were suggested. Two participants reported that they experienced less pain after lifting safely. No participants reported having experienced more pain during or after the study. Although participants overall indicated that their workouts were adequate, two participants stated that their workouts were less intense while performing the lifts safely. Refer to Table 2 for a summary of the evaluation results.

Table 1

Symptoms Survey						
<i>Participant</i>	<i>Diagram-area</i>	<i>Symptom #</i>	<i>Answer</i>	<i>Diagram-area</i>	<i>Symptom #</i>	<i>Answer</i>
P1	Both shoulders, both wrists, both ankles, left foot	6,7	Weak wrists sometimes cause weak grip in both hands; yes; yes	No change		Now I really do; yes
P2	right shoulder sometimes, 6 left knee used to hurt but is better now	6	The rotator cuff damage occurred during martial arts practice and is sometimes compounded by lifting; probably not, no formal training, but read some info	right shoulder	6	rotator cuff is fine at the moment; safer than before; kinda
P3	pecks, hamstring	1,11	yes;yes	hamstrings	1	now I do;body building books only
P4		2	lower back makes popping noise when doing inclined sit-ups; yes, I know I need to improve; only in gym classes	right knee		yes;only info was in gym class given by instructor
P6	right shoulder	2,3,6,7	left shoulder clavicle injury;yes;yes	right shoulder	2,6,7,10	yes;yes
P7						yes;yes
P8	right shoulder	9	wrist problem one year ago; in some areas:ves			yes;yes
P9			not sure:ves			ves: ves
P10	right shoulder, arm, abs	6,9,10,12	pulled bicep;yes;yes	shoulder, back	1, 6, 9, 10	yes; yes
P11		6,10	possibly; yes but limited	shoulder, knee		yes: yes

Symptoms:

1. Muscle strains and ruptures.
2. Avulsions.
3. High blood pressure.
4. Retinal hemorrhages.
5. Fractures.
6. Rotator cuff.
7. Anterior shoulder instability.
8. Atraumatic osteolysis of the clavicle.
9. Spondylolysis.
10. Osteoarthritis.
11. Weight lifter's cephalgia.
12. Hernias.
13. Weight lifter's heart.

Questions:

- A. Do you believe you are currently lifting safely?
- B. Have you read any information or received training on how to lift safely?

Table 2

Debriefing Evaluation Questions												
Participant	1	2	3	4	5	6	7	8	9	10	11	12 Total Score
P1	5	5	5	1	5	5	1	2	4	5	none better, but less weight	38
P2	5	5	5	1	5	5	1	5	5	5	more exercises it feels much better	42
P3	5	4	4	1	5	5	2	5	4	4	none most cases better, but not full effect on bench	39
P4	5	5	5	1	4	5	1	3	4	5	none better, experienced no pain after feedback was given	38
P6	5	5	4	1	5	5	1	4	3	5	none better	38
P7	5	5	5	1	5	4	1	4	4	5	none better	39
P8	5	5	5	1	5	5	4	5	5	5	none Bench press and lats were biggest better	45
P9	5	5	5	1	5	5	4	5	5	5	improvement none	30
P10	3	3	3	1	4	4	3	2	3	4	It was conducted very well not as intense of a workout	36
P11	5	4	4	1	4	5	2	3	3	5	It was safer but exercises felt easier, like I wasn't pushing as hard	36
Averages	pos. 4.45	4.36	4.36	1.27	4.73	4.91	2.45	4.18	4.45	4.8	4.53	39
	neg										1.86	

Questions:

1. Do you feel like your safety performance improved over the course of the study?
2. Did you find this study helpful?
3. Will you continue to use the suggestions you received during the study in future lifting?
4. Did you have any problems with the manner in which you received feedback?
5. How would you rate the intervention (positive practice) that you received?
6. Were you aware of your responsibilities as a participant from the beginning of the study?
7. Did you find it difficult to attend your scheduled sessions?
8. Did you feel like you were able to get an adequate workout during your lifting session?
9. How do your graphs compare to your perception of your lifting performance?
10. How would you rate your overall experience as a participant?
11. Any improvements?
12. Was the quality of your workout better, the same, or worse using the safe exercises as compared to your original exercise?

DISCUSSION

Summary of Results

The results of the study suggest that information alone resulted in minimal increases in the safe weight lifting performance of the three participants who received information. Information produced an average increase of 11% in the safe performance of all four exercises, across participants. Positive practice was associated with substantial sustained improvements in the safe weight lifting performance of the targeted exercises. The 10 participants demonstrated an average increase of 64% safe over baseline levels and an increase of 52% safe over information levels following the use of positive practice.

A summary of the safe lifting performance of each of the components within the four exercises may indicate that specific components are frequently performed more unsafely than others among recreational lifters. Five components, the elbow, thighs, back, hips, hands and legs were performed on average below 20% safe across participants. The remaining 5 components, back (bench, squat, knee), chest, and head were performed on averaged above 50% safe during baseline conditions.

Information

The overall effects of information suggest that information alone resulted in minimal improvements in performance, if improvements were

made at all. Of the three participants receiving information, one participant (participant 4) demonstrated no change in safe performance across all four exercises after receiving information. Two participants (participants 1 and 7) demonstrated increases in safe performance of two and one of the four targeted exercises during the information phase, respectively.

The information phase was provided to approximately one third of the participants to examine, (1) the utility of the most common form of instruction available among recreational lifters, and (2) reactivity resulting from the combination of the presence of an observer and information. Most recreational lifters are limited to reading materials either on-line or in hard copy such as magazines and journals to identify critical information regarding correct use of specific exercises. Though other services are available, such as personal trainers or classes, the majority of recreational lifters refer to written materials or hear-say for guidance. The information phase was designed to emulate common forms of information provided to the average recreational lifter, though common, written information is not the most effective form of information. In addition to common practice, by explaining to the participant the behaviors being observed by the observer, the participant was given the

opportunity to make any adjustments to behavior that may result from the observer being present.

According to the data, the common practice of receiving information alone was not sufficient to substantially improve safe lifting performance, even given the potentially motivational role of the presence of an observer. Although the effects of information were minimal, the greatest improvements were seen in the safe performance of the latissimus dorsi pull down. Unlike other exercises the participant is not likely to change body position between repetitions within a set. As a result, when safe performance is obtained initially, the participant continues to lift safely across the remaining repetitions. Several factors may explain the limitations of information provided alone. During the information phase, participants were read a description of the correct lifting procedure for each of the four techniques. However, the participants were not able to practice these techniques at that time and therefore did not come in contact with the proprioceptive stimuli associated with correct posture unless they practiced after the observation session. After the initial presentation of the information, participants did not receive feedback on their use or misuse of the recommendations. More specifically, the study targeted a number of movements that a participant may not have been able to see him or herself perform. As a result, participants may have

required feedback in order to make the necessary changes and correct those behaviors that were less visible. For example, while performing the bench press, oftentimes the participant's elbows were out of peripheral vision when they exceeded the participant's frontal plane. Even after the participant received information about how to perform the bench press safely he or she may not have "realized" the behavior was unsafe or may not have been able to discriminate between at-risk and safe stimuli associated with the location of his or her elbow. This is not a factor for which static information alone can correct. A more dynamic form of information such as feedback may be required in these cases.

Another potential explanation is related to each participant's specific lifting history. Some participants with a long history of lifting reported being reluctant to change their posture as a result of receiving information provided by the observer. Observers in all cases explained the physical mechanics of the recommendation in order to "convince" the participant to employ the safe practices. During the information phase there were no consequences for applying the instructions given by the observer. Clearly, other contingencies, such as building bulk or showing off for onlookers, may have competed with the performance of the safe procedures during the information phase.

Positive Practice

The overall effects of positive practice support previous reports of the efficacy of positive practice in the suppression of inappropriate behaviors. Previous research has shown success for individuals diagnosed with developmental disabilities and autism across multiple undesirable behaviors including hair pulling (Adams, 1980), nail biting (Azrin, Nunn, & Frantz, 1980; Delparto, Aleh, Bambusch, & Barclay, 1977) and more.

One strong example of the impact of positive practice on safe lifting performance as demonstrated in the current study by participant 1, depicts a parametric change in performance across the three phases, baseline, information, and positive practice for two of the target exercises. The participant performed progressively more safely with the onset of each intervention. During positive practice the participant maintained 100% safe performance across all four exercises.

There are several reasons why, as a behavior change strategy, positive practice appears to be more effective than information. During positive practice the participant is able to come in contact with the proprioceptive stimuli associated with safe lifting procedures. The participant learns to discriminate between stimuli associated with safe and at-risk lifting. As a result, the participant can monitor safe movements even when they are out of visual range. During positive

practice participants receive further clarification through corrective feedback beyond the information read to them. The participant is able to correct any “misconceptions” that may have resulted from a brief information statement. Also, during positive practice the requirement of practicing the exercise for five repetitions if performance is at-risk poses strong opposition to other lesser competing contingencies such as potential improvements in physical appearance that could result from performance having a less restricted range of motion.

In addition to having a substantial effect on lifting performance, positive practice is a socially acceptable application of an otherwise basic punishment procedure. As compared to positive practice the use of punishment is often restricted. Therefore, positive practice is seen as a viable alternative response suppression procedure for use with inappropriate behaviors (Miltenberger & Fuqua, 1981).

Behavioral Mechanisms of Positive Practice

In the literature on overcorrection, there are very few attempts to describe the behavioral mechanisms of positive practice. As of 1981 there were no existing component and/or parametric analyses of the multi-component procedures subsumed under “overcorrection” according to a review of the literature (Miltenberger & Fuqua, 1981). A recent literature review conducted for the purposes of this study did not uncover any

additional analyses of the behavioral mechanisms at work during overcorrection procedures. However, Miltenberger and Fuqua suggest that the identification of the behavioral principles responsible for the behavioral effects of overcorrection is important to understanding the effectiveness of overcorrection in specific situations. The authors suggest that the literature on overcorrection is littered with a number of methodological weaknesses including failure to demonstrate the reliability of treatment effects, aggregating data which are not representative of individual behavioral processes, and using overcorrection in combination with other behavior change procedures. The cumulative outcome of these weaknesses prohibits an overall analysis of the unique impact of each of the many components involved in overcorrection procedures. However, all applications of overcorrection include a common feature in which there is a contingent relationship between the occurrence of the problem behavior and the subsequent overcorrection behavior(s). The following is an attempt at speculating about some of the complex behavioral mechanisms potentially at play during overcorrection. To begin, overcorrection has been noted to have both punishing and evocative effects on behavior.

Punishment. There are a number of functional and procedural similarities between positive practice and punishment that make it reasonable to classify overcorrection as a punishment procedure. The

definition of punishment stated by Azrin and Holz (1966) is, “.... a reduction in the future probability of a specific response as a result of the immediate delivery of a stimulus for that response” (p. 381). In the current study, decreases in at-risk responses were seen following the delivery of the guided practice repetitions. The large decreases in at-risk behaviors seen across participants are similar to the results of many punishment procedures (Denny, 1980; Foxx & Azrin, 1972; Foxx & Martin, 1975).

Miltenberger and Fuqua (1981) identified a list of factors as potential contributors to the response suppressing effect of overcorrection. The factors are described in the following statement.

“Interruption of ongoing sequences of undesirable behavior; aversive aspects of physical contact and sometimes vigorous physical guidance; time out from available sources of positive reinforcement while engaging in overcorrection; the avoidance or escape contingencies under which overcorrection activities are emitted; the forced occurrence of any behavior which is effortful; the fact that overcorrection movements occur under extinction conditions or culminate in potentially punishing consequences; and unspecified punishing stimuli (e.g., harsh voice tone, “rough” physical guidance accompanying the overcorrection) (p.137).”

The factors listed above may describe the response suppression effect that occurred during the implementation of positive practice in the current study. While engaging in the practice repetitions the participant was forced to take time out away from natural reinforcers such as the “feel” of building muscles and getting closer to the end of the session. The

actual performance of the practice repetitions may be aversive, similar to a response cost in which the participant must perform additional effortful behaviors such as removing and replacing weights before and after the practice repetitions. Participants are likely to have performed safely to avoid or escape the aversive practice repetitions.

Alternatively, non-contingent practice may further clarify the behavioral effects of positive practice. Acquisition and practice may be a more persuasive argument than punishment when describing the behavioral mechanisms of positive practice.

Although the practice repetitions are likely to be aversive to the participant, the physical guidance and practice of the safe lifting procedures may have functional value to the participant in which the participant learns to contact naturally occurring reinforcers such as increased comfort during and after lifting, the ability to lift more weight, and the avoidance of injury (Azrin & Powers, 1975).

The complexity of the behavioral mechanisms of overcorrection make it difficult to rule out the operation of other behavioral processes (e.g., differential reinforcement of incompatible behavior) (Miltenberger & Fuqua, 1981). There are a number of components within positive practice that may contribute to changes in performance, such as corrective feedback, physical guidance, practice, and negative reinforcement.

Evocative effect. Foxx and Azrin (1972) claimed that overcorrection can have evocative value. However, few studies have demonstrated an increase in appropriate behavior directly related to an overcorrection procedure. In the current study an evaluation of the covariation between inappropriate behaviors and appropriate behaviors suggested that reductions in at-risk performance were replaced by increases in safe weight lifting behaviors. The inverse relationship between the incompatible at-risk and safe performance of lifting practices suggests an evocative effect of positive practice in addition to a punishing or suppressive effect. In an article by Azrin and Holz (1966) the authors state that the effectiveness of punishment can be enhanced by the availability of alternative, incompatible responses that result in reinforcement, in the same stimulus class as the punished response. In the current study, positive practice was avoided by lifting safely. As a result, safe lifting increased and was reinforced by avoidance of the aversive practice repetitions. In essence, safe lifting practices were negatively reinforced because the participant avoided the aversive experience of having to practice the exercise contingent on his or her safe performance of the previous set. In addition to negative reinforcement, the verbal response made by the observer, such as “good job, no practice”

stated after safe performance may have also contributed to a future increase in safe performance during the subsequent sets.

The warning stimuli involved in weight lifting may also have had an effect on safe performance by altering the value of the practice repetitions as an establishing operation. An establishing operation (EO) is a stimulus or procedure that has two effects; it (1) momentarily alters the effectiveness of a reinforcer or punisher (i.e., the practice repetitions), and (2) momentarily increases the frequency of behavior that has occurred before the consequences whose effectiveness has been altered (Michael, 1993). A conditioned establishing operation (CEO) alters the effectiveness of conditioned reinforcers or punishers. More specifically, a reflexive CEO (CEO-R), is a stimulus change that establishes its own termination as a reinforcer or punisher and alters the frequency of behaviors that have been followed by specific consequences in the past (Michael, 1993; Olson, Laraway, & Austin, 2001). The CEO-R may accurately describe the motivation among the participants of the study to decrease the warning stimuli related to unsafe lifting. During observation sessions participants were likely to have generated a rule statement related to the performance of safe lifting when approaching the opportunity to perform. For example, the participant may have stated covertly, “if I lift correctly, I will not have to practice five times.” As a result, the rule statement may have increased

the self-monitoring of specific warning stimuli, for example elbow position, associated with specific lifting procedures. As the participant became more unsafe, i.e., as the participant's elbows approached his or her frontal plane, the warning stimuli became more aversive. Consequently, any movements to correct the unsafe posture, i.e., pushing against the weight, may have become more reinforcing by terminating the aversive warning stimuli. As a result, the participant increased safe performance while decreasing at-risk performance.

Other considerations. There may have been some skill development required to perform each exercise safely. A brief up trend found at the beginning of the positive practice phase for several participants (participant 1, latissimus dorsi pulldown; participant 2, squat; participant 3, squat, knee extension; participant 7, squat; participant 8, bench press, latissimus dorsi pulldown; and participant 9, squat) may suggest that some exercises were not easily corrected by specific individuals. Often, participants needed more than one practice session before they were able to perform the exercise perfectly.

Passive Observation

An additional manipulation and analysis was performed to evaluate the effects of passive observation on the weight lifting practices of a single participant. Learning from observation occurs informally in most

recreational settings in which patrons learn lifting practices through their observations of other lifters. The analysis of passive observation may add to our understanding of common informal learning occurring in recreational facilities. Passive observation may resemble “imitation” or “modeling” as cited in D’Ateno, Mangiapanello and Taylor (2003) in which modeling using a video was used to teach complex play sequences to a preschool child with autism. In the current study, participant 10 observed participant 11’s exposure to positive practice across all four exercises without directly experiencing the positive practice intervention. Following observation, participant 10 demonstrated increases in safe performance across all four exercises corresponding to the sessions in which participant 11 received positive practice.

The possible active components of passive observation include information, demonstration and a rule statement. However, unlike positive practice, during the passive observation condition the participant was not directly exposed to programmed corrective feedback, contingent practice or negative or positive reinforcement. Anecdotally, during some sessions participant 10 asked “should I perform this safely or how I usually perform it,” or “I don’t have to practice, right?” Subsequently, participant 10 often made remarks regarding the attention given to participant 11 by the experimenter.

The substantial effects of passive observation may suggest the utility of other less intrusive interventions in which the participant is exposed to a demonstration of the correct lifting procedures through modeling and is given performance feedback following each set. However, future research is needed to systematically evaluate the effects of passive observation. Anecdotal reports from participants and informal observations suggest that the contingency statement may have influenced participant 10's safe performance of the four exercises even though the statement was never in effect. Future researchers would benefit from studying the effects of a contingency statement that is audible but not directly applied to the participant.

Discussion of Individual Performance

Exercises. Performance trends across the four targeted exercises were examined. No overall trends associated with specific exercises were found across participants. During baseline, individual participants appeared to perform differently across the four techniques, most likely related to differing weight lifting histories. However, certain components within the four exercises appeared to be more difficult for some participants to correct. A closer examination of the gradual increases in performance during the first session of positive practice revealed that a number of components appeared to be more difficult to correct for specific

participants. These participants were not able to perform 100% safe during the first session of positive practice. Instead, these participants required several practice sessions in order to correct all components of the lift. For example, participant 3 struggled to correct back positioning for the first three sessions of the positive practice phase before achieving 100% safe performance. Overall, participants tended to struggle to keep their backs against the bench while performing the bench press, they also tended to struggle to maintain a straight back position while performing the latissimus dorsi pulldown. Judging from informal reports from individual participants as well as from baseline performance, if a participant had a history of arching his or her back, it was slightly more difficult to help the participant correct back position across all four exercises.

Confounds. A number of incidences occurred during the course of the study outside of the proposed methodology, and these incidences may have impacted individual performance. These incidences can account for some of the variability in the data. As noted on the graph by an arrow, participant 6 was injured in a climbing class immediately preceding observation session number 4. As a result, his safe lifting performance improved across the squat, knee extension and bench. The participant reported soreness in his back while performing these three exercises.

Originally, the participant's unsafe performance resulted from overextending his shoulders and legs. However, after his injury he was not able to overextend and had a tendency to minimize the intensity performed across the three exercises, resulting in safer scores.

In another case, due to rescheduling and to a lack of space, two observation sessions under different intervention conditions were conducted in close proximity. As a result, during the last set of the information phase for the bench press, participant 4 observed another participant receiving positive practice. Immediately following this observation, participant 4 performed 90% safe on the bench press, 53% more safe than previous sessions. The increase in performance appeared to be related to passive observation of the administration of positive practice with a second participant. Participant 4 continued to perform 100% safe under positive practice conditions.

As indicated on the graph, participant 9 demonstrated a clear increase in safe performance of the latissimus dorsi pull down following advice from her boyfriend regarding lifting recommendations. Anecdotal reports from the participant suggest that her increase in safe performance was affected by her boyfriend's comment to correct her hand positioning. The increase was maintained for the duration of baseline conditions. Her

safe lifting performance increased to 100% following the onset of positive practice.

Following an academic break, an observer accidentally administered positive practice-like procedures during a baseline session for participant 8. According to the protocol, all observers presented positive practice as a consequence after the participant had performed the first set. The participant then received information based on his or her previous performance, an explanation of how to correct the performance and physical guidance in order to practice the exercise safely. Instead, participant 8 received information, corrective feedback and the contingency statement *prior to* performing his first set. As a result, the participant's performance on the squat increased to 100%, an increase of 50% over the previous session. The performance maintained at 100% after normal positive practice procedures were restored. The results of the first set of the first session of positive practice resembled performance of the remainder of sets and sessions in the positive practice condition.

Weight. The weight amount lifted by each participant across each exercise was recorded for each session as a secondary variable. There did not appear to be any relationship between the amount of weight lifted and the safety performance of each participant. Participants lifted varying amounts of weight however, weight amounts did not vary substantially

across phases for individual participants. Participants demonstrated minor increases and decreases in weight amounts across intervention conditions.

Variability. Between-subject differences in safe performance of the four exercises during baseline conditions most likely resulted from each individual's unique learning history. Differences noted during intervention phases may have been influenced by the same learning history in which positive practice was more or less aversive. For example, if a participant had been playing a sport for years and received repeated instruction different from the procedures suggested during the study, the participant may have found making corrections to be more aversive than would a relatively inexperienced lifter. Potentially, the more aversive the positive practice the greater the behavior change to avoid coming in contact with the practice repetitions. Other factors such as fatigue from previous lifting the day before, soreness related to other activities or lack of sleep may also have accounted for small variations within participant performance. Even though participants were instructed to refrain from their normal workout until after their session, several participants were observed lifting immediately prior to their observation session.

Breathing, repetition cadence, and weight amounts were different across participants. Participants were not instructed regarding breathing

techniques, the speed with which they should perform each repetition, or the weight amount lifted. Rather, these decisions were made by each participant based on his or her preference and comfort level. Breathing and repetition cadence were not tracked during observation sessions. Only postural observations were recorded. However, participant preferences related to breathing and lifting cadence during lifting may have accounted for differences in performance *between* participants.

Alternative visual representation of data. An alternative graphing method was used to examine the individual safe performance from an additional vantage point. See Figure 21. All four exercises across all ten participants were graphed in terms of the percentage of safe repetitions observed. The percentage of safe repetitions was a more conservative representation of safe performance than the total percentage of components safe. According to the more conservative method, a participant had to perform all the components of a repetition safely in order to meet the criteria of a safe repetition and then the total number of safe repetitions performed were shown as a percentage of the total repetitions (i.e., the method reported in the results section). In the less conservative method, the number of correct components across all ten repetitions was calculated out of the total number of components performed during each set. The more conservative (percentage of safe

repetitions) method created variability in the data. For example, performance scores were often either 100% or 0%. Although improvements in performance appeared to be more substantial, any variation in the data tended to scale the entire range of the dependent variable.

Limitations

Although substantial improvements in safe performance of the four exercises were seen across all ten participants, future research is needed to help clarify a number of issues identified during the study. There are a number of weaknesses associated with the systematic application of positive practice procedures similar to those found in many applied studies. In the current study, due to the nature of the observation sessions, observers established friendly relationships with individual participants. These relationships may have, however, caused observers to lose objectivity in some cases. Observers may have begun to share in the frustration or enthusiasm experienced by the participant. As a result, an observation of unsafe performance may have become aversive to the observer. The observer may have felt the need to intervene or congratulate the participant during performance. However, these responses would have deviated from the protocol.

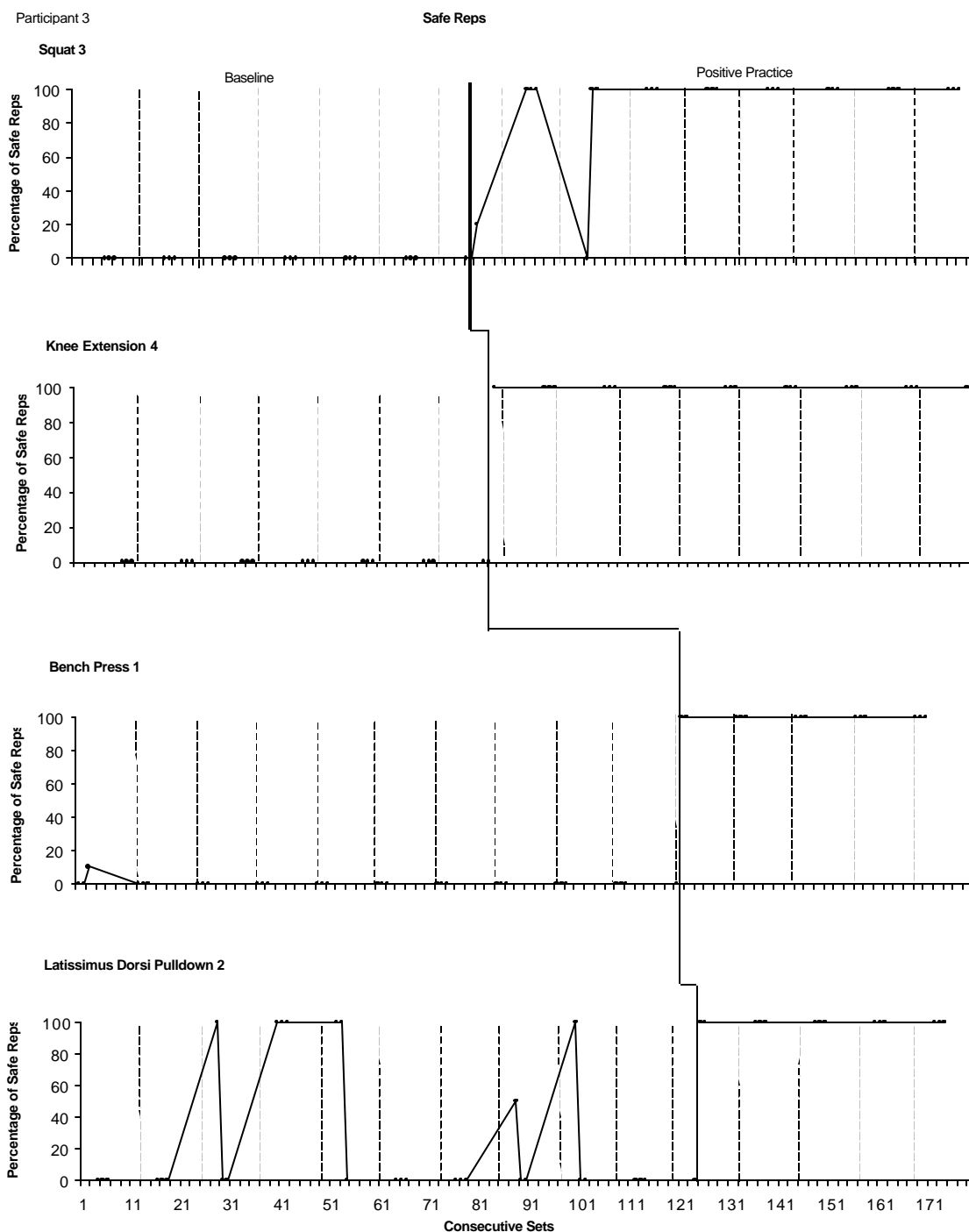


Figure 22. Sample data for Participant 3. The Figure Represents the Percentage of Repetitions Performed Safely Across the Four Exercises.

Although intervention integrity measures taken throughout the study suggest that the application of the intervention was 100% correct across all observers and participants, many subtle social interactions were not assessed. These personal exchanges between the observer and participant may have contributed to the success of the intervention. Future research is needed to evaluate the effects of the social interactions likely to occur during the positive practice procedure used in the current study. The tendency to praise safe lifting may actually strengthen the effects of positive practice as indicated by Foxx (1977). Future research should evaluate the effects of adding praise to the intervention suggested in the current study.

One potential disadvantage to using positive practice relates to the time required by staff to apply the procedure. During the current study observation sessions were, on average, completed in 30 minutes. In the future, if applied in recreational facilities, staff members' time may be limited by other competing demands. However, staff members may only need to monitor exercises that are performed incorrectly, instead of all four exercises as practiced in the current study.

Maintenance of safe lifting performance was measured in two follow-up sessions. According to the data, safe performance of both

participant 1 and 2 during follow-up sessions was sustained at 100%. Longer periods of follow-up data are needed to examine the conditions under which performance is sustained for an extended amount of time. There were no formal measures of the generalization of safe performance outside of observation sessions, however informal reports from observers and participants are promising. Observers reported occasional informal observations of safe performance outside of the session in which participants were likely aware of the observer's presence. Also, during observation sessions participants frequently noted unsafe lifting demonstrated by other lifters in the weight room. These observations informally conducted by participants may have prompted correct lifting by the participant both during and outside of formal observation sessions.

Several suggestions as to why positive practice effectively improved safe lifting performance have been presented in the current study however, future research is needed to systematically identify the unique contributions of the multiple components functioning as the positive practice package. Researchers may choose to evaluate the effects of the punishment contingency without practice. For example, a participant may be asked to perform an unrelated task such as push-ups following each at-risk performance instead of practicing the targeted lift. By removing the practice component, the participant will not have the

opportunity to immediately experience the proprioceptive stimuli associated with correct lifting. Also, if skill development is a factor in increasing safe performance, as a result of the removal of practice, skill development may be delayed. Researchers may also examine the effects of non-contingent practice, wherein a participant is required to practice the lift correctly after the set regardless of the safety of the previous performance. If performance improves under these conditions, the contingency may be an unnecessary component of the treatment package.

The duration of the correction period has been reported to be a factor in the effectiveness of overcorrection. Miltenberger and Fuqua (1981) recommend the use of the least amount of time necessary to achieve the desired behavior change. During the current study, participants were asked to practice lifting safely for five repetitions following at-risk performance. Further investigation may conclude that a fewer number of practice repetitions may result in the same behavior change found in the current study.

A final methodological weakness related to the definition of the four dependent variables may need to be addressed in future research. A couple of participants reported that safe performance of the four exercises felt less rigorous than unsafe lifting. These comments suggest that positive practice must be implemented carefully, in which participants are

encouraged to complete each movement with the maximum range of motion while maintaining the safety of the lift. For example, while performing the squat the lifter should be instructed to continue to bend his or her knees deeply, as long as his or her thighs do not go below parallel to the ground. The methodology suggested in the current study did not include instructions for observers to encourage the most rigorous work out possible. As written in the methodology, participants were scored as safe as long as they did not reach a certain point. As a result, in some cases participants may not have received the benefit of a more rigorous workout while performing the lifts during the observation sessions. An improved measurement procedure might define a safe lift as falling within a more specific range of motion, rather than requiring the nonspecific response of any movement less extended than the final criterion of safety.

Strengths of the Study

The results of the current study add to the literature showing the positive effects of positive practice. The current study further supports the use of positive practice to improve safe performance of four weight lifting exercises. One of the greatest strengths of the study relates to the substantial improvements in safe performance following positive practice. Information alone resulted in an average increase over baseline of 32%

safe during the latissimus dorsi pulldown, -3% safe during the bench press, -3% safe during the squat, and 19% safe during the knee extension. Positive practice resulted in an average increase of 46% safe during the latissimus dorsi pulldown, 70% safe during the bench press, 56% safe during the squat, and 60% safe during the knee extension. Additionally, the high number of reliability sessions conducted (49% of all observation sessions) over the course of the study further supports the reliability of the data collected.

The current study successfully demonstrated experimental control through the employment of a multiple baseline design across the four exercises. The multiple baseline design was recommended by Miltenberger and Fuqua (1981) as the most appropriate methodology for evaluating the effects of overcorrection interventions. In conclusion, positive practice has been validated both empirically and socially as a useful technology to decrease unsafe lifting performance, while increasing safe lifting performance among recreational lifters. The current study demonstrated a novel application of positive practice. No other efforts to employ positive practice to improve fitness behaviors were found by our literature review.

Implications


The current study suggests that positive practice may be used to improve safe weight lifting. An inexpensive program based on positive practice procedures including minimal training for floor staff and an observation checklist may be used at local gyms. During the program, floor staff could occasionally approach members and employ positive practice when members were observed as at-risk. An analysis of the individual components of each exercise suggests that broad applications of positive practice aimed at improving lifting performance may benefit from targeting specific components within the four exercises identified.


Researchers may intervene on the components typically performed most unsafely first, for example the elbow, thighs, hips, hands and legs.


In addition to increasing safety among recreational lifters, positive practice may also be useful in alternative settings. Positive practice may be implemented as an intervention strategy to decrease unsafe behaviors in organizational or educational settings, as well as to improve other socially and organizationally relevant behavior. The current findings will hopefully encourage a line of research aimed at broad applications of positive practice interventions spanning across many populations and settings.


Appendix A
Observation Checklist

Date: _____ Day: M T W T H F S S U Observer: 1 2 3 Participant #: _____ Session # _____ Phase: B I PP IOA Observer: 4 5

Latissimus Dorsi Pull-Down		Reps												Reps																				
		1	2	3	4	5	6	7	8	9	10	%	11	12	13	14	15	16	17	18	19	20	%	21	22	23	24	25	26	27	28	29	30	%
	1. HIPS Lean back at hips. (No bend in back).											/10											/10											/10
	2. HANDS Grip bar little more than shoulder width.											/10											/10											/10
	3. CHEST Open chest. (Back straight, headup).											/10											/10											/10
	4. HEAD Pull down in front of head.											/10											/10											/10
		S	S	S	S	S	S	S	S	S	S	/40	S	S	S	S	S	S	S	S	S	S	/40	S	S	S	S	S	S	S	S	S	S	/40
Weight: S1 S2 S3		Total :																																
Observer: 1 2 3		IOA:																																

Bench Press/ Chest Fly		Reps												Reps																				
		1	2	3	4	5	6	7	8	9	10	%	11	12	13	14	15	16	17	18	19	20	%	21	22	23	24	25	26	27	28	29	30	%
	1. ELBOWS Elbows even with frontal plane.											/10											/10											/10
	2. BACK Back is flat against equipment. (watch ribs)											/10											/10											/10
		S	S	S	S	S	S	S	S	S	S	/20	S	S	S	S	S	S	S	S	S	S	/20	S	S	S	S	S	S	S	S	S	S	/20
Weight: S1 S2 S3		Total :																																
Observer: 1 2 3		IOA:																																

Knee Extensions		Reps												Reps																				
		1	2	3	4	5	6	7	8	9	10	%	11	12	13	14	15	16	17	18	19	20	%	21	22	23	24	25	26	27	28	29	30	%
	2. STRAIGHT Flex angle is 170 degrees or less.											/10											/10											/10
	3. BACK Back resting flat against equipment.											/10											/10											/10
		S	S	S	S	S	S	S	S	S	S	/20	S	S	S	S	S	S	S	S	S	S	/20	S	S	S	S	S	S	S	S	S	S	/20
Weight: S1 S2 S3		Total :																																
Observer: 1 2 3		IOA:																																

Squats		Reps												Reps																				
		1	2	3	4	5	6	7	8	9	10	%	11	12	13	14	15	16	17	18	19	20	%	21	22	23	24	25	26	27	28	29	30	%
	1. THIGHS Thighs are not parallel to the ground or less.											/10											/10											/10
	2. SPINE Straight spine.											/10											/10											/10
		S	S	S	S	S	S	S	S	S	S	/20	S	S	S	S	S	S	S	S	S	S	/20	S	S	S	S	S	S	S	S	S	S	/20
Weight: S1 S2 S3		Total :																																
Observer: 1 2 3		IOA:																																

POSITIVE PRACTICE:
Describe what exercise was at risk and which components were practiced.

INFORMATION:
What exercise did you provide information on?

Appendix B
Observer Script

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Observer Script

Directions: The following script should be practiced by observers during the appropriate phase. Each participant will receive baseline and positive practice for each of the four exercises. Positive practice will be employed in a multiple baseline across the four exercises individually for each participant. Please follow the script regarding baseline when observing behaviors under baseline conditions and use the script on positive practice procedures when observing behaviors targeted for intervention. It is extremely important that you make the distinction.

Baseline

During baseline the participant should be encouraged to lift normally. Say something like, "I am interested in observing you as you would normally lift." If the person asks if they will be receiving feedback you can disclose that at some point in the study you will be giving them feedback on their lifting technique. Make sure that the participant is filling out the weight lifting form, so that you will be able to transfer the information in the future. During baseline, observers should build rapport with participants in order to encourage attendance and establish open communication. You might want to consider giving them a short checklist to prompt them about what they need to do.

Don'ts during baseline: Don't give the person feedback, even if they request it. Don't demonstrate or point out incorrect or correct techniques. Don't talk about other subjects. Don't make any gestures that might indicate how the person is performing. Don't ask leading questions like "hurt when you do that?"

Note: Baseline procedures will be arranged to mirror normal lifting practices in which participants may continue to be at-risk. The participants will be instructed during the introductory meeting to terminate a lifting session if at any point they experience discomfort above that associated with normal lifting practices. The observers alone will not interfere with participant lifting during baseline conditions.

Information

For the participants receiving instruction, review the correct components of each of the four exercises described in the rationale below. You will simply read each of the descriptions titled “solution” and withhold from providing any feedback on the participant’s previous performance or physical guidance.

Positive Practice

The following applies only to the targeted technique. After observing the specific technique you will explain that according to the literature the technique is contraindicated, in which it results in both muscle gain but may also lead to an injury. Explain to the participant that you will help them to adjust their posture to prevent injury. Review the components of the correct technique and have the person practice the technique five times without weight. You may have to physically guide the person into the correct position and help them to maintain the correct position. At the end of the session record in general what components the participant practiced in the designated area on the observation checklist. If the person questions your instructions, you can elaborate on the specific risk and injuries related to the incorrect use of that technique. I have included a summary of the literature that describes the rationale behind the correct use of the four exercises.

Rationale Behind Techniques By Exercise:

Exercises of interest: (Reeves, R. K., Laskowski, E.R., & Smith, J.(1998).

1) Latissimus Dorsi Pull-down

*Problem-*Weight is lowered behind the neck. Excessively flexes the cervical spine and does not maximally challenge the muscle. Increases the load on cervical disks. Increases risk of spinous process fracture. Shoulder at mechanical disadvantage.

Injuries resulting= rotator cuff injury, anterior shoulder instability

Solution- Sit, lean back at the hips, grip bar slightly wider than shoulder width, pull down slightly in front of head.

2) Bench Press & Chest Fly

Problem- Hyperextension (dropping elbows behind the plane of the body) places pectoralis muscles at mechanical disadvantage. Glenohumeral instability (through repetitive shoulder capsule trauma). Excessive traction on acromioclavicular joints.

Injuries= shoulder area

Solution- Adjust exercise machine or starting position so that elbows are even or above frontal plane beginning and during reps.

3) Knee extension

Problem- Potentially damaging tibiofemoral forces greater during 5 to 10 degrees of extension, knee flexion greater than 60 degrees increases patellar compression.

Solution- Avoid hyperextension at the completion of knee extension (smaller range) Recommend= squats and leg presses

4) Squats

Problem- Deep squat (thighs are parallel to the floor or lower) increases shear load on knee where the articular cartilage is the thinnest.

Solution- Avoid deep squats, maintain lumbar spine (keep back straight)

At the end of each session confirm the next scheduled session with the participant. Make sure that your participants have your contact information. If they have any more questions, please write them down and tell them you will get back to them. Later, you can pass the question to me and I will let you know what to do in the future. If you are aware of something that might influence the results of the study please note the necessary information on your observation checklist. Thanks for your help.

Sincerely,

Leslie Shier

Leslie.shier@wmich.edu

349-1572.

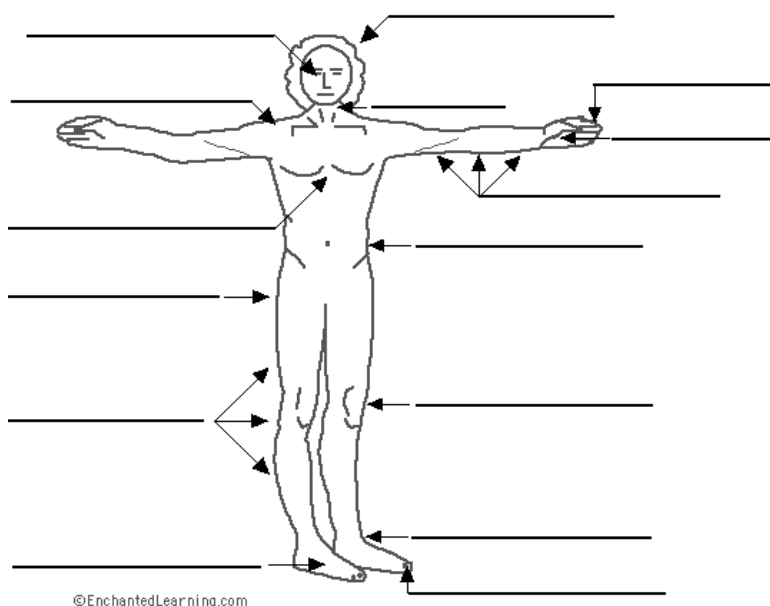
Appendix C
Symptoms Inventory

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Symptoms Inventory

-Directions: The following questionnaire is designed to survey your personal history of symptoms related to certain fitness techniques. The survey is comprised of symptoms pertaining to, but not exclusively related to, common injuries resulting from weight lifting. Please answer the questions carefully according to any occurrence you have experienced in the past or are experiencing currently. For confidentiality purposes your answers to this form will be coded. You can request a copy of the inventory by contacting the lead investigator at leslie.shier@wmich.edu. To complete the inventory, first identify general locations of injuries or pain that you have noticed since you began weight lifting. Second, answer the questions that correspond with the diagram. Third, in the space provided report any discomfort that you have experienced related to lifting not covered in the inventory. Thank you for your time.

Diagram (Please mark any area where you have experienced prolonged discomfort since you began weight lifting)



(Continued)

Questions

Please put a check by the items that you have experienced since you have been weight lifting.

Muscle Strains & Ruptures

____ 1. Lower back or hamstring pain resulting in limited range of motion and decreased strength.

Avulsions

____ 2. Noticeable “pop” when attempting a forceful hip extension while your knee is flexed.

Blood Pressure

____ 3. High blood pressure.

Retinal Hemorrhages

____ 4. Loss of vision or redness in the whites of your eyes.

Fractures

____ 5. Fractures.

Rotator Cuff

____ 6. Diffuse aching shoulder pain that sharpens with overhead activity.

Anterior Shoulder Instability

____ 7. Looseness in your shoulder or transient numbness in your arms.

Atraumatic Osteolysis of the Distal Clavicle

____ 8. Aching pain in your chest during or after using the bench press.

Spondylolysis

____ 9. Low-grade back pain that radiates outward.

Osteoarthritis

____ 10. Tenderness in your joints.

Weight Lifter’s Cephalgia

____ 11. Sudden on-set of a headache while lifting that can last for days or even weeks.

Hernias

____ 12. Treatment for a hernia.

Weight Lifter’s Heart

____ 13. History of heart problems (i.e., irregular heart beat) since you began lifting.

Please report any injuries related to weight lifting that you have experienced that were not mentioned in the inventory.

A. Do you believe you are currently lifting safely?

B. Have you read information on safe lifting exercises or received formal training on how to lift properly?

Appendix D
Consent Form

WESTERN MICHIGAN UNIVERSITY
DEPARTMENT OF PSYCHOLOGY

Reducing Performance of Unsafe Weight Lifting Techniques Using
Positive Practice.

Leslie Shier and John Austin
WESTERN MICHIGAN UNIVERSITY

My name is Leslie Shier and I am graduate student in the Department of Psychology at Western Michigan University. This study will fulfill my thesis requirement. My faculty advisor is Dr. John Austin.

Purpose

You are invited to participate in a research study entitled “Reducing Performance of Unsafe Weight Lifting Techniques Using Positive Practice.” The purpose of the study is to examine changes in your current lifting practices after receiving guidance from a trained observer.

Your involvement in this study will enable me to evaluate the effects of a minimally intrusive intervention on improving the safe performance of lifting behaviors. Depending on the results of this study, a similar intervention might be applied successfully in other gym locations by weight room employees. Also, as a result of participating in the study you may experience a decrease in discomfort and a reduced risk of an injury while lifting. Ultimately, the results of this study may be used to help other lifters avoid serious injuries that could be incurred when performing incorrect lifting techniques.

Duration.

You will be asked to participate in two observation sessions a week over three months. During each session, you will be observed as you complete three sets of ten reps across the following four exercises: the latissimus dorsi pull down, the bench press/chest fly, the knee extension, and the squat. Observation sessions will last for approximately 30 minutes and can be followed by optional exercises of your choice. The observation sessions will be scheduled at your convenience according to your regular lifting schedule. The number of sessions will range from 20 to 30. The length of your participation in the study will vary depending on your availability. Please plan on attending your scheduled sessions until the completion of the study. You will be able to terminate your involvement, for any reason, without penalty. Please contact the

investigators listed below if you would like to withdraw from the study at any time.

Explanation of Study Procedures

Prior to observation, you will be asked to complete a symptoms inventory. The same inventory will be completed a second time at the termination of the study. Your behavior will be observed daily by a trained observer from Western Michigan University as you lift normally during your workouts. All trained observers are experienced in behavior-based safety and will be instructed in safe lifting practices according to a literature review. Before the first observation session, you will receive a form explaining the core program; each of the four exercises and the corresponding reps and weight lifted for each set. When you receive this form you will need to indicate the beginning weight lifted for each of the exercises. You will be asked to fill out this form at the end of each set. You will have the option of choosing the sequence that you will perform the four exercises. You will need to specify this sequence in the appropriate area below and will be responsible for maintaining this sequence throughout the study.

Core Program:

<u>Exercise</u>	<u># of Sets</u>	<u># of Repetitions</u>	<u>B.</u>
<u>Weight Sequence</u>			
1. Chest fly/ Bench Press	3	10	
2. Lat Pull-downs	3	10	
3. Squats	3	10	
4. Knee Extensions	3	10	

Optional Program: (These must be performed after the core program)

<u>Exercise</u>	<u># of Sets</u>	<u># of Repetitions</u>
5. Side Lateral Raises	3	10
6. Bicep Curls	3	10
7. Tricep Curls	3	10
8. Calf Raises	3	10
9. Abs Crunches	3	10-30

*The optional program was designed by Erin Bernerd, Exercise Physiologist

As you complete the lifts, the observer will record your performance on a checklist. Your behavior will be observed for a number of days prior to receiving any instruction. You will continue to be observed once a day and will eventually receive feedback on your performance of each of the four exercises.

Benefits

You may learn safe lifting techniques to prevent future occurrences of common injuries related to incorrect weight lifting practices as a result of your participation in this study.

Risks and Protections

You may experience mild uneasiness associated with being observed. This risk will be minimized by the fact that each observation session will only begin after you have given your verbal approval to begin.

As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency procedures will be taken; however, no compensation or additional treatment will be made available to you except otherwise stated in this consent form.

Confidentiality

All information obtained in this study will remain strictly confidential. You will be assigned a number at the start of the study and this will be used to identify your data when they are presented as part of this research study; no names or other identifiers will be used. If results are presented publicly, you will not be identified by name or any other identifying information. By signing the consent form you will be giving permission for data obtained in this study to be presented in professional presentations and publications. Any incidental information collected (e.g. during observations or via phone calls) will be held in confidence.

Voluntary Participation

Your participation in this study is completely voluntary. You are free to refuse to participate or withdraw at any time without penalty. You can cut short an observation if circumstances require and I will reschedule another time that is more convenient. If you are unable to participate in the current study but would like to pursue further instruction in weight lifting, please contact the Student Recreation Center for information on available services. You will help me determine where to position myself while I observe you so that I will not disrupt your lifting. At the end of the study, the experimenter will answer any questions you have and explain how your data helped us learn more about safe lifting.

Who to Contact With Questions

You may call Leslie Shier at 349-1572 whenever you have questions or concerns about this study.

In addition, Dr. John Austin, my faculty advisor can be reached at 387-4495. You may also contact the Chair, Human Subjects Institutional Review Board at 387-8293 or the vice President for Research, 387-8298 if questions or problems arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.

Your signature below indicates that you read the above information and agree to participate in the study.

Participant Signature

Date

Appendix E
Weight Training Form

Weight Training Form

Appendix F
Debriefing Questionnaire

“Reducing Performance of Unsafe Weight Lifting Exercises Using Positive Practice”

Debriefing Questionnaire

-Thank you for your participation in this study. At this time your observer will review your performance graphs. Please feel free to ask any questions about your involvement, the purpose of this study or the potential use of the data collected. Please circle the number that best describes your experience in this study.

1. Do you feel like your safety performance improved over the course of the study?

1	2	3	4	5
very little		some		very much

2. Did you find this study helpful?

1	2	3	4	5
not helpful		moderately helpful		very helpful

3. Will you continue to use the suggestions you received during the study in future lifting?

1	2	3	4	5
not at all		somewhat		consistently

4. Did you have any problems with the manner in which you received feedback?

1	2	3	4	5
no problems		mildly uncomfortable		disliked

5. Would you rate the intervention (positive practice) that you received ?

1	2	3	4	5
did not like		okay		helpful

6. Were you aware of your responsibilities as a participant from the beginning of the study?

1	2	3	4	5
no		somewhat		clearly

7. Did you find it difficult to attend your scheduled sessions regularly?

1	2	3	4	5
not at all		sometimes		much of the time

8. Did you feel like you were able to get an adequate workout during your lifting sessions?

1	2	3	4	5
not at all		somewhat		yes

9. How do your graphs compare to your perception of your lifting performance?

1	2	3	4	5
nothing alike		similar		the same

10. How would you rate your overall experience as a participant?

Appendix G
Intervention Integrity Checklist

Intervention Integrity Checklist

Baseline	
#1: No information was provided in regards to the correct lifting techniques	Y N
#2: The observer established rapport with the participant through casual conversation.	Y N
<i>Total % Correct</i>	/2
Information	
Step 1: Read a verbal description of the correct techniques used during the targeted technique located on the observer script.	Y N
Step 2: If requested. Read the additional rationale for the suggested techniques aslo found on the observer script.	Y N
* Remember, there should be no gesturing or added information provided not included on the script.	Y N
<i>Total % Correct</i>	/3
Positive Practice	
Step 1: <i>Corrective feedback component</i> - Provide an explicit verbal summary of participant's performance of the relevant components of the 4 techniques and suggestions for improvement.	Y N
Step2: <i>Practice</i> - Instruct the participant to correct and repeat the techniques that were originally performed incorrectly.	Y N
Step3: <i>Practice</i> -Explain the correct form and, if needed physically guide the participant so that he or she is able to practice the correct technique 5 times without weight.	Y N
Step4: <i>Practice</i> -If at any point during the practice trials the participant begins to use incorrect technique the observer will immediately guide the participant into the safe position. (This will be repeated across all components of technique that were observed as at risk during one or more reps)	Y N
<i>Total % Correct</i>	/4
Did the observer record the intervention provided on the observation checklist?	Y N

Appendix H
HSIRB Approval

HSIRB Approval

The HSIRB approval letter is on file with the Graduate College.

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