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Goal Setting in Sports: Increasing the Rate of Dribbling a Basketball

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Alex Nieto

Dr. Matthew Lewon/Thesis Advisor

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Alex Nieto

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Matthew Lewon, Ph.D.
Advisor

Bethany Contreras, Ph.D.
Committee Member

David Croasdell, Ph.D.
Graduate School Representative

Markus Kemmelmeier, Ph.D., Dean
Graduate School

December, 2022

Abstract

Many children participate in organized sports, and sports practice settings serve as an occasion both for the development of sports skills and for social skills. Because of this, youth sports coaching practices may be considered a particularly important factor in child development. Research in the area of youth sports coaching has demonstrated a lack of evidence to support many coaching practices. Shortcomings of common coaching practices include large proportions of downtime, lengthy instructional sessions, and ineffective speeches and drill design. Furthermore, precise measurement of behavior rarely occurs in the context of most youth sports coaching, and relatively little is known about relations between environments arranged by coaches during practice and performance in competitive play. More research is needed to identify the most effective and efficient way to teach youth athletes specific skills and how drills/practice for fundamental component skills impact more complex composite sports behaviors in competitive play. The aim of this study is to examine these issues through a) comparison of goal-setting methods (progressive-ratio versus percentile methods) for training a fundamental basketball skill (dribbling) and b) observation of the effects of goal-setting methods for this skill in practice on dribbling performances in situations more similar to those prevailing during competitive play.

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Introduction

Coaching is an instructional practice that involves one party teaching, training, or guiding another party towards improving a specific skill or skillset (Life Coach Directory, 2019). In the context of sports, the primary aim of coaching practices is to produce behavior change in athletes relevant to outcomes that serve as the basis for determining winners in a competitive game or match between individuals and/or teams (Knowles et al., 2006). Another function of sports coaching practices is to foster athletes' social and emotional development (Smith et al., 1983; Biddle, 1993; Brustad et al., 2001).

These functions may be seen to be particularly important in the context of youth sports coaching (Lockwood and Perlman, 2007). Youth participation in sports happens between the ages of 5 to 13 years old and can occur in various settings and programs that vary widely in terms of the level of organization and competitive expectations, including schools, recreational community leagues, and/or rigorous programs/camps/leagues aimed at preparing young athletes for participation in professional sports. In fact, over 51% of all children in the United States have participated in an organized youth recreation league at one point in their lives (Wilson et al., 2010). The ubiquity of youth sports, and by extension, youth sports coaching, means that coaching practices can be a major contributor to the development of both sports performance and general social skills of children and adolescents (Biddle, 1993; Brustad et al., 2001).

In light of its importance, it is somewhat surprising that relatively few evidence-based practices are used by sports coaches. Borrie and Knowles (2003) have suggested that most common coaching practices are based on convention/tradition, personal experience/philosophy, and anecdote, rather than on demonstrated efficacy. Because of

this, less-than-maximally effective and efficient practice designs can be perpetuated based on convention and prevalence within the sport community. Wilson, Bloom, and Harvey (2010) argue that coaches across sports have reported day-to-day coaching activities and interactions with other coaches as their major source of knowledge acquisition, the product of which has been the development of coaching practices not guided by scientifically derived data. In addition to this, most coaches are rarely judged on the quality of their own practices, which makes understanding and improvement of their techniques unlikely (Knowles et al., 2006). Because coaches are almost exclusively judged by their competitive performance outcomes, the processes by which these outcomes are achieved, or may be made more likely, are overlooked (Knowles et al., 2006).

Youth sports coaching practices have received even less scientific attention than coaching practices at other competition levels (Smith et al., 1983). Smith and Smoll (1997) reported that most coaches at the youth level are employed on a volunteer basis. Though these coaches may have knowledge regarding the technical aspects of a given sport, they may also lack the skills to develop and evaluate the effects of practice design, where most sport skills are shaped (Lockwood & Perlman, 2007). Furthermore, volunteer coaches who have received no formal training may fail to promote a healthy, positive learning environment for their athletes (Smith et al., 1983; Wilson et al., 2010). As noted, this is exceptionally important at a youth and teenage level, and research has suggested that a youth or high school coach can either positively or negatively influence both an athlete's psychosocial characteristics and continued involvement in sports (Biddle, 1993; Brustad et al., 2001).

Some researchers have acknowledged the importance of practice design and the measurement of performance in coaching. For example, Cote et al. (1995) argue that coaches must build a systematic "plan of action" for their athletes if they wish to improve individual skills and repertoires most effectively. They suggest incorporating observation, assessment, plan development, plan implementation, and arguably most important, reassessment. By incorporating data collection and analysis throughout the training process, a coach can be guided in the development and selection of practice strategies by athletes' performances (Cote et al., 1995; Wilson et al., 2010). Once researchers and coaches have developed a systematic and objective process for effectively training athletes, these practices may be disseminated across competition levels.

Applied Behavior Analysis in Sports Coaching

Applied behavior analysis (ABA) is concerned with identifying the features of learning environments that facilitate the emergence of particular skills, and researchers in this field have developed many methods for designing learning environments and measuring the effects of these on behavior (Cooper, Heron, & Heward, 2020). As such, the focus and methods of ABA are particularly suited to the study of sports performance, and in particular, the relationship between coaching practices and the development of sports skills (Luiselli & Reed, 2011, 2015; Seniuk, Witts, Williams, & Ghezzi, 2013).

ABA has contributed to the development of sports teaching packages and various teaching components that have been assessed empirically across a range of sports (Luiselli & Reed, 2015; Schenk & Miltenberger, 2019). Sports teaching packages derived from ABA include behavioral coaching (Allison & Ayllon, 1980; Martin & Hrycaiko, 1983; Seniuk, Witts, Williams, & Ghezzi, 2013) and behavioral skills training (Harris, Casey, &

Meindl, 2010; Harris et al., 2020; Quintero et al., 2020; Tai & Miltenberger, 2017). Teaching components derived from ABA include those designed to bring sports performances under appropriate stimulus control (Bolton, Belfiore, Lalli, & Skinner, 1994; Osborne, Rudrud, & Zezoney, 1990; Ziegler, 1987), goal-setting (Ward, 2011), video and expert modeling (Aiken, Fairbrother, & Post, 2012; Boyer, Miltenberger, Batsche, & Fogel, 2009), group contingency management (DePaolo, Gravina, & Harvey, 2018), precision teaching/fluency training (Pallares, Brooks Newsome, & Ghezzi, 2021) and various types of performance feedback, e.g., video and graphical feedback (Harris, Casey, Meindl, Powell, Hunter, & Delgado, 2020; Quinn, Miltenberger, Abreu & Narozanick, 2017), teaching with acoustical guidance feedback (TAG; Elmore, O'Healy, Lydon, & Murray, 2018; Quinn & Miltenberger, 2017), and public posting of performance data (Quinn, Miltenberger, Abreu et al., 2017).

A notable feature of ABA research in sports is that teaching components are rarely evaluated in isolation; they are often assessed in combinations as part of a package deemed to be appropriate to the sport/skill being studied (Luiselli & Reed, 2015; Schenk & Miltenberger, 2019). As a result, it is often not clear which components of treatment packages were necessary and sufficient to bring about changes in performance.

This has led to discussion among ABA researchers as to what constitutes behavioral coaching and how it should be defined (Seniuk et al., 2013; Schenk & Miltenberger, 2019). Seniuk et al. (2013) have suggested that behavioral coaching is not defined by the use of a specific technique or treatment package, rather it is characterized by six more general features: 1) frequent measurement of athletes' performance, 2) acknowledgement of the difference between the acquisition and maintenance/generalization of skills and the need

to train for both, 3) measures of individual athletes' improvements is assessed against their own performance (not the performance of others), 4) the use of empirically-validated coaching practices, 5) self-evaluation of coaching practices (i.e., coaches assess the effects of their coaching practices on athletes' performances), and 6) the selection of coaching practices, athlete goals, and outcomes that are socially valid (i.e., those that are important and acceptable to parents, players, and others involved).

As noted in the preceding section, many common coaching practices, especially in youth sports coaching, suffer from a lack of empirical validation. A potential benefit of the behavioral coaching approach as defined by Seniuk et al. (2013) is that empirical validation does not necessarily need to come in the form of peer-reviewed research studies. Rather, coaches may play a prominent role in the evaluation and evolution of their own coaching practices by observing and measuring relations between 1) the situations they arrange for athletes in practice, 2) changes in athletes' performance in these situations, 3) performance in competition settings, and 4) the social validity of these.

Selection of Behaviors and Measurement

The selection of behaviors targeted for change and how they are measured are important considerations in evaluating coaching practices as described above. While the gross/composite performances that are most important in a given sport may be relatively obvious, it may not be clear whether coaches should target gross/composite performances for intervention or focus on more elementary components that serve as prerequisites to adequate performance of a composite skill. For example, winning a point with a forehand winner in tennis (i.e., a shot that is not returned by one's opponent) depends on a series of component performances, including observing where an opponent's shot will land and

getting into the proper position to return it in enough time, observing the opponent's position in the court, drawing the racket back with the appropriate grip, watching the ball while swinging, and swinging with the correct movement of the racket given one's own position in the court. In performances of this sort, a desired composite performance (hitting a winner) may not be possible until all component performances are trained, and much time may be wasted in coaching without considering this. This issue of the relation between component and composite skills is considered in more detail below.

With respect to the behaviors targeted for change, it is also important to consider the dimension(s) of the performance upon which measurement and intervention should be focused. There are many aspects of performance that can be measured in the context of sports, including topography or form, rate, duration, or the percentage of steps performed correctly in a behavioral chain. The dimension(s) of sports skills that are important depend on the nature of specific sports and the criteria by which performance and "winning" are judged.

In some sports, competitive performance is judged entirely on the topography or form of athletes' behavior (e.g., gymnastics, dancing, diving, figure skating). However, in other sports, competitive performance is judged primarily by the effects or outcomes of athletes' behavior. For example, in sports such as basketball, tennis, soccer, the topographies by which athletes shoot a basketball, hit a tennis ball, or kick a soccer ball do not entirely determine whether or not points are awarded in the context of competitive play. In these games, points are awarded only if a basketball goes through the hoop, the opposing player does not return a tennis shot, or the soccer ball enters the goal. Of course, even in these situations, topography may still be considered important because certain forms of

shooting/hitting/kicking may be more effective in producing the desired outcomes, and the rules of a sport may also limit the forms of behavior that are allowable in competition (e.g., in soccer, goals cannot be scored using players' hands). The fact that topography or form is relevant to sports with both form- and outcome-based judgement criteria is perhaps the reason why the majority behavioral coaching research studies have measured and intervened upon the dimension of response topography (Schenk & Miltenberger, 2019).

Nevertheless, sports in which topography is not the sole criterion for judgment allow a degree of variability in form across players. It is therefore possible that different forms of behavior may emerge among individual players, and some of these may even be more effective than conventional or traditional forms in a competitive setting. It is also possible that improvements in form are not necessarily correlated with improvement in performance as measured by a given sports' judgment criteria. The relationship between changes in form brought about through coaching and changes in the ultimate criterion for performance in competition cannot be assessed without measuring both dimensions of performance.

An illustrative example of this relation in basketball was provided by Kladopoulos and McComas (2001). The researchers analyzed the effects of behavioral topography/form training on shooting free throws. Three athletes on a women's collegiate basketball team participated in the study, and after baseline measures of performance were collected, athletes were given instructions regarding the conventional form for shooting free throw shots. Participants were then given the opportunity to take free throw shots, and experimenters provided descriptive praise on the correct features of form to the participants when they made shots. No feedback was provided following missed shots. An interesting

feature of this study was that the researchers measured two dependent variables concurrently: 1) the extent to which the topography/form of shots was correct and 2) the percentage of shots made. Feedback on form improved topography substantially, to the point that nearly all shots were performed correctly in terms of form. However, the effects of this on percentage of shots made was variable across participants. Percentage of shots made increased substantially for one participant, but the improvement was relatively slight for the other two participants. The results suggest that form training can be effective in increasing outcome-based measures of performance (i.e., shots made), but that additional coaching through other methods may be required to achieve higher levels of proficiency/consistency in some skill domains that are important in competitive play.

Precision Teaching and Fluency

An alternative or supplement to coaching practices focused on topography/form in sports where judgment is not entirely based on form is training aimed at improving other dimensions of performance. One dimension known to be important to many types of performances, both in sports and other activities, is *rate of behavior* (i.e., the number of times a particular behavior occurs within a given unit of time; Lindsley, 1996).

Training aimed at increasing the rates of behaviors is one hallmark of precision teaching (PT; Binder, 1996). PT research has shown that increasing rates of various performances to optimal levels leads to an outcome called *fluency* (Binder, 1996; Johnson & Layng, 1992, 1996; Johnson & Street, 2013; Kubina & Yurich, 2012). Fluency has been described as "the fluid combination of accuracy plus speed that characterizes competent performance" (Binder, 1996, p. 164). It is characterized by a constellation of measurable outcomes known as RESA (Johnson & Layng, 1996): 1) retention (i.e., a performance is

maintained across time even without practice), 2) endurance (i.e., a learner can engage in a performance for extended periods of time), 3) stability (i.e., a learner can engage in a performance in the face of distraction) and 4) application (i.e., the performance facilitates the acquisition of other more complex skills that are not directly trained).

In addition to an emphasis on rate of behavior as a determinant of fluent performance, PT is characterized by the collection of frequent measures of performance during opportunities for practice of skills, display of performance measures on the standard celeration chart (SCC), modification of training strategies on the basis of learner performance, and a focus on training component skills to facilitate the emergence of more complex composite skills (Binder, 1996; Johnson & Street, 2012; Kubina & Yurich, 2012). The SCC graphing format that combines calendar time on the x-axis and rate of behavior on a semilogarithmic scale on the y-axis (Binder, 1996). In graphing performance data on the SCC, trainers can determine how performance changes over time, otherwise known as celeration (acceleration or deceleration). Graphing of learner performance occurs in the moment, and this allows for frequent and ongoing evaluation of teaching methods and informs decisions regarding changes in teaching strategies on the basis of learner performance. As noted above, the measurement of athlete performance and the evaluation of coaching practices in terms of changes in these measures is an important characteristic of behavioral coaching.

Another potential contribution of PT to behavioral sports coaching lies in its explicit focus on teaching prerequisite component skills to facilitate the emergence of composite skills (Johnson & Street, 2012). As suggested above, the gross/composite skills of importance in sports often require the mastery of various component skills, and the

former may not emerge in the absence of the latter. The PT literature has demonstrated that training component skills to fluency can have profound effects on untargeted skills.

Dribbling as a Component Skill in Basketball

In basketball, the ultimate criterion for performance is in scoring points when a basketball goes through a hoop. However, an important component skill facilitating this outcome in competitive play is dribbling. In the early days of professional basketball, the ball could only be moved around the court by passing from one player to another. In 1897, the Yale University basketball team developed dribbling as an alternative strategy for moving the ball around the court as a sort of "self-pass" (The Evolution of Professional Basketball, 2022). Subsequent rules clarifications led to the recognizable type of dribbling allowed in modern professional and youth basketball competition.

Contemporary rules stipulate that players must bounce the ball continuously with one hand at a time when moving about the court while in possession of the ball. When a player stops dribbling, they cannot start again without passing to another player or taking a shot at the hoop. Restarting dribbling after it has stopped or dribbling with two hands on the ball at the same time is known as "double-dribble" and leads to a stoppage of play and a transfer of possession of the ball to the opposing team.

Because dribbling is a primary means of maneuvering the ball around the defensive efforts of opponents and towards the hoop where points may be scored, it is an important determinant of individual players' success in achieving points, and by extension, a team's success in competition with others. Fluent dribbling can provide access to individual and team opportunities for scoring that are impossible without the skill. It may therefore be considered an important component skill to target for coaching in basketball, especially at

the youth level. Nevertheless, to our knowledge, it has not been targeted in either behavioral coaching or PT research studies. Dribbling may be considered a fundamental component skill amenable to PT and rate-building approaches, and the proposed study will focus on methods to develop dribbling skills in youth basketball athletes within a PT rate-building and fluency framework.

Goal-Setting and Schedules of Reinforcement

Goal-setting has been demonstrated as an effective tool for increasing the rate of behaviors in sports and other activities (Athens et al., 2007; Locke & Latham, 1990, 2002; Galbicka 1994; Normand, 2008; Roane, 2008; Ward, 2011; Weinberg et al., 1994). A similar practice occurs in PT with the setting of performance aims to progressively increase the rate of component skills to the point at which the outcomes that define fluency (RESA) emerge (Kubina & Yurich, 2012). Goal-/aim-setting is typically accompanied by feedback for the learner as to whether or not the goal/aim was met. In sports, goal- and aim-setting methods allow coaches to focus their intervention on the rate of a skill instead of form, though it may be used in combination with goal-setting and/or feedback related to form.

Goals in sports coaching are typically decided by the coach (sometimes in collaboration with athletes), but the means by which coaches/athletes decide on these is typically unsystematic (Ward, 2011). This has led researchers to study the goal-setting methods that are most effective in bringing about changes in performance. The literature in this area has suggested that goals are more effective in changing behavior when they 1) are specific, 2) are challenging/difficult, 3) include mastery criteria, 4) specify the circumstances in which the desired behavior should occur, 5) are made public, 6) include

a deadline, 7) are accompanied by performance feedback, and 8) are goals which the athlete finds important/meaningful (Locke & Latham, 2006).

Despite these helpful guidelines, it may be difficult to determine which goals are "challenging" or "difficult" for a particular athlete. Latham and Locke (1991) cited the organizational behavior management literature and suggested that a difficult goal could be defined as one that 10% or less of performers could attain without goal-setting or other behavioral interventions. However, goals of this nature may be unrealistic given the starting point of an athlete and lead to frustration (Ward, 2011). This seems particularly likely at the youth sports level, where skills are just beginning to be established. As such, the consideration of the baseline skill level of youth athletes is an important consideration in selecting performance goals that are both achievable and difficult. Another consideration is how best to gradually increase goals such that athletes continue to practice (i.e., contact sufficient reinforcement to sustain behavior) while performance continues to improve. A final consideration is the selection of mastery criteria. Ideally, sports skills are trained to the point at which fluency and RESA outcomes are observed in the context of competitive play.

Approaches to goal setting that may help address these issues may be derived from behavior analytic research on schedules of reinforcement (Ferster & Skinner, 1957). Schedules of reinforcement describe relationships between behavior and the occurrence of reinforcement. Schedules of reinforcement for behaviors can be arranged on the basis of a wide variety of parameters, including the number of behaviors that occur, rate of behavior, and/or the passage of time. In sports coaching during practice, the primary reinforcers for athletes are typically praise from coaches and/or other sources of performance feedback

arising from engaging in practice activities (e.g., feedback indicating that a goal/milestone has been met; Luiselli & Reed, 2015; Schenk & Miltenberger, 2019; Ward, 2011). Attaining a goal is presumed to be reinforced in these ways. Schedules of reinforcement may be useful in devising systematic goal-setting methods that tie reinforcement to individual athletes' baseline performance, progressively increase performance, and provide enough reinforcement to maintain athletes' behavior (i.e., keep them from "giving up").

Two schedules developed from behavior analytic research that may be appropriate for the application of goal-setting and progressive rate-building in sports coaching are progressive ratio (PR) and percentile (K) schedules. In PR schedules, the criterion for reinforcement (i.e., the "goal") is based upon the number of responses that occur and gradually increases as individuals meet criteria. For example, in a PR-1 goal-setting schedule, an initial assessment of performance would be taken, and the criterion for reinforcement on the subsequent assessment would be one measurement unit higher than the baseline value. When this criterion is met and feedback is provided, the criterion would increase by one measurement unit. In this schedule, the response requirement never decreases; it progressively increases by one measurement unit as previous criteria are met. In research, PR schedules are frequently used to assess reinforcer efficacy and break-point values (i.e., the point at which individuals cease responding for a particular reinforcer; Roane, 2008). However, this schedule is analogous to a goal-setting situation in sports in which the first assessment of performance establishes an individual baseline and reinforcement on subsequent assessments depends upon athletes "beating their previous best," a common goal-setting practice in sports.

An alternative method for tailoring goals to learners' baselines and progressively increasing the criterion for reinforcement is the percentile (K) schedule (Galbicka, 1988, 1994). In a K schedule, the criterion for reinforcement is established by the percentile formula:

$$k = (m + 1)(1 - w)$$

In this formula, k is the criterion for reinforcement for a given assessment, m is the number of preceding assessments that are rank-ordered to determine k, and w is the probability that a performance exceeding k will be followed by reinforcement (in application, this is usually set at 1, i.e., a 100% probability that reinforcement will occur given a performance exceeding k). Consider an example in which the measure of performance is the number of times an athlete dribbles a ball in successive 10-s timings (i.e., rate of dribbling). If $m = 10$ (i.e., the number of dribbles on any given timing is compared to the preceding 10 timings), the criterion for reinforcement k would be one dribble more than the athlete's best performance in the preceding 10 timings. Whether or not this criterion is met, the performance in the timing would be added back into the list of preceding performances to determine k for the subsequent assessment.

PR and K goal-setting schedules both qualify as shaping procedures (Galbicka, 1988) in that 1) criteria for reinforcement are based upon individual learners' performances, 2) criteria change systematically across assessments on the basis of learners' performances during previous assessments, and 3) they may be used to shape athletic performance along the response dimension of rate of behavior, which is relevant to a component skill such as dribbling in basketball. The difference between them is that K schedules are more sensitive to modification of goal-setting criteria on the basis of athletes'

performance during preceding assessments. As noted, criteria set by PR schedules only increase, but criteria set by K schedules can fluctuate depending on athlete performance across *m* number of observation points. While K schedules may superficially seem more difficult for coaches to use in a practice setting, as noted by Athens et al. (2007, p. 476), "a percentile schedule does not require any teaching of the calculation of the percentile schedule or even a conceptual understanding of the method." Normand (2008) further suggested that K schedules of reinforcement hold promise as a sensitive and systematic method of adjusting athletic performance goals. Beginning athletes may benefit from a goal-setting method that is sensitive to baseline performance as well as fluctuations in performance as new skills are acquired.

Purpose

The purpose of this study was to compare the effects of PR and K goal-setting schedules in terms of their effects on the rate of dribbling a basketball for beginning youth athletes. After a baseline assessment of dribbling rate for both hands, rate of dribbling was measured across a series of timings in which performance rate goals were set by a PR schedule for one hand and by a K schedule for the other. Feedback that followed timings was minimal (i.e., only whether or not the goal for the timing was met), and no feedback was given regarding form/topography of dribbling. After each timing, performance was plotted on a standard celeration chart (SCC) and changes in dribbling rate produced by PR and K goal-setting schedules were compared in terms of celeration, or the rate at which performance increased/decreased across timings. In addition to this, probes of fluency outcomes (retention, endurance, stability, and application; RESA) were conducted throughout the experiment that assessed the relationship between changes in

rate of dribbling brought about through goal setting and RESA, which intended to assess the relevance of behavior change to more functional outcomes in competitive play.

Method

Experimental Design

The independent variables for this study were the schedule by which dribbling rate goals were set (K schedule versus PR schedule). All participants were exposed to both of these goal-setting conditions, and the dribbling hand to which the schedules were applied was assigned as follows. For the two participants in Group KD, the K schedule was used to set goals for the dominant hand and the PR schedule was used to set goals for the non-dominant hand (see Table 1). For the two participants in Group PD, the assignments were the opposite: the PR schedule was used to set goals for the dominant hand and the K schedule was used to set goals for the non-dominant hand. This allowed for comparisons of the K and PR goal-setting conditions both within subjects (comparison of K/PR schedules for the same participant) and between subjects (comparison of K/PR schedule effects on dominant/non-dominant hands across participants). Additionally, RESA probes were administered that assessed the effects of the goal-setting conditions on each hand's performance of completing the component and composite dribbles targeted across the duration of the study.

The K and PR goal-setting schedules were compared in terms of their effects on a) the celeration of dribbling rate and b) the number of timings to asymptote criteria. Celeration is a measure of the change in the rate of dribbling across timings and allowed

for a comparison between the schedules in their effects on the dribbling performance of interest. The number of timings to stability allowed for a comparison of the relative efficiency of the two schedules in bringing about asymptotic dribbling rates.

Probes that assessed the retention, endurance, stability, and application (RESA) of dribbling skills were conducted at predetermined stages of the experiment and served as an additional measure of the outcomes of the dribbling rate-building that occurred during the goal-setting sessions. RESA are considered to be measures of the fluency of a performance. Probe performances allowed for the assessment of the relationship between rates of dribbling and functional mastery in the form of fluency.

Participants

Four elementary school children between 3rd and 6th grade participated in the study. Participants were recruited through the City of Sparks youth recreation basketball league. The experimental participants included one girl (10 years old/4th grade) and three boys (12 years old/6th grade, 9 years old/4th grade, and 8 years old/3rd grade). To minimize potential ceiling effects that could limit the interpretation of data, eligible participants were in their first year of competitive youth basketball and only played organized basketball in the City of Sparks recreation league (i.e., they did not compete in any other competitive leagues or school teams). Participants were randomly assigned to Group KD or PD.

Materials and Setting

Sessions were held once a day, from one to four times a week between Mondays and Fridays, at the basketball courts of a local community center gym. Materials used

during sessions included a youth-size basketball (size 28), timer, video camera, clipboard, writing utensils, script, and frequency clicker.

Endurance/Stability/Application/Retention Probe Schedule

Endurance, stability, and application (ESA) probes were conducted prior to baseline timings, after 10 baseline timings, following an interval of 20 goal-setting timings, and after the response on each hand reached its asymptotic criteria (see Table 2). The purpose of conducting pre-baseline probes was to obtain a measure of the performances assessed in the probes prior to any practice effects that occurred during baseline timings. The purpose of the post-baseline probes was to assess for any practice effects experienced from the period of the pre-baseline probes and the following baseline phase. Furthermore, the post-baseline probes functioned as a marker that assessed for learning during the intervention phase. In addition, conducting a series of ESA probes on each hand following 20 goal-setting timings provided a consistent celeration analysis throughout the course of the study. The hand that started each probe session alternated across sessions and all probes were completed prior to changing to the other hand (i.e. all left hand probes were completed before going to their right hand). In addition, probe order for all probe sessions were randomly selected by a randomization phone app. Lastly, participants engaged in retention probes 1- and 2-weeks after they reached asymptotic criteria (described below) which examined the effects of a period of no practice on the dribbling response. No programmed feedback was delivered to the participant following performance in any of the probes.

Endurance probe. The purpose of endurance probes was to test the ability to maintain dribbling performance for longer durations than those of the goal-setting session

timings (timings will be 10-s in duration). The participant was asked to dribble for one 20-s timing on each hand. The number of dribbles that occurred during this time was recorded.

Stability probe. The purpose of stability probes was to examine the performance of a response in the face of distraction. Participants received two 10-s timings to assess this, one with each hand. During these probes, the experimenter or research assistant stood in front of the participant in a defensive stance for the duration of the timing. Stability was measured as the rate of dribbling in the presence of this additional distraction.

Application probe. The rate of dribbling performance targeted by the goal-setting schedules may be considered a component of the more complex dribbling performances that occur during competitive basketball games (e.g., running while dribbling, keeping the ball from defenders, crossover dribbling, etc.). The purpose of the application probes was to examine the effects of the rate-building that occurred during goal-setting sessions on the emergence of more complex variations of dribbling that are indicative of functional mastery or fluency. Three performances were assessed in application probes: (a) dribbling while standing and looking at a marker on the wall b) dribbling the ball back and forth between dominant and non-dominant hand while standing, and c) moving forward in a straight line while dribbling the ball. Each were assessed in 10-s probe timings.

Application probes “a” and “c” were displayed as separate celerations on the Standard Celeration Chart (SCC) since only one hand was being utilized. However, for application probe “b”, both hands were needed to execute the dribble. Therefore, only

one “b” probe timing was conducted each interval, regardless of the phase or condition the participant was in. The data collected from this probe represented the performance as a function of the fluency of both hands to complete the composite response. As in the endurance and stability probes, performance was measured by the total number of dribbles made by the participant in a timing.

Baseline Sessions and Handedness Assessment

A baseline session consisting of a series of timings of the dribbling behavior in the absence of goal-setting occurred on the session day after the pre-baseline probe. 10 baseline sessions were conducted for each participant prior to proceeding to the post-baseline probe phase. This session also served to determine participant handedness. The Official National Basketball Association (NBA) Handbook defines dribbling a basketball as a “movement of the ball, caused by a player in control, who throws or taps the ball to the floor” (Section II – Dribble).

For the purposes of this experiment, dribbling was measured by counting each instance that the ball contacted the floor following contact with the hand. During instances where the participant failed to contact the ball with their required hand before the ball hit the floor again, the experimenter did not count that as a dribble. Once the participant resumed the sequence of hand contacting ball, ball hitting the floor, and hand contacting ball, the experimenter then continued counting. There were multiple considerations for only counting the operationally defined dribble desired, rather than collecting error data. First, the aim calculated for that specific timing was a product of the participant’s performances up to that point in the experiment. Secondly, counting errors would be a redundant procedure, due to the assumption that if the participant committed

an error, their likelihood of meeting their goal for that timing was reduced. Lastly, the variability in the topographical features of a dribble can be high, even with the simple form of hitting the ball with your hand and then contacting the ground and so on. If any part of the participant's hand contacted the ball, from the bottom of the palm to the tip of the finger, that dribble was added to the frequency count.

Sessions began with the experimenter reading a script: "Hi _____. This is a baseline session so there is no goal, and I will provide you with no feedback following the timing. You will be dribbling a basketball for 10 seconds, the timer will begin when the ball first touches the floor, and please stop dribbling once you hear the timer and when I say stop. I will first model the dribble, and it looks like this *models dribble*. Do you have any questions?"

Following this, the session commenced with dribbling timings. Participants were stationary and were asked to dribble with the specified hand from when the timer started until it stopped. The experimenter started the timer when the first dribble hit the ground. Each timing was 10-s in duration, and the total number of dribbles in each were counted. No feedback was provided during or after timings during baseline. Throughout the session, only general statements unrelated to dribbling performance (e.g., "thank you," "good job") were made by the experimenter. If the participant had questions about the formal properties of the response, the experimenter simply asked the participant to do their best which minimized the possibility of inadvertently shaping the performance.

20 total timings were conducted, 10 with each hand. All 10 timings were completed on one hand before they proceeded to the other hand. The hand that produced

the most cumulative dribbles during the session was designated as the dominant hand for the purposes of the experiment.

Asymptotic Criteria

There is a natural ceiling on the rate at which participants came to dribble. Because of this, asymptotic performance was expected to occur at some time during goal-setting sessions. Asymptotic criteria were utilized to determine this level and the end of the goal-setting sessions for each hand for each participant. The asymptotic criterion was when a) the participant failed to meet highest numbered goal for three consecutive sessions (minimum 30 timings) and b) at least 40 goal-setting timings were completed. The rationale for these criteria was as follows: a) three consecutive sessions reduced the likelihood of within session variables impacting performance, and b) 40 goal-setting timings provided enough opportunities for the participants to contact the effects of the goal-setting schedule and reached a point where they couldn't dribble any higher.

Goal-Setting Sessions

Following the post-baseline probe, a series of goal-setting sessions with timings were conducted. For each session, the duration/number of timings were the same as in the baseline session, and the number of dribbles were recorded in each timing as described. Timings alternated across hands, and goals for the number of dribbles were established on a timing-by-timing basis according to the schedule/hand combination assigned to each participant. Schedule/hand combination timings were done in a block format, where one hand completed 10 consecutive timings before they moved on to the other hand. Sessions alternated as to which hand was the first hand to conduct timings.

Progressive ratio (PR) schedule timings. Ten 10-s timings were conducted with the hand assigned to the PR goal-setting schedule in each session. The first PR aim in the first goal-setting session was determined by each participant's highest performance from the baseline phase on the hand assigned to the PR schedule. The schedule for goal setting in this condition was a PR-1: the goal for timings was to dribble one time more than their previous best. As mentioned above, participants were informed of their goal prior to the start of each timing. If the participant met or beat the goal for a timing, the instructor delivered reinforcement in the form of verbal praise which consisted of congratulatory statements such as, "Wow you did it!", "You met your goal--great job!", "Yay, you got X (number) dribbles!" The instructor also smiled, clapped, raised arms, etc. while they provided praise. If the participant did not meet their goal for a timing, the instructor stated in a neutral tone, "I'm sorry, you did not meet your goal", "Not quite, you got X (number) dribbles", etc. No feedback on the topographical features of the response was given during or after any timings.

There was no goal-reduction criteria for the PR schedule; once a goal had been determined, that was the target aim across sessions until either, a) the participant met that goal or b) asymptotic criteria had been met. As mentioned above, if the aim produced by the PR schedule was not met for three consecutive sessions and 40 trials had been completed, the goal setting phase concluded. Sessions were identical to the session structure of the baseline condition mentioned previously (i.e., items "a" through "e"), however feedback was delivered contingent on the participant's performance.

Percentile schedule (K) timings. As with PR schedule timings, ten 10-s timings were conducted with the hand assigned to the percentile (K) goal-setting schedule in each

session. These timings alternated with the PR hand/schedule combination timings and were identical with the exception that the goal for the number of dribbles in each timing was determined by the percentile formula $k = (m+1) \times (1-w)$. In this formula, *m* was the distribution of observations, *w* was the probability of reinforcement, and *k* was the current rank the response must exceed to contact reinforcement. The observation window for this study, or *m*, were the participant's performances for the most recent 10 timings. The probability of a response meeting the criteria, or *w*, was directly related to *k*, which identified which of the last 10 performances functioned as the timing aim. For this experiment, $k=5$, in that the aim was one dribble more than their 5^{th} highest performance in their last 10 timings.

This formula was used to establish the first aim in the first goal-setting session for the K-assigned hand on the basis of the 10 baseline timings. The goals for subsequent timings were established using the percentile formula on a timing-by-timing basis. When participants met the goal established by the K schedule, putative reinforcement in the form of praise was delivered in the same manner as described in the PR goal-setting timings section. If participants did not meet the aim, neutral statements were delivered in the same manner as described in the PR goal-setting timing section.

Errors

Error data was collected throughout the experiment for further performance analysis. The operational definition of errors collected in this study was as follows: "An error was marked for a specific goal-setting trial when a) the ball bounced off of a body part that was <u>not</u> associated with the hand (i.e. fingers, nails, palm), and b) the opposite hand contacted the ball, while dribbling, during a specific hand's timing (i.e. right hand

timing and the left hand touched the ball).” In addition to number of errors, the bounce of goal-setting performances on the SCC was calculated. In Precision Teaching, bounce refers to the variability in performance across timings for a given response (Dietrich, 2022).

In instances where the participant failed the continuation of a dribble and needed to restart, these occurrences were not considered an error. Due to the high rate of responding, the difficulty of the goals established, and the physical level the participants dribbled at, discontinuation of dribbles happened frequently. As the stopping of dribbling happens naturalistically within the game of basketball, discontinuation of dribbles were not counted as errors.

Periodic ESA Probes

As shown in Table 2, ESA probes identical to the pre-baseline ESA probe were conducted after every 20 goal-setting timings that assessed changes in fluency measures as a function of changing dribbling rates that occurred during goal-setting sessions. ESA probes were conducted at the beginning of the determined session, regardless of the phase the hand was in. The hand that conducted the probes first, was the hand that went last in the previous probe session.

Retention Probe

ESA probes provided measures of the endurance, stability, and application dimensions of fluency throughout the experiment. An additional dimension of fluency is retention, or the extent to which a performance is maintained after a period of no practice. To assess retention, two 10-s timings were conducted with each hand for each participant one and two weeks after asymptotic performance levels had been achieved for each hand.

Hands were not tied together with respect to mastery, in that, when one hand reached mastery prior to the other, the post-goal setting probe schedule began to operate and did not wait for the other hand to reach its mastery criteria. Therefore, one hand could conclude while the other hand was still participating in the experiment.

Data Collection and Analysis

Raw data was collected on data sheets that displayed the scores over the course of all timings. Recording in this manner made it easier for the instructor to readily calculate timing goals so as to not delay the flow of sessions.

Following the conclusion of each session, the experimenter transferred the raw scores to a daily-per-minute Standard Celeration Chart (Precision X: Central Reach, 2022). Probe data was displayed on a separate daily-per-minute chart. One participant, therefore, had a total of four different charts: (1) dominant hand goal-setting sessions, (2) non-dominant hand goal-setting sessions, (3) dominant hand ESA probes, and (4) non-dominant hand ESA probes. This allowed for within-subjects comparisons of PR and K schedules in terms of a) celeration across timings/sessions and b) number of timings to asymptotic performance. The design of the experiment also allowed for between-subjects comparisons of the effects of the two schedules on performance with dominant and non-dominant hands.

Interobserver Agreement

All timings and every session were recorded via video camera by the experimenter. Interobserver Agreement (IOA) data was then produced by comparing the number of dribbles recorded in vivo by the experimenter with the number of dribbles

counted in the video. IOA was assessed for 25% of all baseline, goal-setting, and probe timings for all four participants.

Procedural Fidelity

As mentioned earlier, each timing consisted of five procedural components: (a) what response the participant executed, (b) what hand was utilized, (c) the phase, (d) if there was a goal and what that goal was, and (e) if the participant had any questions. Procedural Fidelity was calculated for three of the five components: 1) phase timing was accurate, 2) goal was set properly, and 3) feedback was delivered according to protocol. Therefore, in conjunction with all sessions being video recorded, procedural fidelity of the experiment was calculated by scoring whether the instructor or research assistant performed these three items on the script, divided by the total number of opportunities. Fidelity was calculated for 25% of all baseline, intervention, and probe timings for all four participants.

Social Validity Questionnaire

As noted, social validity is an important aspect of youth coaching. A social validity questionnaire (Common & Lane, 2017) was administered to all four participants and one of each of their parents after the completion of participation in the study. For participants, the experimenter either read the statements out loud to the participant or was in a nearby area to assist with understanding or completion of a written version. The participant and parent questionnaires appear as Appendices A and B. The questionnaire consisted of a series of statements with which respondents could choose an answer on a 5-point Likert scale ranging from “strongly agree” to “strongly disagree.” This allowed

for the assessment of participants' and parents' opinions regarding the procedures and outcomes and, for the former, preference for one or the other goal-setting method.

Results

Baseline Timings and Handedness Assignment

Table 3 displays the handedness assessment's raw scores and dominant hand assignments for each participant. KD2 produced the lowest difference of dribbles between hands (5), while PD1 and PD2 had the biggest differences (36 and 34, respectively). KD1 had a moderate difference of 17 dribbles. One notable result from baseline timings was that PD1's baseline level of performance was substantially higher than the other three participants. The discrepancy between participants at baseline will be further highlighted and discussed in sections below.

Table 4 shows the comparison between the hands assigned as dominant on the basis of baseline assessment and the participants' verbal report of handedness. Only two out of the four participants' (PD1/PD2) verbal reports matched the assignment of handedness from baseline timings.

Goal-Setting Sessions

After baseline timings, participants received a series of goal-setting sessions with the goal-setting/hand combinations shown in Table 1. Figures 1-4 show participants' performances (dribbles per minute) on all baseline, goal-setting, and retention probe timings on electronic Daily per Minute Standard Celeration Charts (SCCs; Central Reach, 2022). In these figures, each black dot on the graph represents performance in a single timing. The black lines drawn through the dots are the celeration lines, and the numbers in the boxes above celeration lines are the celeration slope values from the first goal-

setting session to the last. For these values, X indicates an increase, and / indicates a decrease. The green lines above and below the celeration line represents the degree of bounce, or variability in performance across goal-setting sessions. The horizontal axis shows calendar days. Goal-setting sessions occurred between one and four times per week.

KD Group Performance. Figure 1 displays the two KD group participants' performances in K schedule/dominant hand timings. Figure 2 displays the group's performance in PR schedule/non-dominant hand timings. For both KD1 and KD2, both the K and the PR schedules improved the rate of dribbling across goal-setting timings on the assigned hands.

For the K/dominant combination (Fig. 1), KD1's performance had a celeration of X 1.15 and KD2 had a similar celeration of X 1.18. Though the celerations for the participants were similar, there were some differences to note. First, the bounce of KD1's data was X 1.4 compared to X 1.7 for KD2, indicating that KD1's performance was more consistent across timings. Second, KD1 needed approximately twice as many goal-setting sessions as KD2 to reach asymptotic criteria.

The results for the PR/non-dominant combination for the participants in this group (Fig. 2) were similar to those of the K/dominant combination. Celerations were approximately the same (X 1.17 for KD1 and X 1.14 for KD2), and bounce was again smaller for KD1 (X 1.3) than for KD2 (X 1.7). As in the K/dominant sessions, KD1 took approximately twice the number of timings that KD2 did to reach asymptotic criteria.

PD Group Performance. Figure 3 displays the two PD group participants' performances in PR schedule/dominant hand timings. Figure 4 displays the group's

performance in K schedule/non-dominant hand timings. Unlike the KD group, neither the PR nor the K schedule changed the participants' performance in a meaningful way. Celeration values of 1.0 mean that no change in performance occurred across goal-setting sessions, and the celeration values for both participants and schedules were very close to 1.0. There was a very slight deceleration for PD1's performance in K schedule/non-dominant timings (/ 1.04). Bounce was slightly higher for PD1 (X 1.7 for PR/dominant timings and X 1.6 for K schedule/non-dominant timings).

It is interesting to note that while participant PD1's did not increase as measured by celeration across goal-setting sessions, there was an increase in performance for both hands at the beginning of goal-setting sessions relative to baseline. After this initial increase in the first goal-setting sessions, performance stayed at approximately the same level for the remainder of the study. This suggests that the introduction of goals had at least some effect on PD1's performance.

Notably, both participants in this group reached asymptotic criteria in relatively few timings (range 5 – 8 timings). Additionally, there was almost a two-week interval between timings 4-5 for participant PD2.

Comparison of K and PR Schedules.

Performance. Figures 5 and 6 offer a comparison of the effects of the two schedules on performance. Figure 5 shows the number of dribbles for every timing for each participant. Despite the variability, improvement across timings can be seen for KD1 and KD2. Of all the participants, KD1 improved the most but also took substantially more timings to reach asymptotic criteria than the other participants. Relatively little change occurred for PD1 and PD2. While variability in performance across timings can

be seen for all participants, PD1 showed the most variability in performance across timings, especially in the PR timings, which were with the participant's dominant hand. Sharp decreases in performance shown in this figure tended to be timings in which dribbling was discontinued or an error occurred. The majority of these decreases were dribble discontinuations, as percentage of timings in which an error occurred was between 3.6% - 5.4% (see Table 5). By their last timings, participants were all dribbling approximately 40 times in a 10-s timing, suggesting that dribbling rates in this range may represent asymptotic levels of performance for individuals within the age range of the participants in this study.

Figure 6 shows a "celeration collection" (Cooper, Kubina, & Malanga, 1998), which is a display of only the celeration lines for all participants across goal-setting sessions with the K and PR schedules. In these data it is clear to see the overall trends in performance: both KD group participants showed noticeable improvements in both types of goal-setting timings, while the participants in the PD group showed no improvement under either schedule.

Goal Criteria. Another point of comparison between the goal-setting schedules is the effects they have on goal criteria across timings. Figure 7 shows the goal criteria for each participant across all timings. The top panel shows that the K schedules arranges it such that goals may increase or decrease across timings, and this depends on the participants' performances on preceding timings. Goal criteria did not substantially decrease for KD2 and PD2, but the K schedule produced more dramatic increases and decreases in goal criteria for KD1 and PD1.

The bottom panel of Figure 7 shows the change in goal criteria for each participant for all PR timings. For PD1, there was a rapid increase in criteria during the first 10 timings followed by very few changes in criteria for the remainder of timings. The increase in criteria was more gradual and steady for the other participants. Criteria for KD2 and PD2 eventually plateaued and there were few changes in criteria afterwards. The data for KD1 are interesting in that there was a gradual increase, a plateau, and another series of increases before leveling off again in the last 30 timings.

Goals Met. Figure 8 shows the mean percentage of timings in which goals were met for all participants for both goal-setting schedules and dominant/non-dominant hands. Goals were met substantially more frequently in K goal-setting timing sessions (52%) than in PR timings (8%). However, there was almost no difference in the percentage of dominant/non-dominant hand timings in which goals were met (32% and 31%, respectively).

Figure 9 shows the percentage of timings in which goals were met for each of the 10 timings that occurred within goal-setting sessions. As noted above, a consistently larger percentage of K timings resulted in goals being met in all 10 timings within a session. However, for both K and PR timings, there was a slight decrease in the goals met across the 10 timings, suggesting that fatigue may have affected performance during timings later in sessions.

Summary. K and PR goal-setting schedules did not appear to differentially influence performance as measured by celeration across goal-setting timings. Both KD participants showed approximately equivalent improvements across timings with the two schedules, and the PD participants both showed little improvement with the two

schedules. This was no evidence that the degree of improvement across timings was related to dominant versus non-dominant hand. Additionally, as shown in Table 5, there was little difference in the number of errors that occurred during either type of goal-setting timing with either hand.

However, K and PR schedules differed substantially in their effects on goal criteria setting and the probability that criteria will be met. Specifically, K schedules, because of their sensitivity to the performance of the individual, made it more likely that goals will be met. There were also more goal criteria changes per session in K schedule timings (Table 5). K schedules had these effects on timings for both hands.

Probes

As described previously, two probes for the retention (R) component of RESA fluency outcomes were conducted one and two weeks after asymptotic criterion was met for a given hand/schedule. In addition to this, probes for the endurance, stability, and application (ESA) measures of RESA were conducted after every 20 timings in the goal-setting phase.

Table 6 shows probe celerations for all participants' dominant/non-dominant hands and associated goal-setting schedules. An interesting finding was that the two participants who showed the largest celerations in goal-setting sessions (KD1 and KD2) also showed larger celerations across almost all probe types. Celerations for these participants for all probes ranged from X 1.40 to X 4.24. While the improvements were observed for both schedule/hand combinations for these participants, the largest celerations were for KD2's non-dominant hand. On the other hand, the two participants who showed negligible improvement in goal-setting sessions also showed relatively little

change in performance across the probes. Celerations for these participants ranged from / 1.26 to X 1.97. As such, it seemed that celeration rates during goal-setting sessions predicted improvements in measures of fluency as measured by RESA.

Interobserver Agreement and Procedural Fidelity

Interobserver agreement (IOA) and procedural fidelity data was collected for 25% of all baseline, goal-setting, and probe timings. As shown in Table 7, the mean IOA for all participants' sessions combined was 97%. Mean procedural fidelity for all participants' sessions combined was 99%.

Social Validity Questionnaire

Table 8 shows participant scores for each statement on the social validity questionnaire and mean scores. For all participants scores for all social validity questions were 4 or 5 (agree or strongly agree). Questions 3a and 3b required the participants to circle the hand for which they preferred timings and write why they chose that hand. Two participants (KD1 and PD2) reported preferring their K schedule hand because "it was easier." The K schedule hand was assigned dominant for KD1 and non-dominant for PD2. KD2 preferred the PR hand (assigned dominant) since it was "the hand they use." PD1 had no preference because "it didn't matter." Parent/guardian stakeholders also received questionnaires, and the results appear in Table 9. As with the participants, answers for all questions were between 4 and 5 (agree to strongly agree).

Discussion

We have suggested that youth sports coaches may play a prominent role in the evaluation of their coaching practices (as well as the efficient development of skills by their players) by observing and measuring relations between 1) the situations they arrange

for athletes in practice, 2) changes in athletes' performance in these situations, 3) performance in competition settings, and 4) the social validity of these. This study was designed to be a step in this direction by assessing the effects of two goal-setting schedules, percentile (K) and progressive ratio (PR), on the rate of dribbling a basketball with first-year youth athletes. In addition to training the stationary response of dribbling, measures of fluency (retention, endurance, stability, and application; RESA) were probed at various times throughout the experiment to assess the generalization of what was learned in goal-setting sessions to other more competition-like performances. Finally, social validity of the study method was assessed with both participants and parents. The main findings and their implications are considered below.

Effects of Goal-Setting Schedules on Performance

The introduction of dribbling rate goals after baseline timings produced immediate and significant increases in performance for three of the four participants. This suggests that simply stating goals, regardless of the schedule by which they are set, can have substantial effects on performance for youth athletes.

While there was not clear evidence of a difference in the goal-setting schedules on dribbling performance for the participants, two of the four participants (KD1 and KD2) showed substantial improvements in dribbling in goal-setting sessions under both types of schedules. These improvements occurred for both dominant and non-dominant hands, and they also translated into increases in their performances in the RESA probes. This suggests that increasing the rate of dribbling as was done in this study may have some validity as a component skill or set of skills (e.g., hand-eye coordination, finger/arm movements) that contribute to the development of other more complex dribbling skills

needed for competitive play. It also suggests that focusing coaching on dimensions of a skill other than form/topography can produce desired changes in performance.

There are several potential reasons why improvements were not observed for two of the participants (PD1 and PD2). First, goal setting by itself may not be sufficient to produce behavior change in all learners. As noted above, most investigations in the domain of behavioral coaching have studied treatment packages containing several components aimed targeting multiple variables. Aside from non-descriptive feedback in the form of praise, goal setting was the primary variable (along with dominant/non-dominant hand assignments) manipulated in the present study. This was done for the purposes of experimental control, but this arrangement is unlikely to occur in real-world coaching situations. Future research may investigate the role of these goal-setting methods in the context of a treatment package that includes multiple empirically validated elements.

Second, participant characteristics and skill levels appeared to be a significant factor in performance in the study. As shown in Table 3, PD1's baseline performance was much higher than the other participants. This may have represented a ceiling on performance that stunted improvements as measured by celeration. PD2 was physically smaller than the other participants and struggled performing in probes, particularly with the non-dominant hand. It is possible that the skill targeted for this study was too complex or too physically demanding for this individual. Coaches making evidence-based decisions could identify these circumstances and individualize practice suited to the skills of their learners.

A final possible reason why improvement was not observed from some participants may have been related to the asymptotic criteria (AC) employed. As noted, PD1 and PD2 had relatively few goal-setting sessions before meeting AC. AC stipulated that goal-setting sessions stopped for a given hand when the previous best performance had not been beaten for 30 timings. It is possible that this cut off participation too soon and that improvement may have occurred with more sessions. Future research may consider the impact of termination criteria such as the one used in this and perhaps utilize other types of criteria, such as stability or consistency criteria. An important consideration in this domain is the relationship between skill criteria and the emergence of fluency (i.e., RESA).

Characteristics of K and PR Goal-Setting Schedules

In addition to their effects on performance, the study allowed for the observation of certain characteristics of K and PR schedules that have implications for youth sports coaches. First, as can be seen in Figure 7, PR schedules increase goals quickly in the beginning. However, as learners are required to beat their previous bests, goals escalate to the point at which relatively few timings meet the goal. As can be seen in Figure 8, participant goals were met in only 11% of all PR timings during the study. This state of affairs could be quite frustrating for a developing athlete and perhaps discourage continuation in a sport or practice of a skill.

K schedules are different in that they only require an individual to beat the highest of their previous *n* timings. This allows goal criteria to fluctuate depending on the learners' recent performances. Because of this, goals were met in a much higher percentage of K timings in the present study (52%, Figure 8). In real-world sports,

meeting goals is often accompanied by various forms of reinforcement. Reinforcement is a large part of what keeps athletes playing sports and practicing. As such, K schedules seem to have value in increasing the amount of reinforcement athletes may contact. However, as suggested by Haughton (1972) and Binder (1996), K schedules may prevent learners from reaching their potential because they can continue to contact reinforcement by maintaining relatively consistent performance without the need to push to personal bests. The present study utilized a K5 schedule; other K schedules may have different effects and be more appropriate for different types of learners/athletes.

Taken together, it seems that the type of goal-setting schedule that is most appropriate depends on the learner and their stage of development relevant to the skill(s) in question. PR schedules are useful for quickly increasing performance in the early stages of learning, but as learners reach true asymptotic performance, the frequency of meeting goals becomes smaller and smaller. K schedules such as the one used here appear have utility in the later stages of learning. They could help maintain near-asymptotic performance while still allowing learners to contact reinforcement often enough to keep them practicing and maintain rapport between coaches and players. Further research on these schedules as systematic methods for goal setting and the stage(s) of skill development at which they are most effective could serve to elucidate these issues.

Toward the Development of Data-Based Coaching Practices

The present study makes several modest contributions to the broader area of youth sports coaching by demonstrating the potential value of several aspects of behavioral coaching that can be used by any youth sports coach. The first is in the measurement of

performance. As noted, much youth sports coaching takes place in the absence of any form of measurement. Athletes are asked to engage in practice-related activities, but changes in performance brought about through these activities are not measured. Much in the way of evaluation of coaching practices can be done by coaches themselves (or their assistants) by measuring the extent which these change performance.

Second, the study demonstrated a method for selecting goals based upon the performance of individual athletes and using a within-individual approach to evaluating coaching practices. Regardless of the level at which coaching occurs, individual athletes vary considerably in terms of their baseline skill levels, motivation and preferences, and physical characteristics. Research suggests that some of the characteristics of effective goals is that they are individualized and challenging (Ward, 2011). Goal setting in the present study was based upon each participant's baseline performance levels and modified systematically on the basis of subsequent performance. Two of the four participants showed notable improvements under the conditions of the experiment while the other two did not. Although the experimental design did not allow for modifications/additions to the goal-setting feature investigated in this study, the results highlight the importance of developing goal-setting and coaching strategies that are appropriate and effective for individual athletes.

Third, the present study contributes to the youth sports coaching literature by adopting a Precision Teaching (PT) approach to studying the relationship between skill acquisition in practice and performance in more competitive-like circumstances. We have noted that coaching practices are not typically evaluated by the extent to which they contribute to success in competitive play. In PT, fluency is an outcome defined by the

observation of RESA. If RESA does not emerge, teaching continues and/or is modified. Measuring RESA allows for the assessment of whether what is being taught in contrived learning environments translates into performance in real-world situations where it matters. Success in competition is an important outcome of sports coaching at any level, and observing relations between coaching practices and competitive performance outcomes is bound to identify practices that contribute the most to competitive success.

Finally, improvements in performance through practice often represent small but cumulatively significant outcomes. This is because improvements across instances of performances may be miniscule, but the effect of many such small improvements may be significant for the athlete and the coach. In the absence of measurement and the graphical display of performance data, these small improvements may go unobserved by both coaches and athletes. Measurement and review by coaches and athletes provides both parties with evidence of demonstrable change. It provides both immediate and long-term feedback. Coaches can make immediate adjustments to coaching practices rather than waiting and hoping for general improvement over time. It also serves as a source of feedback for athletes and allows them to notice/attend to the changes in their behavior. Whatever is measured, it allows for data-based decision making, and this should be the foundation of any coaching repertoire.

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Tables and Figures

Table 1

Group Assignments

Group	Participant	Schedule on Dominant Hand	Schedule on Non-Dominant Hand
KD	KD1 KD2	Percentile (K)	Progressive (PR)
PD	PD1 PD2	Progressive (PR)	Percentile (K)

Note. Table 1 identifies which participants will be randomly assigned to which group, in addition to which goal-setting condition will be utilized on which hand following the hand assessment. For example, "KD" represents K (percentile) schedule on Dominant hand and "PD" for PR (progressive) schedule on Dominant hand. Furthermore, "KD1" and "KD2" represent the two participants assigned to that group, similarly for the PR group.

Table 2

Retention/Endurance/Stability/Application (RESA) Probe Schedule

Probe Schedule
1. Pre-baseline timings
2. Post-baseline timings
3. After every 20 goal-setting timings
4. After asymptotic criteria met
5. 1- and 2-weeks after asymptotic criteria met

Table 3

Handedness Assessment Raw Scores

Participant	Hand			
	Left	Right	Difference	Dom Hand
KD1	182	165	17	Left
PD1	305	341	36	Right
PD2	244	210	34	Left
KD2	166	171	5	Right

Note. Each total under the "Left" and "Right" column reflects the cumulative number of dribbles produced after 10 baseline timings. The values under the "Difference" column reflect the number of dribbles separating the total produced between hands.

Table 4

Baseline Assessment and Verbal Report Results

Participants	Baseline Dominant Hand	Goal-Setting Group	Verbal Report	Match?
KD1	Left	KD	Right Hand	No
PD1	Right	PD	Right Hand	Yes
PD2	Left	PD	Left Hand	Yes
KD2	Right	KD	Left Hand	No

Note. "Match?" column indicates whether the baseline hand dominance assessment aligned with participants' verbal reports.

Table 5

Hand and Goal-Setting Group Results

Measure	Means (n = 2 each)			
	K on Dom	PR on Dom	K on ND	PR on ND
Goal Met Percentage	56.0%	8.0%	48.0%	14.0%
Number of Goal Changes Per Session	3.1	0.8	3.6	1.2
Mean Terminal Goal at Asymptotic Criteria (AC)	43.0	54.5	41.5	49.0
Percentage of Timings with Error(s)	4.1%	3.6%	4.1%	5.4%

Note. "Goal Met Percentage" refers to the number of timings across goal-setting sessions that the performance met goal criterion. "Initial to Terminal Goal Percent Change" represents the percentage of growth from the first goal produced following the baseline assessment to asymptotic criteria. K and PR refer to percentile and progressive ratio schedules, respectively. "Dom" means dominant hand and "ND" is non-dominant hand.

Table 6

Celeration Values for Goal-Setting and Probe Performances for All Participants

Assessment	Participants/Hand							
	KD1		KD2		PD1		PD2	
	K/D	PR/ND	K/D	PR/ND	PR/D	K/ND	PR/D	K/ND
Goal-Setting	X 1.15	X 1.17	X 1.18	X 1.14	X 1.00	/ 1.04	X 1.04	X 1.00
Endurance	X 2.00	X 2.21	X 2.53	X 3.80	/ 1.26	X 1.44	X 1.48	/ 1.10
Stability	X 1.93	X 2.00	X 2.64	X 4.24	X 1.97	X 1.29	X 1.36	X 1.30
Application - Marker	X 1.92	X 1.92	X 1.97	X 3.21	/ 1.07	X 1.06	X 1.36	/ 1.13
Application - Moving	X 1.51	X 1.47	X 1.40	X 1.40	X 1.66	/ 1.26	/ 1.02	/ 1.47
Application - Crossover	X 1.46		X 2.51		X 1.18		/ 1.05	

Note. "X" denotes accelerations in rate and "/" represents deceleration in rate across assessments. The "Application – Crossover" assessment has one celeration value because both hands are required to engage in dribbling during these timings. "D" and "ND" refer to dominant and non-dominant, respectively.

Table 7

IOA and Procedural Fidelity Results

Participant	Assessment				
	Baseline	Goal-Setting	Probe	Combined IOA	Total Fidelity
KD1	100%	85%	92%	92%	99%
PD1	100%	93%	98%	97%	98%
PD2	100%	97%	99%	99%	100%
KD2	100%	96%	99%	98%	99%
Mean Total	100%	93%	97%	97%	99%

Table 8

Participant Social Validity Survey Results

Number	KD1	PD1	PD2	KD2	Average
1	5	5	5	5	5
2	5	4	5	4	4.5
3a	Dom (K)	No Preference	ND (K)	Dom (PR)	
3b	"It was easier"	"It does not matter to me what hand"	"Because it was easier dribbling RH than LH"	"Because that is the hand that I use"	
4	5	5	4	5	4.75
5	5	5	5	5	5

Note. For statement 3, experimenter included the corresponding group assignment for this table ("LH (K)"), no information was given to the participant for which schedule was operating on which hand. 3a's responses for each participant was transcribed word for word from social validity questionnaire.

Table 9

Parent/Guardian Social Validity Survey Results

Number	KD1	PD1	PD2	KD2	Average
1	5	4	5	4	4.5
2	4	5	4	5	4.5
3	5	5	5	5	5
4	5	4	5	5	4.75

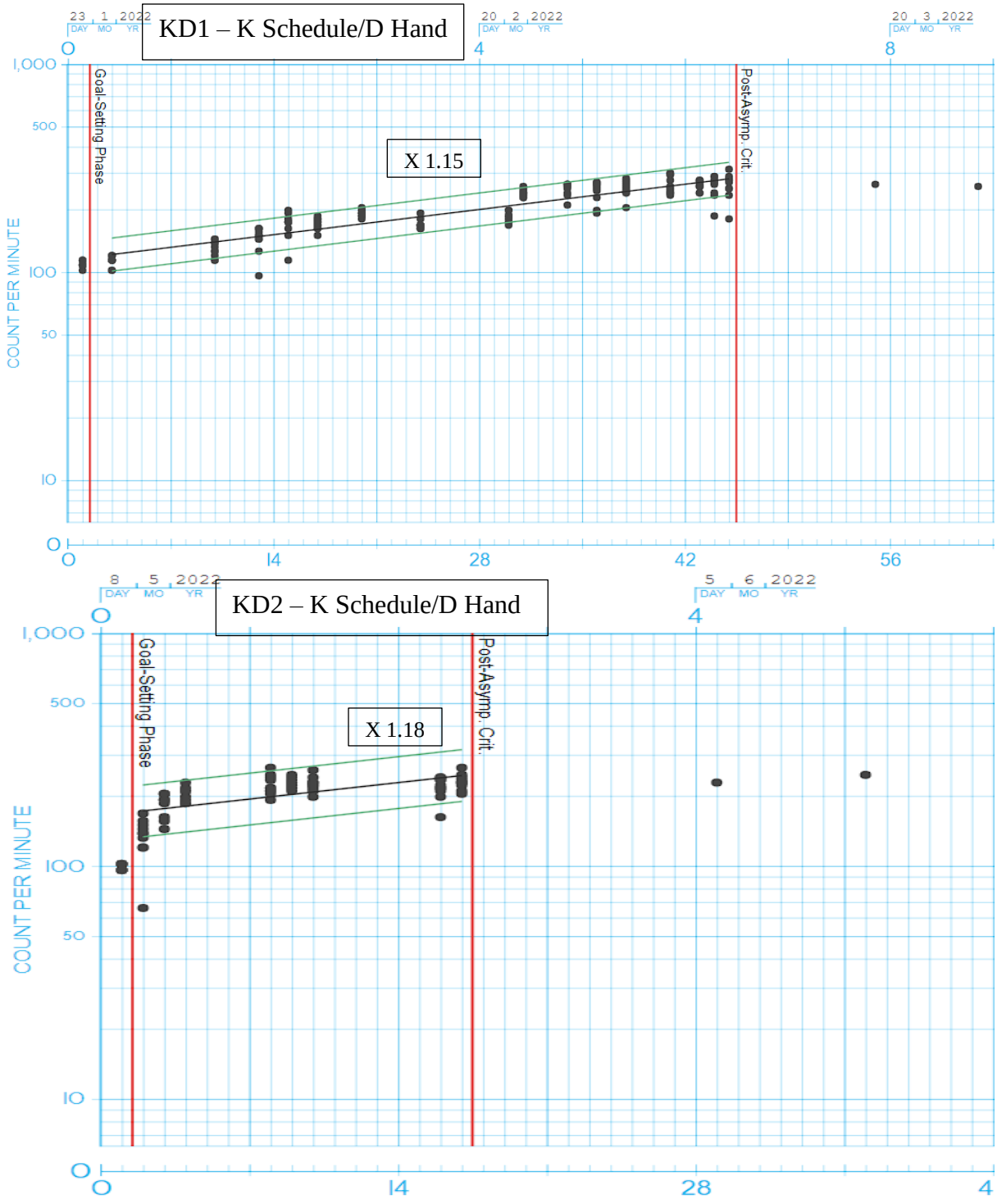

Figure 1. Dribbling rates (dribbles per minute) for participants KD1 (top) and KD2 (bottom) with the K goal-setting schedule assigned to the dominant hand during baseline

timings (left), goal-setting sessions with the K schedule (middle), and retention probes after asymptotic criterion was met (right).

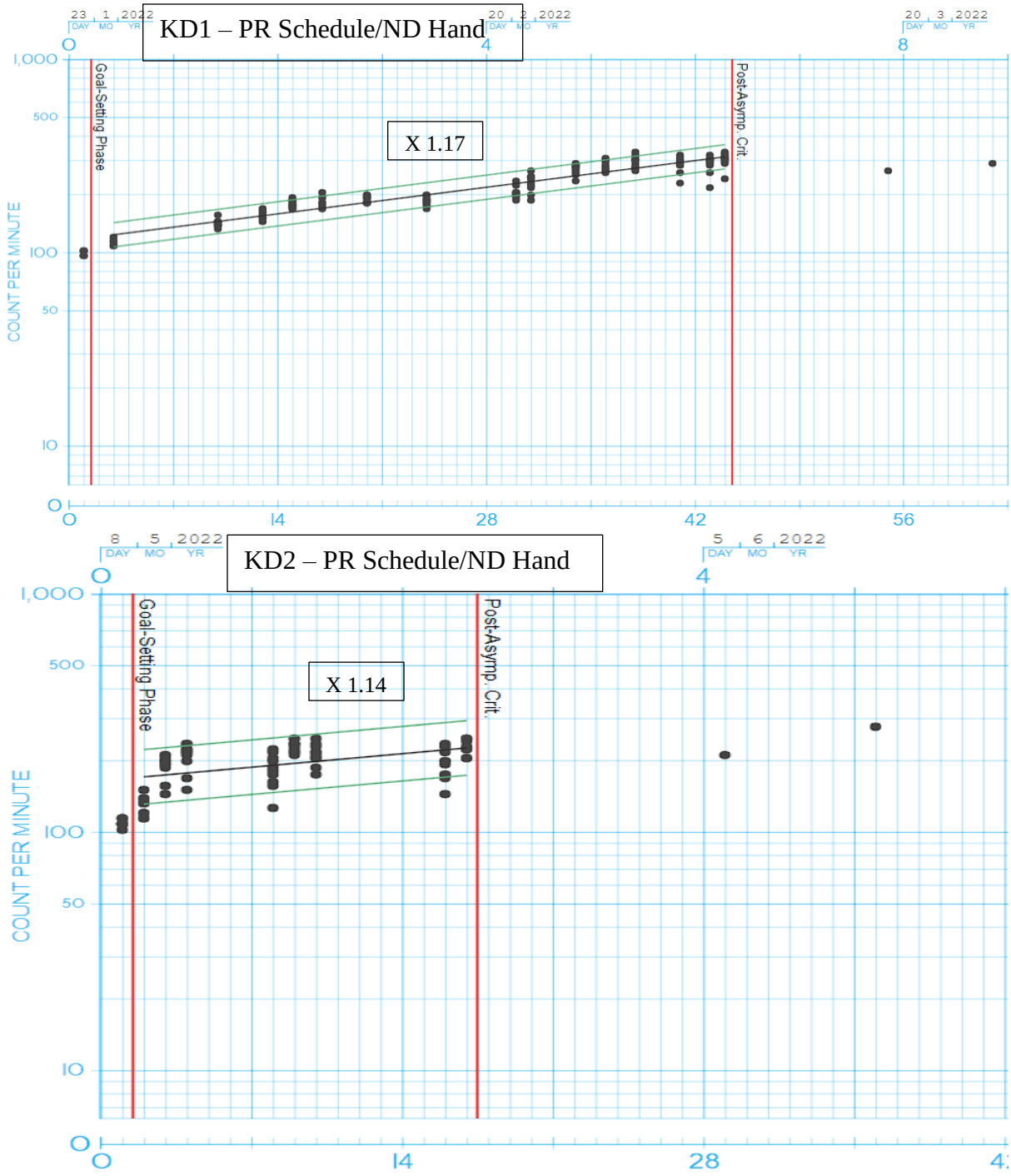

Figure 2. Dribbling rates (dribbles per minute) for participants KD1 (top) and KD2 (bottom) with the PR goal-setting schedule assigned to the non-dominant hand during

baseline timings (left), goal-setting sessions with the PR schedule (middle), and retention probes after asymptotic criterion was met (right).

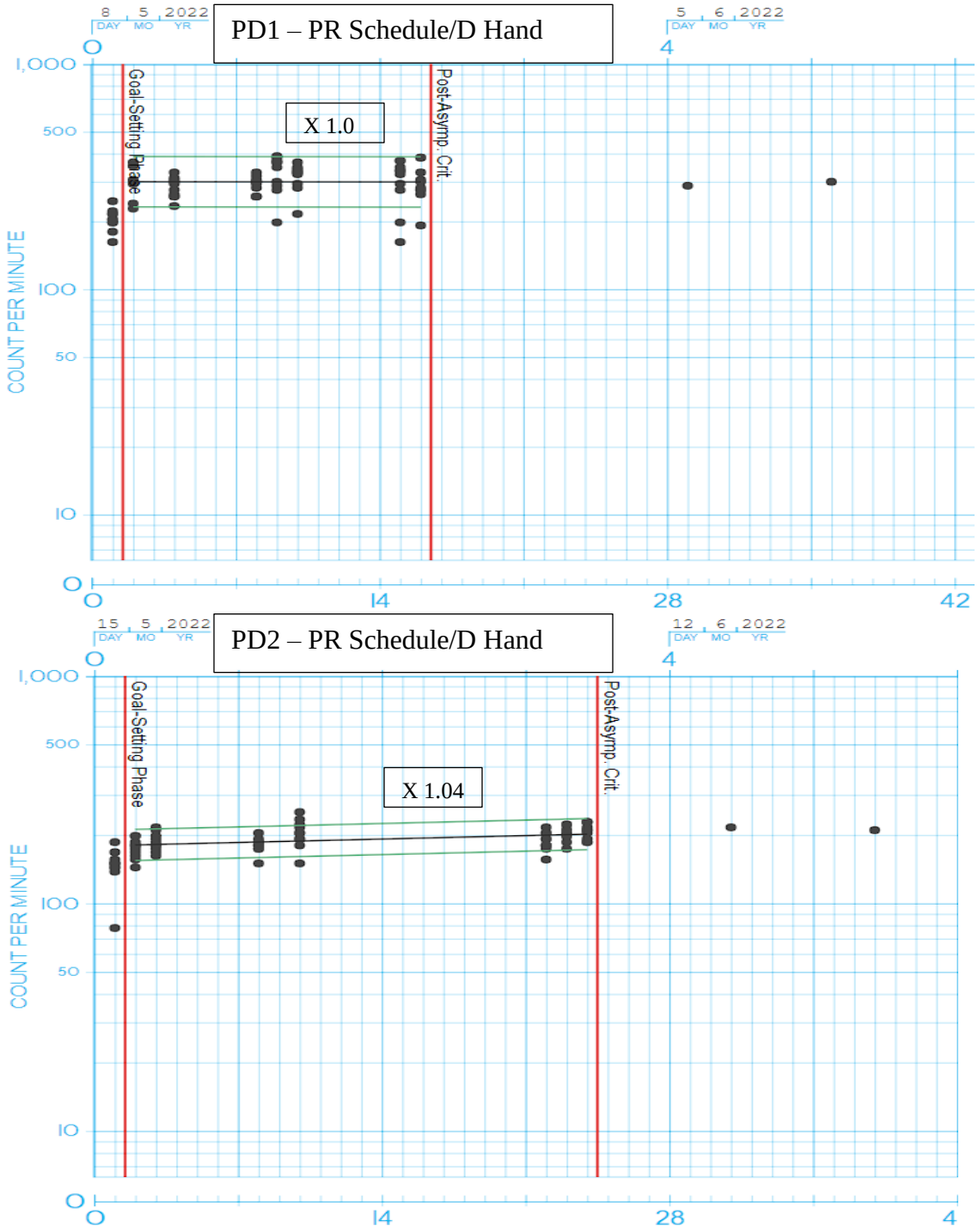

Figure 3. Dribbling rates (dribbles per minute) for participants PD1 (top) and PD2 (bottom) with the PR goal-setting schedule assigned to the dominant hand during baseline

timings (left), goal-setting sessions with the PR schedule (middle), and retention probes after asymptotic criterion was met (right).

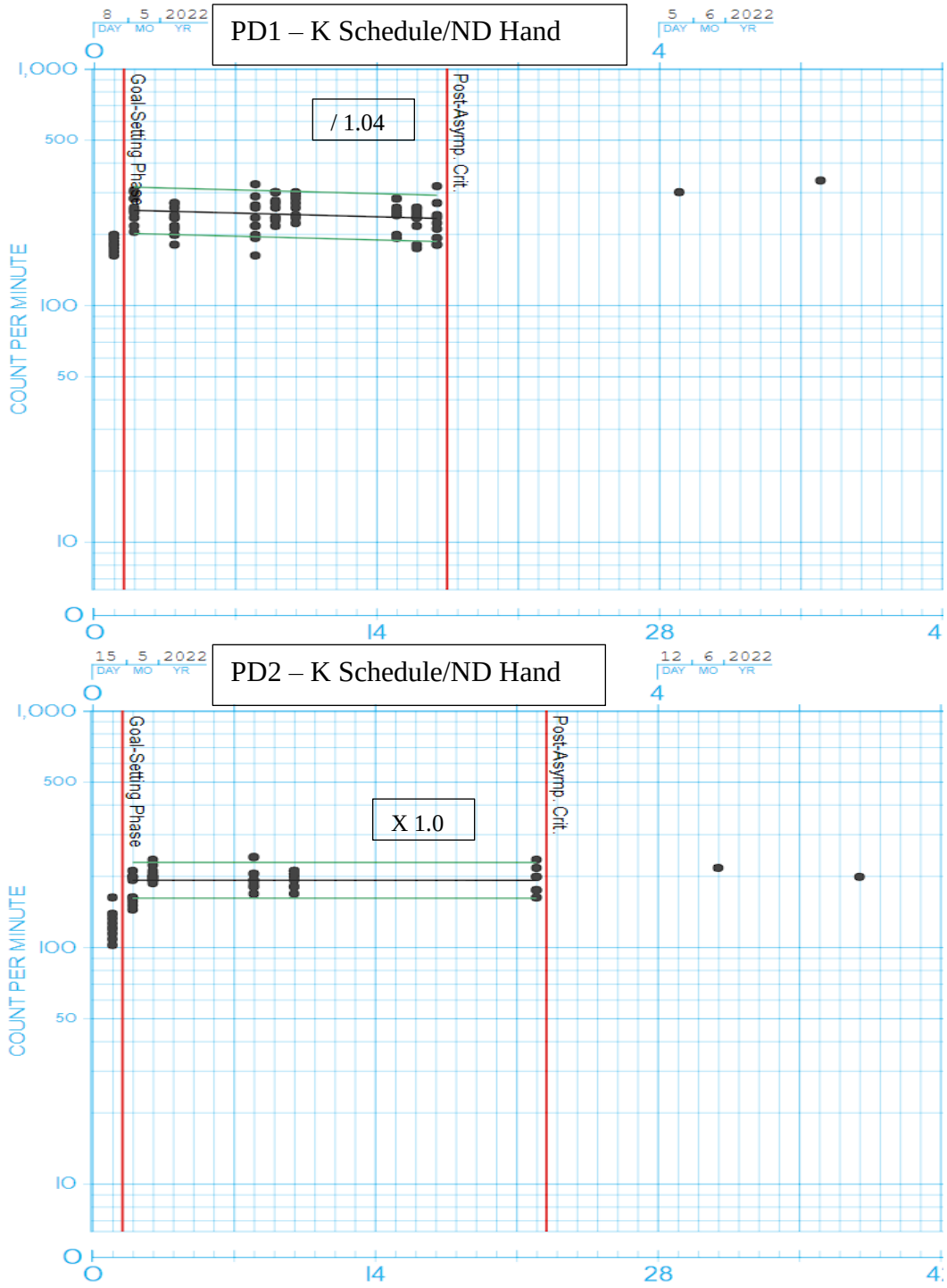

Figure 4. Dribbling rates (dribbles per minute) for participants PD1 (top) and PD2 (bottom) with the K goal-setting schedule assigned to the non-dominant hand during

baseline timings (left), goal-setting sessions with the K schedule (middle), and retention probes after asymptotic criterion was met (right).

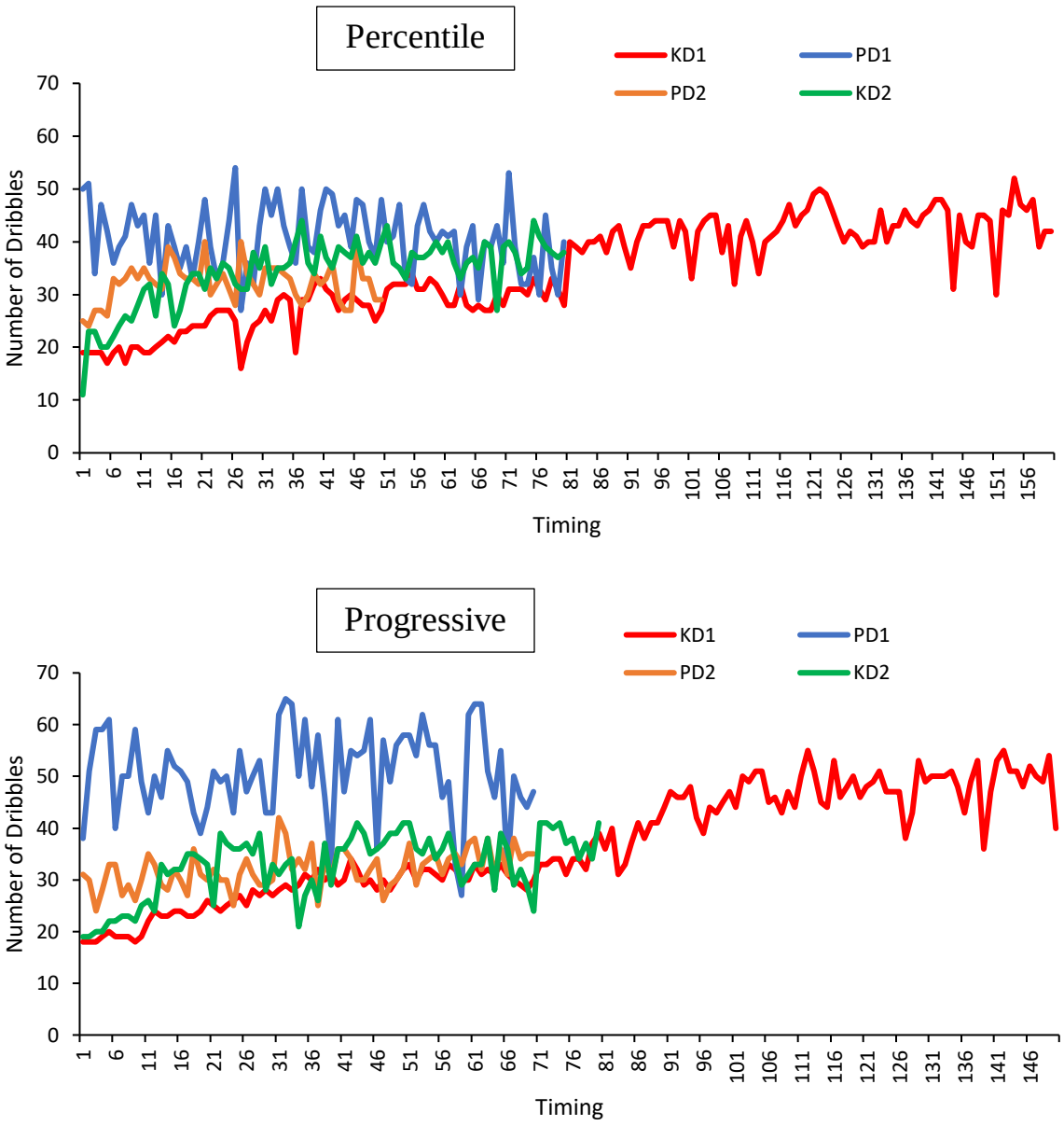

Figure 5. Dribbles per timing for all participants in K schedule goal-setting timings (top) and PR goal-setting timings (bottom). Each line represents a single participant.

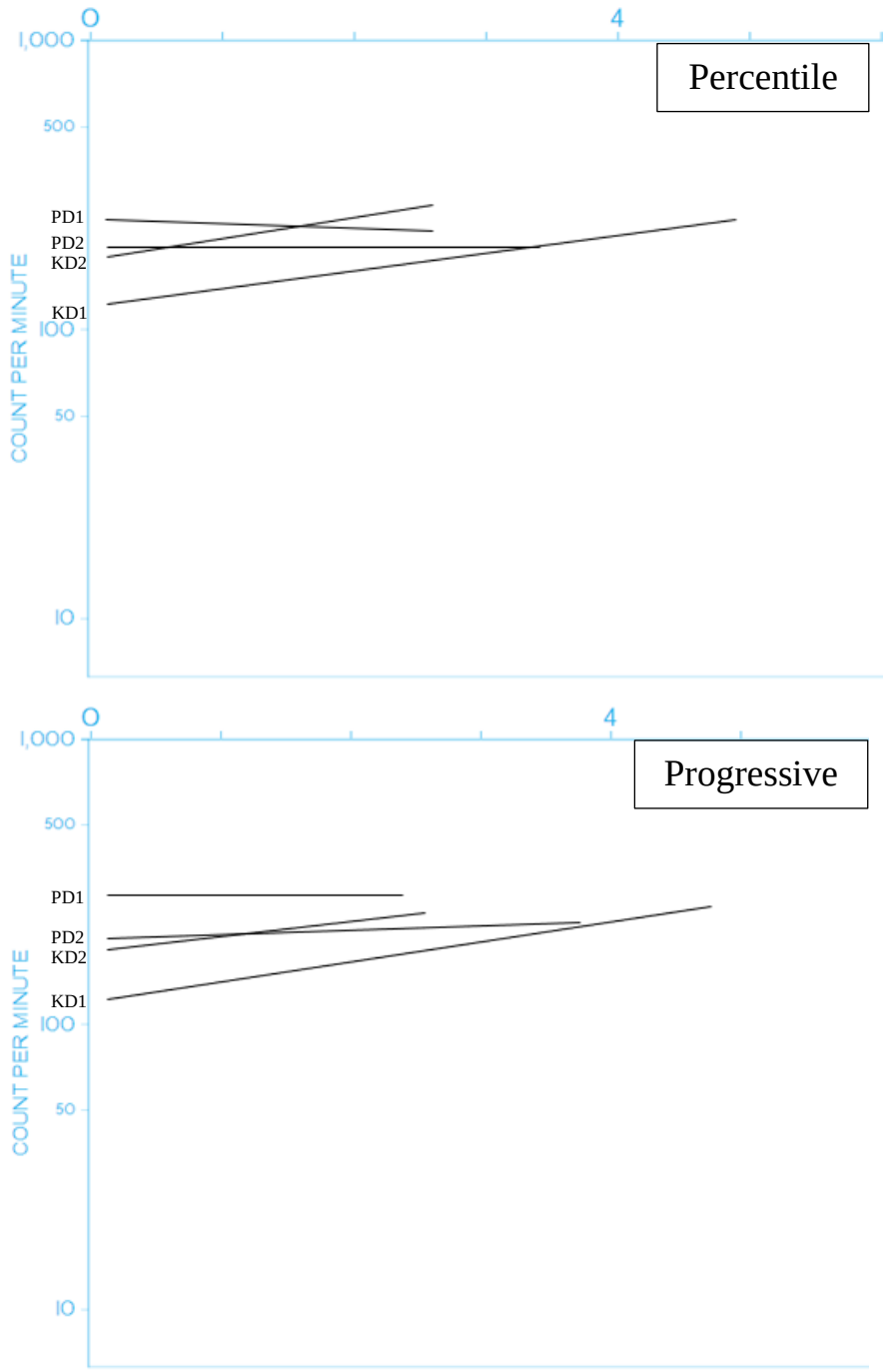

Figure 6. Celeration slopes across goal-setting timings for all participants under the K schedule (top) and the PR schedule (bottom). Each celeration line represents a single participant (see labels).

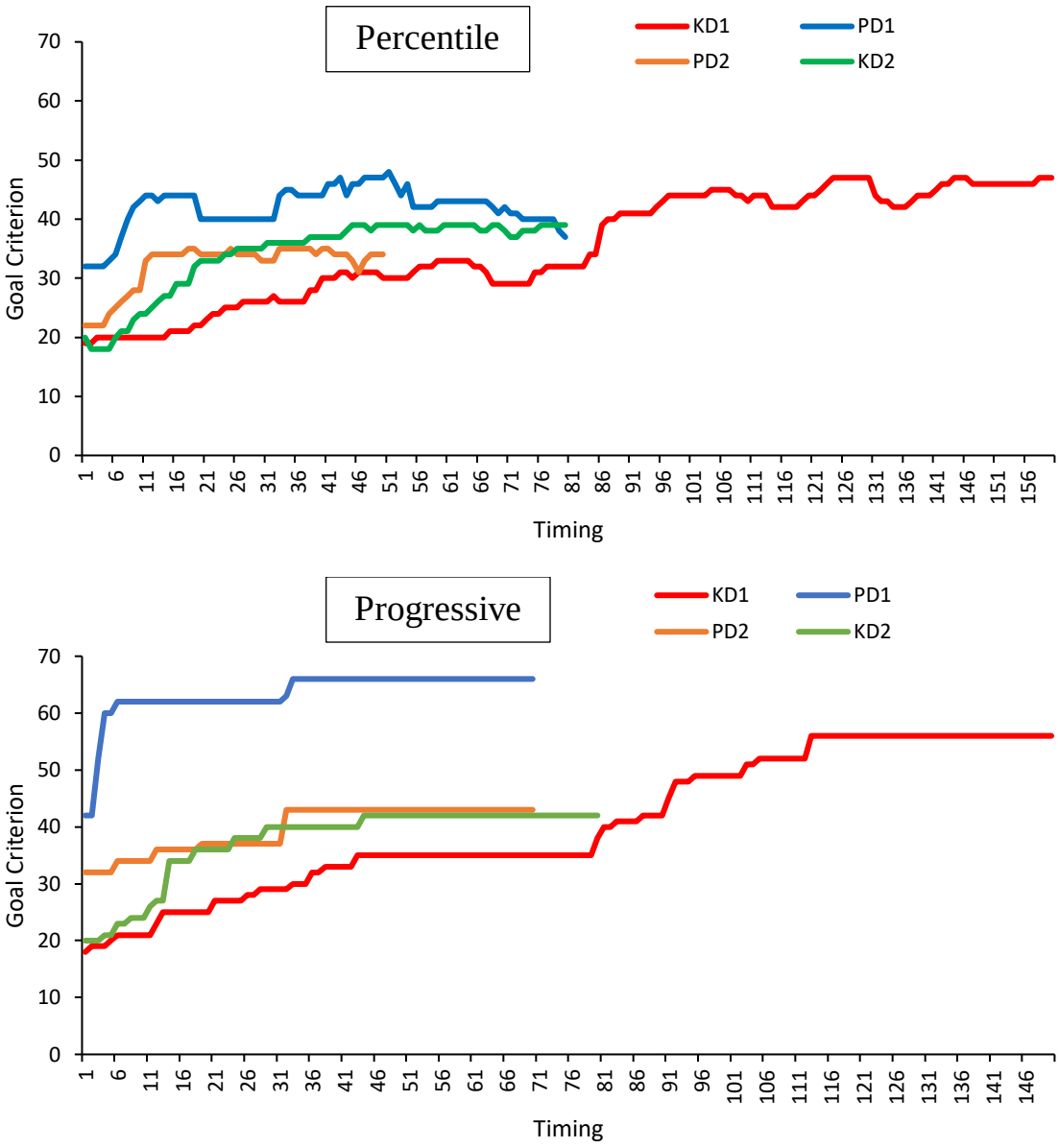

Figure 7. Goal criteria (dribbles per minute) for each K schedule goal timing (top) and PR schedule timing (bottom) for each participant. Each line represents a single participant.

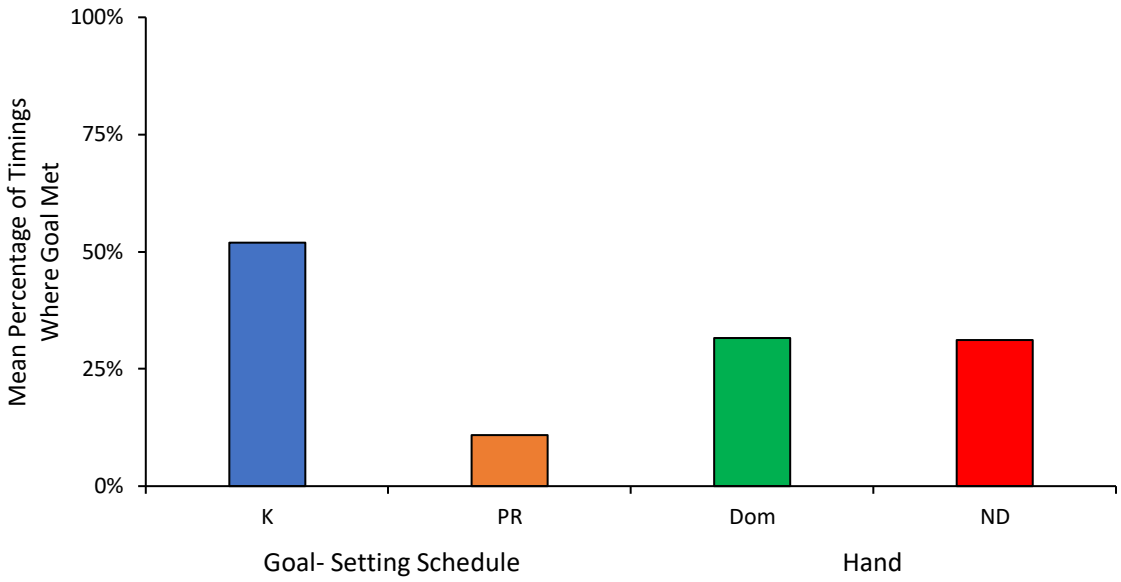

Figure 8. Mean percentage of timings in which goals were met for all participants in K versus PR goal-setting schedule timings (left) and goal-setting timings with the dominant hand versus nondominant hands (right).

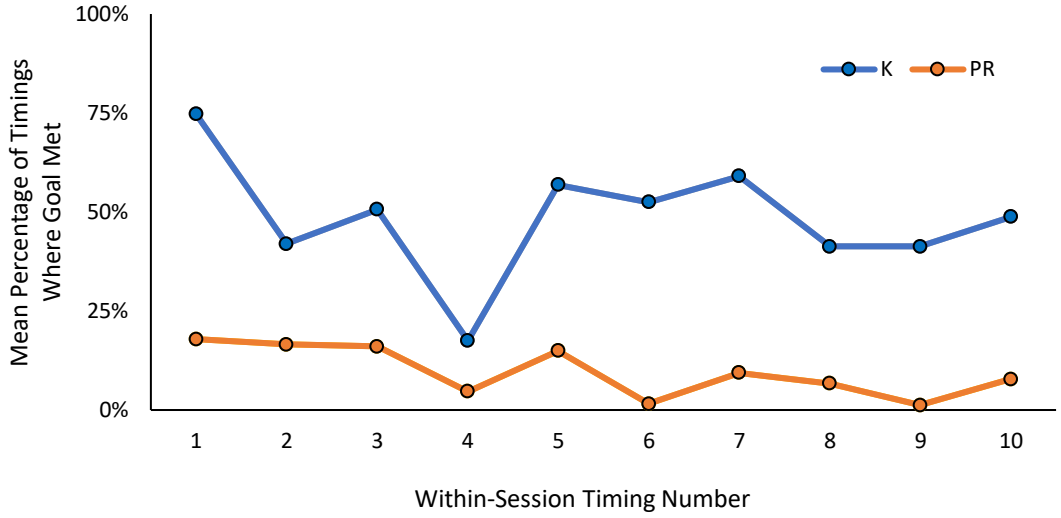

Figure 9. Mean percentage of timings in which goals were met for each of the 10 timings occurring within goal-setting sessions for all participants in K sessions versus PR sessions.

Appendix A

Participant Social Validity Survey

Number	Statement
1	My dribbling is better because of this study.
2	I got better at the more difficult types of dribbles.
3a	What practice timings did you prefer? Circle one. (LH/RH/NP)
3b	Why?
4	This will help me be better during games.
5	This study makes me want to keep playing basketball.

Appendix B

Parent/Guardian Social Validity Survey

Number	Statement
1	This improved my child's dribbling.
2	This study increased my child's interest in basketball.
3	My child enjoyed coming to these practices.
4	I would continue these practices if my child wanted to continue, too.