AN ANALYSIS OF PRECISION TEACHING

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TRUDY LOUISE POCOCK

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ABSTRACT

This research examined three components of precision teaching; charting, timed practices, and performance aims. In the first study beginner skaters performed two roller skating skills, forward crosses and back scissors, with the aim of increasing fluency in these skills using precision teaching methods. Skaters were told to perform the skills as fast as they could during 1-min practises, aiming at a set performance aim, or goal. After each timing skaters were told how many repetitions they had performed. One group charted back scissors only and the other forward crosses only. The skaters became faster in both skills and charting did not produce faster rates. The improvement seen may have been a direct result of the performance aims. Therefore the second study, using back crosses, compared a fixed, difficult performance aim (complete 50 per minute) for one group and an easier, flexible performance aim (beat your previous sessions' high score) for a second group. After each timing skaters were told how many back crosses they had performed. Performance rates increased similarly for both groups, thus the different performance aims did not have different effects, contrary to the goal-setting literature. A third study investigated this further. Skaters performed forward crosses and back scissors during a baseline condition, where there were no performance aims or feedback. Increases in performance rates for both skills occurred. In a second condition, a performance aim higher than their number of repetitions in the previous condition was set and feedback was given for one skill only. There was an immediate increase in rate of the targeted skill for 3 of the 4 skaters, suggesting that the goal, when given with feedback, influenced the rate at which the skaters performed the skill. In the fourth study, where the effect of feedback and practice was examined more closely, soccer players dribbled a ball in and out of cones. As expected those who took part in eight to ten sessions that were told to do their best (an easy goal) and not given feedback performed this skill faster than those who completed only two sessions with the same conditions. Unexpectedly, they also performed faster than those set a performance aim of beating their previous highest score (a hard goal) and who were given feedback. Methodological issues that may have been responsible for this latter result were addressed in the fifth study. Skaters completing 10 sessions of forward crosses, with feedback and with a performance aim of

completing 60 repetitions in one minute (a hard goal), became faster than skaters completing 10 sessions without feedback who were told to do their best. Skaters told to do their best, who completed only three sessions without feedback, did not get faster. These results support those in the goal-setting literature that, hard goals with feedback have more effect than being told to do your best. Overall these studies show that short, timed practices and hard performance aims, or goals, may be effective components of precision teaching while visual feedback from charting may not. Further, precision teaching methods were effective when applied to sporting skills such as those used by roller skaters and soccer players for building fluency of basic skills.

DEDICATION

This thesis is dedicated to “my boys”; My husband and best friend Darron, and my two wonderful sons, Zachari and Zyean, without whom my life would be empty.

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My only regret is that my father Bob Pocock, ever confident that I could achieve this, is not here in person to see me do so. His hugs of love and support were valuable and are sorely missed. I feel certain, however, that he continues to proudly watch on from where he is now.

Finally, to Darron who still loves me even though completing this thesis has meant that other things have had to go by the wayside: I have often been amazed at your patience and tolerance when I have worked long hours and been immensely unsociable. I can only imagine your elation in seeing this project finished! My love to you always.

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To demonstrate that a skill has been learnt the first requirement is to be able to perform the skill accurately. This is true both for academic skills, such as arithmetic and writing, and performance skills, such as playing a musical instrument or playing a sport. However, being able to do a task accurately is only one aspect of performance, to be considered skilled in performing a task (i.e., an expert) also requires that the task be performed fluently.

Accuracy vs. fluency

While accuracy means performing correctly, fluency means performing the skill quickly and easily. Thus fluency has been defined as fast, accurate performance (Binder, 1987; Le-Grice, Mabin, & Graham, 1999) and this is the definition used here. Fluent performance may be important if the skill needs to be performed at speed, amidst distractions, or in novel settings. It has also been suggested (Johnson & Layng, 1992; Kuhn & Stahl, 2003; Le-Grice et al., 1999) that fluency in component skills, i.e. skills which can be used together to perform more complex skills or tasks, is necessary if a learner is to concentrate on performing a new task using those components. Dougherty and Johnston (1996) suggest that if attention is needed to carry out the smaller components of a task, the task itself becomes more difficult to perform. Fluent performance then, is seen as accurate performance at a high rate.

While rate of accurate performance is perhaps the most common overall measure of fluency (West, Young, & Spooner, 1990), Howell and Lorson-Howell (1990) have suggested two ways that the degree of fluency could be measured and each reflects the rate at which a skill is being performed. The first is latency, defined as the time between when a task is set and the start of the task or skill being performed. Howell and Lorson-Howell suggest, for example, that starting to write the letter “a” may happen sooner once the child recognises the letter “a” and can verbally report it. Binder (1993) has suggested that these shorter response latencies are a direct measure of fluency, i.e., as the skill is started more promptly, performance is said to be more fluent.

Duration, or the time it takes to perform the skill, is the second measure of fluency suggested by Howell and Lorson-Howell (1990). When the time it takes to perform the skill decreases, the performance is said to become more fluent. Keyboard skills on the computer are likely to take less time once they can be

performed fluently. At some point maximum fluency will be reached as physiological constraints act upon the performance of the skill. For example, at some point it becomes physically impossible to type faster on a keyboard.

Johnson and Layng (1996) have suggested that fluent performance of a skill may lead to outcomes such as retention, stability, application, and endurance. Oddsson (1998) defines retention as skills being maintained over time and stability as a learner's ability to perform a skill in the face of distraction. Application means that when certain cues occur, indicating that a certain skill should be utilised, the correct skill is performed even when cues occur within a complex task (Kubina, 2005). Endurance is a product of the skill being performed easily once it becomes fluent. A skill that is easily performed is one that can be repeated over longer periods of time before the performer becomes fatigued (Kubina & Morrison, 2000).

Doughty, Chase and O'Shields (2004) have reviewed the research showing that fluency-building methods lead to these outcomes. They report that there is no clear evidence to support a link between fluency and these outcomes. However, Kubina (2005) argues that Doughty et al. "misrepresented and misclassified some of the fluency outcome studies" (p.75). Regardless of whether these outcomes occur, fluency can be advantageous if the quality of performance is dependent on accuracy and speed.

Overlearning, fluency and automaticity

Dougherty and Johnstone (1996) have suggested that fluency is similar to overlearning and automaticity. They say overlearning occurs once 100% accuracy has been achieved. How much overlearning has occurred is measured by the rate of accurate performance, i.e., higher rates of accurate performance signify a greater level of overlearning. Automaticity, a term that occurs more frequently in the literature than overlearning, refers specifically to skills that can be executed without conscious attention (Howell & Lorson-Howell, 1990). Dougherty and Johnstone (1996) have suggested two characteristics of automaticity. Firstly, that conscious attention interferes with the execution of the automatic behaviour or skill. Secondly, that it is possible to engage in other behaviour that requires our attention while also performing the automatic behaviour or skill.

While Dougherty and Johnstone (1996) suggest similarities between overlearning, automaticity and fluency, the overlearning and automaticity literatures are quite separate from the fluency literature. This division is a result of different theories which are used to explain the acquisition of each of these outcomes (see Speelman & Mayberry, 1998). Theories aside, automaticity and overlearning fit the definition of fluency used here (i.e., fast, accurate behaviour) and it may be that fluency of performance is equivalent to both automaticity and overlearning.

One area where fluency may be important is in education where students are learning skills that they will use repeatedly over their lifetime. Spence and Hively (1993), however, state that teachers seldom take learning to a level of fluency. They point out that when fluency is not reached in component skills, other skills that rely on those component skills are affected and cannot become fluent until those initial component skills are learnt. As such, both Johnson (1997) and Spence and Hively (1993) conclude that fluency of component skills should be an important part of education. Spence and Hively (1993) identify Ben Bronz Academy, a school for learning-disabled students, as a school which utilises fluency-building programmes. Areas that Ben Bronz Academy focus on include mathematics, done on the computer, and reading. Johnson (1997) reports that Morningside Academy is another institution claiming gains in reading, language and maths for its students as a direct result of focusing on fluency. Both Johnson (1997) and Spence and Hively (1993) report more than two years academic gain per academic year at these schools and report that these claims are supported by data from standardised testing spanning a number of years.

One common factor in fluency-building programmes, such as those offered by the Ben Bronz Academy and the Morningside Academy, is repetitive practice of basic tasks or skills. Even at higher levels of education, i.e., universities, this type of instruction may still be beneficial. The Centre for Individualized Instruction teaches university students to high levels of fluent, accurate performance in basic skills to enable students to “think fluently” in their subject area (McDade & Goggans, 1993). McDade and Goggans report that approximately 85% of students who follow this program of instruction go on to pass courses which use the skills the students have learnt to fluency. However, no

statistics are given indicating the pass rate of other students enrolled in the same courses and as a result no conclusion seems possible.

Precision teaching

One teaching method designed to promote fluency is precision teaching. Originally designed by Lindsley (1971), precision teaching is incorporated in programmes run by the above institutions. Research has shown that performance becomes more fluent than it would have otherwise when precision teaching is used (Johnson, 1997; Spence & Hively, 1993).

A number of authors suggest that precision teaching is based on the learning principles of B.F. Skinner (Binder & Watkins, 1990; Lindsley, 1971, 1990; West et al., 1990). Lindsley (1971) says that these principles include selecting behaviour that is observable, using rate as a measure of performance, measuring behaviour at every session, and charting results meaningfully. Lindsley emphasises the use of rate as a measure. He points out that Skinner's research has determined that rate of performance provides a measure of the temporal dimension of behaviour, a more useful measure of learning than accuracy alone.

Johnson and Layng (1996) suggest another important principle derived from Skinner's research is the use of free-operant responding, i.e., in using precision teaching methods the teacher or experimenter should not be limiting the rate of behaviour in any way. This allows the student to show the fastest rate at which they can perform. Oddsson (1998) investigated free-operant responding using three groups of college students to compare the effectiveness of three computerized training methods. In one method, 50 tasks were presented at once on the computer screen. The remaining two methods involved a series of tasks being presented one at a time with 0s and 1.5s interval between each presentation. The data showed that subjects reached a pre-determined level of fluency sooner, and with less practice, when all tasks were presented at once allowing free-operant responding to occur.

A major aspect of the precision teaching procedure is the repetition of skills, or behaviour, within timed periods. The rate at which skills are performed is used to measure change over sessions and is recorded on a chart (Lindsley, 1971). Binder (1993) reports that he and Haughton, both early contributors to

precision teaching methods, were the first to initiate short periods of skill practice, typically of 1-min duration, to allow practice to be done several times a day. They measured the rate of both correct and incorrect responses and used this information to make changes in the teaching procedures they were using. They found that there was a relation between the rate at which a skill was performed during the timed period and the students' ability to complete new tasks that relied on performance of that skill (Binder, 1993). These short practice periods have now been adopted as part of the methodology of precision teaching as it has been found that students reach higher levels of performance faster by keeping to shorter timed periods of around 1 minute, at least initially (Binder, 1996; Binder, Haughton, & Van Eyk, 1990; Lindsley, 1996).

Fluency is determined, when using precision teaching methods, by performance aims or standards (Kubina, 2005). These performance aims, which are also referred to as fluency aims, serve as "an indicator of a skilled, well-practiced performance" (Kubina, 2005, p.75). That is, when performance aims have been reached it is assumed that the individual is now performing fluently and is ready to learn a new skill. Binder (1996) reports that when these performance aims are reached, outcomes such as retention, endurance, and application are observed.

The timed periods of precision teaching have been used in the absence of performance aims to assess instructional methods (Howell & Lorson-Howell, 1990; Peterson et al., 1990; White, 1986). Because precision teaching involves charting data on a daily basis, over time a data line is created which allows teachers to see clearly what behaviour change is taking place for any particular instructional method. For example, Lovitt et al. (1990) reported that when using precision teaching to assess three instructional methods, the data generated by short test periods and subsequent charting, clearly showed performance differences between both pupils and teachers on all three instructional methods.

Other authors Binder, 1996; Binder et al., 1990; Brandstetter & Merz, 1978, Johnson, 1971, Kessissoglou & Farrell, 1995; Lindsley, 1990) have suggested that precision teaching is a tool that enables other teaching methods to be more effective so that learning is further improved. For example, one teaching method commonly used with precision teaching is Direct Instruction (McDade & Goggans, 1993). Direct Instruction is a method where instructional content is

systematically analysed and then structured into small units of content which is then taught to students (Johnson, 1997). Precision teaching is often combined with direct instruction to enable students to perform tasks which have been taught in each unit of content quickly. Precision teaching has also been combined with computer assisted instruction ((McDade & Goggans, 1993) and SAFMEDS, a flashcard instructional method (Lindsley, 1996). Precision teaching techniques are used with these instructional methods to enable measurement of rate and to chart progress, as well as to build fluency.

Overall, then, while some authors see precision teaching simply as a measurement tool, other authors have demonstrated that precision teaching can be used to increase the speed and accuracy with which a skill is performed, i.e., increase fluency. However, there are a number of components within the precision teaching method such as charting, short timed practice periods, and repetition of skills and there is no research which makes it clear whether all, or any, of the components contribute to the increased fluency seen after precision teaching has been used. The first aim of this current research, then, was to specifically separate out components of precision teaching to determine whether they contribute to building fluency.

Precision teaching has mainly been used in education and with academic skills (Chiesa & Robertson, 2000; Kessissoglou & Farrell, 1995, Lindsley, 1990, 1992a, 1992b). Academic skills involve knowledge of a subject, e.g., maths, languages and science. Baum (1994) refers to such skills as declarative knowledge or ‘knowing that’. Individuals generally demonstrate their declarative knowledge of a subject through their verbal behaviour, e.g., a person may demonstrate their knowledge of mathematical basic facts by answering math problems correctly. They may demonstrate their fluency by answering a number of these problems within a set time period or by answering each question quickly (with a short latency). Precision teaching has been shown to be a way of producing fluent performance on such skill. Other skills such as motor skills, e.g., handwriting or swimming, involve the individual being able to perform the skill. Baum refers to being able to do something as procedural knowledge or ‘knowing how’. Procedural knowledge is demonstrated by doing the behaviour. For example, an individual is said to know how to swim when we see them swimming (Baum, 1994). Thus, both procedural and declarative knowledge are demonstrated by the

individual performing a measurable behaviour. The difference is that in one case the behaviour is verbal. However, even the verbal responses to questions could be taken to show the individual knows how. In fact, Ryle (1949) argues that all cases of declarative knowledge are simply complex cases of procedural knowledge. Thus even though some distinctions can be made between academic and other skills – all involve knowing how. There appears to be no reason why precision teaching cannot be used much more widely than in the academic area. Johnson and Layng (1996) report that precision teaching has been used in therapy, business and industry as well in teaching people with developmental delay a range of skills including motor skills, e.g., dressing.

Most sports require fluent performance of motor skills and many sporting activities contain compound skills that are reliant on a range of motor skills that may be amenable to precision teaching methods. There does not appear to be any published research that has used precision teaching with sporting skills. One further aim of this present research was to determine whether fluency building methods, similar to those used in precision teaching, can be effectively applied to sporting skills. Roller skating was the sport used initially, because it is has skills that can be broken down into separate component skills, which in turn can be readily observed and measured by others.

EXPERIMENT 1

A review of the literature has shown that, although a large amount of research demonstrates precision teaching's effectiveness, there is a lack of research showing what components of precision teaching are directly responsible for bringing about fluency. Therefore an aim of this experiment was to single out one component of precision teaching to measure its effectiveness. One component of precision teaching is the use of daily charts to show progress. Many authors have stressed that these daily charts showing the rate of progress are essential in precision teaching (Galloway & Galloway, 1971; Johnson & Layng, 1996; Raybould & Solity, 1982; West et al., 1990; White, 1986). Ogden Lindsley, Eric Haughton, and other graduate students of Lindsley's, developed the semi-logarithmic chart, shown in Figure 1, for use in precision teaching. Such charts are commonly referred to as standard celeration charts, because they chart both accelerations and decelerations. Behaviour frequencies span the range of one

response per 24 hours to 1,000 responses per minute. Lindsley (1990) argues that learning should markedly change frequency of behaviour and that resulting data should be multiplicative, resulting in a linear plot on the charts. In fact he suggests that teachers should aim to, at least, double the frequency of a behaviour each week, regardless of the starting frequency. An increase of 10 behaviours to 20 behaviours per minute is seen as equivalent to an increase of 100 behaviours to 200 behaviours per minute. Thousands of these behaviour charts that have been used in numerous projects are stored in “The Behaviour bank” (Koenig, 1971) demonstrating their wide use.

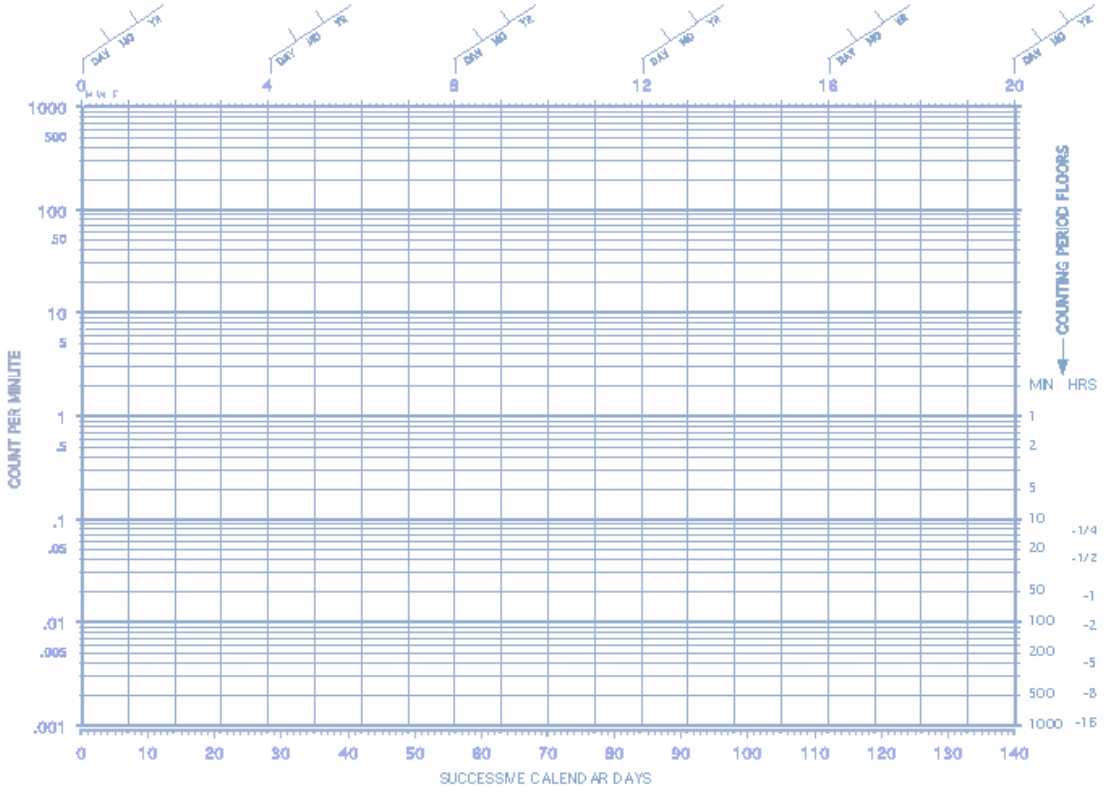

Figure 1. Example of a celeration chart designed by Ogden Lindsley.

Lindsley (1971) suggests these standard celeration charts may serve several different functions. For example, upon viewing celeration charts, practitioners and teachers often change their teaching programme in an attempt to accelerate target behaviour. In these cases, any changes in the rate of performance, as a result of a change in teaching programme, are attributable to that new teaching programme, and not to the use of the celeration chart.

However, Lindsley (1990) reports that many teachers who have used charting state that charting alone accelerates academic performance. Binder and Watkins (1990) report that over time “learning pictures” are created on each celeration chart as more data are added, giving students and teachers a clear picture of improvements and plateaus. Johnson and Layng (1992) suggest this makes it easy for students and/or teachers to make quick, daily decisions about progress which would not have been made in the absence of charting. They further suggest that students become their own fluency coaches because they are improving their performance through daily practice, self-monitoring via the chart, decision making based on the chart, and self-correction. It is also possible that charts are used by both students and teachers as a basis for discussion and making decisions on future learning strategies (Binder, 2001).

Yawkey and O’Meara (1974) found that when a teacher used celeration charts with children, the children’s mathematical performances were better than those of other students not using celeration charts. In their study all children were tested on single and double digit addition problems for a minute each day. In both of two conditions, children graphed the number correct onto vertical bar graphs. In one condition the experimenter then also graphed their performances on celeration charts. During this same condition the teacher analysed the celeration chart, discussed learning opportunities with the child and suggested additional work that the child could do to improve their responding. The celeration charting combined with the teacher feedback increased performance. It is not clear how much the viewing of progress on a celeration chart alone contributed to the increased performance or if additional social reinforcement occurred for those students who had their progress charted.

Alper and White (1971) suggest that charts alone may alter behaviour through the visual feedback that they provide. They propose that once data have been plotted onto a graph, the plot may indicate to the learner what progress is being made and that this in turn may function to aid behaviour change. Johnson (1971) reports a student being “motivated” by the charting process because it “showed her that she was learning”(p.110). Based on his claims, Ayers, Potter, and McDearmon (1975) used charting with four adults with aphasia and reported that the charting “motivated” the participants in the study. This study produced changes in their specified language behaviours. Unfortunately “motivation” is an

abstract term that was not quantified in this study and there were no participants who did not use charting with whom to make comparisons and so it is not possible to conclude how much charting itself changed the behaviour of the participants.

In another study, Brandstetter and Merz (1978) report that charting resulted in increased reading rates for 4th graders. They argue that their results confirm what Lindsley (1990) and earlier researchers have said about charting being an essential part of precision teaching. Their data suggest, however, that semi-logarithmic celeration charts were not as effective as non-logarithmic charts as there was no significant effect of celeration charts compared to no charting. In comparison, the data indicated that non-logarithmic charts did have an effect. Unfortunately, the two sample groups used differed greatly from each other in that each group of students was at a different stage of learning and so this may have impacted on the results found. Thus true comparison between semi-logarithmic, non-logarithmic and no charting conditions is not possible.

In summary then, research in the area of charting appears to be limited. While many authors suggest that charting is an essential part of precision teaching (Lindsley, 1971; Raybould & Solity, 1982; West et al., 1990, White, 1986), there is not a large amount of research to validate this. Some of these authors report that their research demonstrates the importance of charting, however, nobody has looked into why charting may be effective. One possibility, suggested by Alper and White (1971), is that visual feedback, which charting provides, may contribute to the effectiveness of precision teaching. The main aim of this first study was to explore the effectiveness of charting by comparing the performances of beginner skaters using precision teaching methods both with and without the component of charting. All skaters using precision teaching methods learnt one of two skills. The two selected skills, forward crosses and back scissors which are defined below, were chosen because they are essential for more difficult skills, i.e., they are components of other skating skills that are taught both in and from the beginner classes. They are also discrete skills that are initially difficult to perform and are easily observable.

A precision teaching procedure often involves additional teaching programme changes being implemented when a student's rate of performance plateaus or regresses. However, to avoid effects being attributable to these

programme changes, rather than the charting, a precision teaching procedure using practice only, with no additional teaching programme changes being made, was used with one selected skill and the same procedure without charting was used with the other (please refer to Table 1 below). As neither skill had been used with precision teaching methods previously, it was not possible to be certain that one skill could not be learnt more easily using precision teaching methods than the other. For this reason another group of skaters learned the same two skills but with conditions reversed. This allowed a comparison to be made between skills for both charting and non-charting conditions. To allow a comparison of the same skill over different skaters, a group design was used. As all skaters needed the same amount of exposure to training, a set number of sessions were required and in this case, ten were used as it was considered that changes in performance should be observed over this number of sessions if precision teaching methods were effective. This number was based on experience of the author as a skating instructor. It was expected that, if charting was an effective component of precision teaching, skaters would show a greater improvement for the charted skill.

Table 1. Components used with typical precision teaching methods and the elements that were used in each experimental condition for Experiment 1.

Typical Precision Teaching	Precision Teaching Method With Charting Experiment 1	Precision Teaching Method Without Charting Experiment 1
• 1 minute practices • Focus on both accuracy and performing fast • Performance aim • Results of each timed minute are recorded on a celeration chart and shared with student • Teaching methods are changed if performance is not progressing as expected	• 1 minute practices • Focus on both accuracy and performing fast • Performance aim • Results of each timed minute are recorded on a celeration chart and shared with student • Teaching methods *are not changed* if performance is not progressing as expected	• 1 minute practices • Focus on both accuracy and performing fast • Performance aim • Results of each timed minute are recorded later on a celeration chart *but not shared* with student • Teaching methods *are not changed* if performance is not progressing as expected

As presented earlier, institutions such as Ben Bronz and Morningside Academies have demonstrated that building fluency using precision teaching can improve academic skills over and above that normally achieved without the use of such methods (Johnson, 1997; Spence & Hively, 1993). A further aim then of this first experiment was to see if precision teaching, when applied to two basic skills required for roller skating, gave greater progress than standard training alone. Standard skating assessments were used at the end of the study to assess the progress of those skaters who used precision teaching methods as well as those skaters in the beginners class that did not. It should be noted that this design does not rule out that any differences between the groups which may result from extra practice for those with the extra training or of the fact that these individuals volunteered for the extra training.

METHOD

Participants

Twelve children (P1-P12) from the local beginner roller-skating class participated in the precision teaching sessions. The 6 participants in Group 1 (P1-P6) were aged between 6 and 13 years at the start of the study with an average age of 9.0 years. There were 5 girls and 1 boy. The participants in Group 2 (P7-P12) were all girls aged between 6 and 9 years with an average age of 7.8 years. All participants completed the study. A further 7 children of similar age in the beginner classes were also included in the final assessment of general skating competency.

Apparatus

A cassette tape containing the words “three, two, one, GO” indicated the beginning of each 1-min interval. This was followed by three short tones every 15 seconds until the word “O.K.” indicated the end of a timed minute. This sequence was repeated on the tape a number of times and was used to time the 1-min periods of skating. Some of the skating sessions, as detailed below, were recorded on video using a Sony Handycam Vision camcorder.

Procedure

Two roller skating skills, forward crossovers and back scissors, were the targeted skills. Definitions of each skill were established and the expected frequencies of correct repetitions per minute as typically executed by a fluent skater were used as the basis of the performance aim. Following observations of an experienced skater at the rink, a performance aim of 50 correct repetitions per minute was set for both forward crosses and back scissors.

Forward crossovers allow skaters to skate forwards around corners. This skill includes the crossing action of one skate across the front of the other. To perform this accurately, while moving forward, the skater must lift the first skate off the skating surface and place it back on the rink surface either directly in front of the second skate or to the outside of the second skate so that the skaters little toes are now next to each other. Then they lift the second skate from the skating surface so that they are rolling on the first skate only. In this study, for the purposes of scoring, if the skater did not cross the first skate far enough over the second skate or fell at any point then that repetition of the skill was counted as an "attempt" rather than a "correct" by the observer.

To execute a backward scissor correctly, the skater must move both skates backwards simultaneously, firstly away from each other and then back towards each other. In this study, for the purposes of scoring, both skates had to be rolling throughout the manoeuvre to be scored as correct. If one or both skates became stationary, or the skater overbalanced and/or fell resulting in the wheels of at least one skate leaving the rink surface, then that repetition of the skill was recorded as an "attempt' by the observer.

The general procedure used is shown in Figure 2 below. Initially all skaters attending local beginner classes were given an information sheet (see Appendix A) and consent form (see Appendix B) to hand on to their parents. The information sheet outlined the main researcher's background in skating, stating she was a qualified skating coach, and gave a general overview of the study. Parents were invited to sign the consent form if they wished their child(ren) to take part in the research. Consent forms were obtained for all 12 participants. These skaters were then randomly assigned to either Group 1 or Group 2. Participants in the study were required to commit to attending two 15-20 minutes sessions at the skating rink each week for the duration of the study.

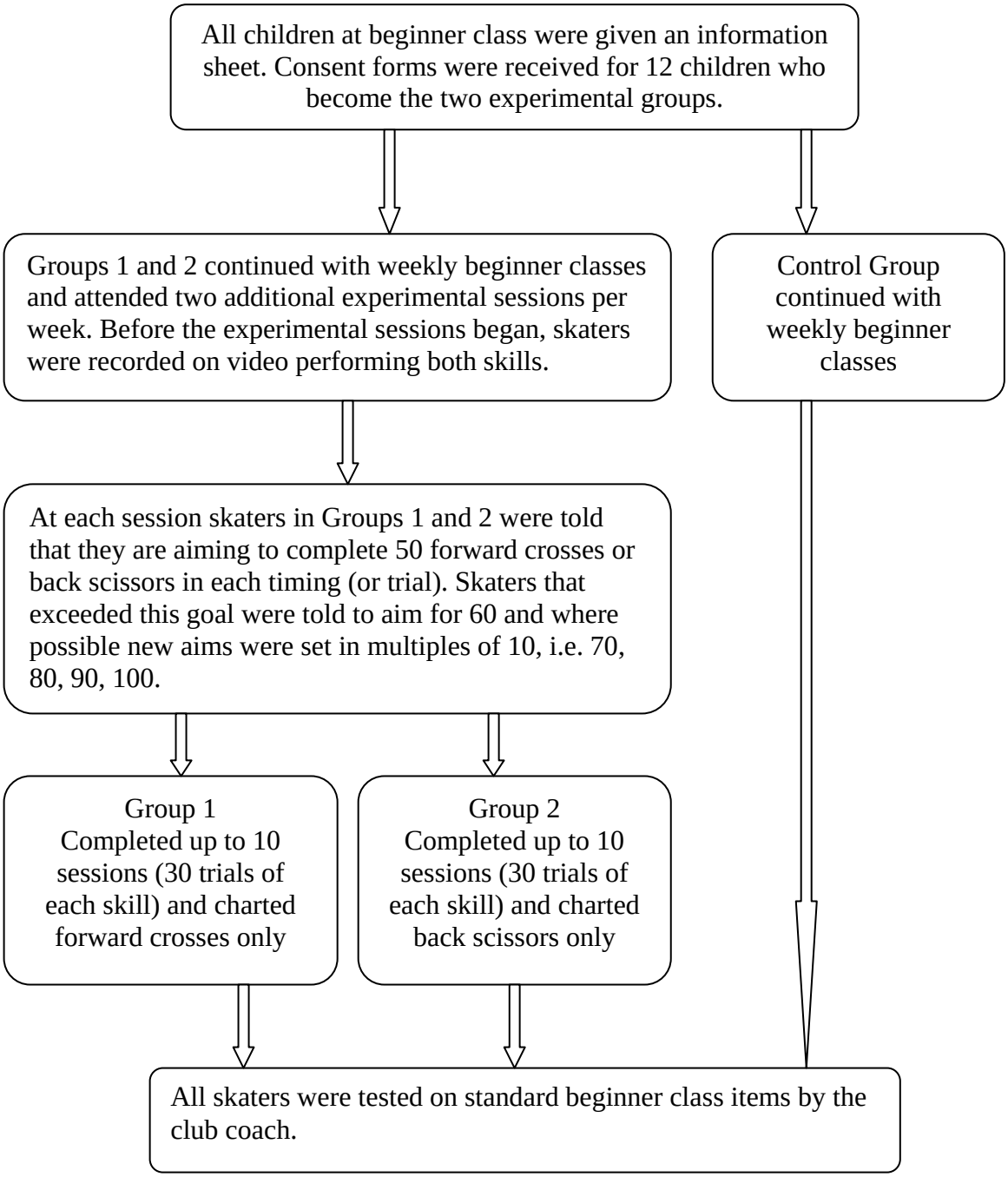

Figure 2. Flow diagram of procedure used in Experiment 1.

At the first meeting at the rink the researcher explained to each child what was going to happen at the sessions and confirmed that the child was prepared to participate. Each skater was told that over the next 5 or 6 weeks they would be learning two important basic skating skills, forward crossovers and back scissors. At the end of this time they should be able to do these two skills faster and more

easily. To see how much faster they were getting, the number of forward crosses or back scissors they were doing in one minute would be counted. Skaters were told they would have three attempts at doing this for both skills each time they came to the rink and that they would be aiming to do 50 repetitions in one minute. However, for this first meeting they were told they would simply be taught the two skills and then have a chance to practice doing each of the skills for 1 min while their performance was recorded on video.

Skaters were then shown a sample celeration chart with data points already plotted and the chart was explained to them. Each child was asked questions relating to the chart to check their understanding of it. The experimenter then taught them the skill that they would be charting in the study. Following a 1-min practice of that skill each child plotted the results of that timing onto a clean celeration chart. Each skater was then recorded on video during a further 1-min practice. For one participant, P4, this was not possible due to technical problems. At the request of her parents P10's performance was not recorded.

The second meeting at the rink was treated as the first experimental session. There were ten experimental sessions scheduled across 5 weeks. If a skater did not attend a scheduled session then this session was counted as a missed session. Missed sessions were included towards the total number of sessions to ensure that all skaters started and stopped the experiment during the same time period.

At every experimental session each skater was given the opportunity to nominate which skill they performed first. They were encouraged to change which skill they chose to start with for each session, and to complete all three timings for one skill before they completed the three timings for the second skill. In this way each skater performed six 1-min timings, i.e. six trials, in each session. The researcher reminded each skater at all sessions what performance aim they were trying to reach. During the experiment it became clear that some children were able to perform the skills much faster than the experienced skater on which the performance aim had been set. Thus skaters who surpassed the performance aim of 50 were given a new aim of 60. When it became clear further increases were possible new aims were given in multiples of 10 i.e. 70, 80, 90, and 100. Before each of the three timings, or trials, completed for each skill in a session, the researcher had the skater practice the current skill about to be observed until they

had done it correctly at least once and gave feedback to them on each try. The timing was then started and the researcher counted corrects and errors.

Immediately after every timing the skater was told how many correct and incorrect repetitions had been observed by the researcher. This was done for both skills. While Group 1 participants plotted their results for forward crosses on a celeration chart, Group 2 participants plotted the results of their back scissors on a celeration chart.

At the completion of Session 10 the skaters were asked to do an extra 1-min timing for each skill and this was recorded on video. Again, at the request of her parents, P10 was again not recorded on video. To establish the level of interobserver reliability, the researcher and two other observers watched the video taken of each skater at the first and last sessions on a standard 23 inch television screen. All three observers recorded the number of correct and incorrect executions they observed in each timed minute onto paper. These were then collated to determine a measure of interobserver reliability.

After all ten experimental sessions had been completed, all skaters in the beginners classes were tested on standard beginner class items by the club coach to asses whether they were competent enough to move up a level within the classes. Each class level includes 10 different items that a skater must perform.

The University of Waikato Psychology Research and Ethics Committee approved all experiments.

RESULTS

Figure 3 shows the number of forward crosses and back scissors completed for each individual skater in Group 1 presented on semi-logarithmic charts. The data from each of three 1-min timings in every session are shown. A vertical line separates each session. The y-axis represents number completed per-minute and uses a logarithmic scale. The numbers of correct forward crosses are plotted using a solid black line with no markers, the number of correct back scissors in a broken line with round markers, with square markers and cross markers representing incorrect repetitions for forward crosses and back scissors respectively.

Skaters in Group 1, P1-P6, both counted and charted forward crosses and simply counted back scissors. They were initially aiming for 50 correct repetitions

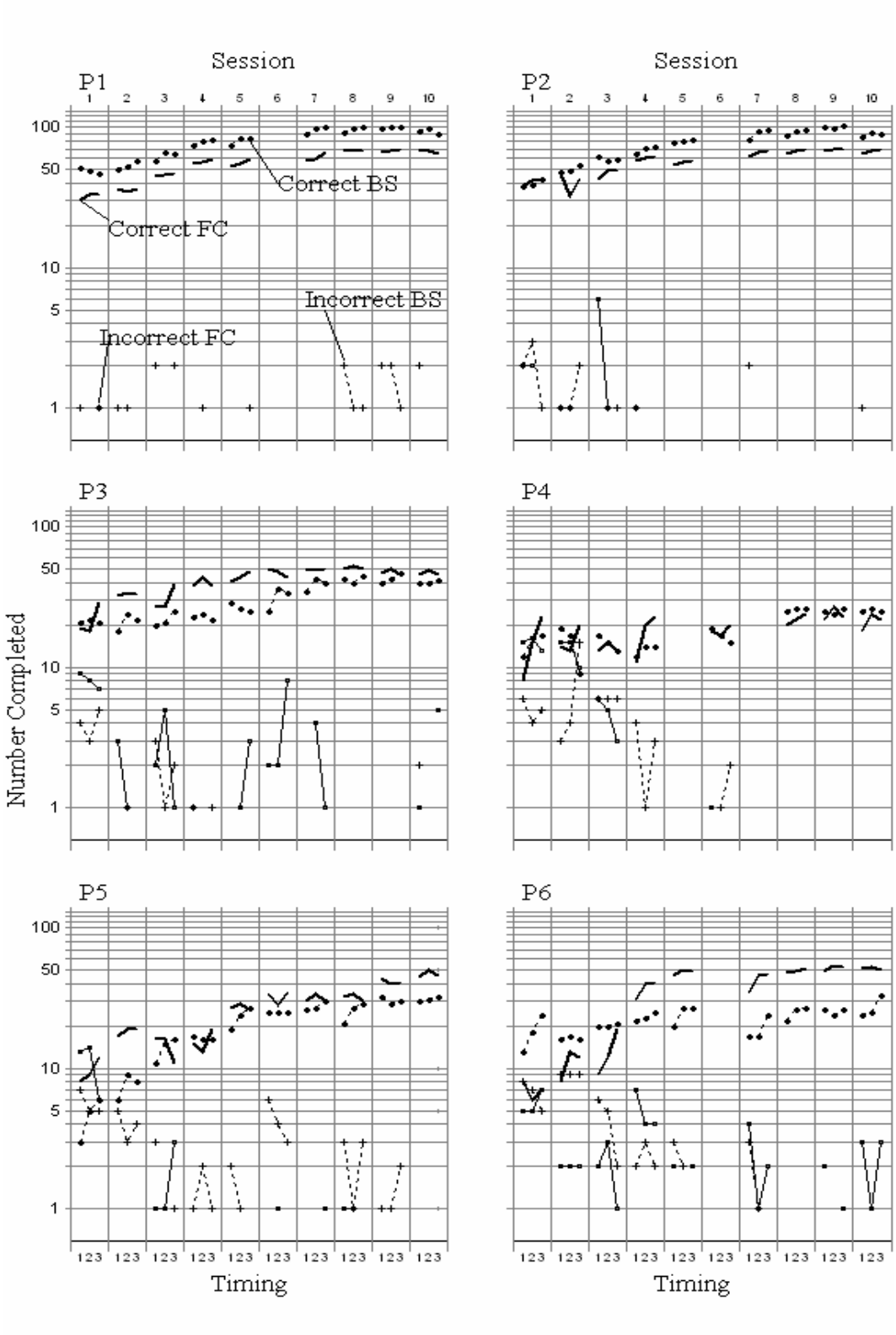

Figure 3. Number of correctly and incorrectly completed forward crosses (FC) and back scissors (BS) performed in one minute for six participants in Group 1 (P1 to P6) across ten sessions. Each session included three 1-min timings, i.e. three trials. Participants in this group were charting their forward crosses.

per minute for both of these skills. All skaters, except P4, reached this aim for forward crosses with two skaters (P3 and P6) reaching a plateau after attaining this rate. Two skaters (P1 and P2) continued past 50 repetitions per minute to complete 70 correct repetitions per minute at which point they also reached a plateau. These two skaters were the only skaters to complete 50 correct repetitions for back scissors reaching rates of around 90-100 correct repetitions per minute where they reached a plateau. The other four skaters were not able to reach the goal for back scissors and showed a plateau at around 30-40 per minute. P6 changed from rollerblades to roller skates in Session 7 which resulted in a drop in the number of correct repetitions for both skills. All skaters in this group reduced their number of errors over sessions to around 1 per minute by the final session.

Figure 4 shows forward crosses and back scissors for skaters in Group 2 presented on similar charts to those used in Figure 3. All skaters in this group counted forward crosses and charted back scissors, and were aiming for 50 correct repetitions per minute for both of these skills. Three of the 6 skaters, (P8, P10 and P11) reached this aim for both skills with P8, P10, P11 and P12 reaching a plateau around 50 correct repetitions per minute for forward crosses and P8 reaching a plateau around 40 correct repetitions for back scissors. One skater, P9, failed to meet this aim for either skill. The remaining two skaters in this group (P7 and P12) reached the aim for one skill only. Again all skaters in this group reduced their number of errors over sessions to around 1 per minute by the final session. Because there was some variation in the beginning rates of performance both between skills and between participants, and because some participants completed fewer than ten sessions, it was decided to fit lines to the data to obtain a measure of rate of change over sessions, rather than simply to compare starting rates with finishing rates. Straight lines were used as this type of line is typically used by precision teachers to predict improvements in rate of performance over time on celeration, or semi-logarithmic, charts. However, when straight lines were fitted to the data in Figures 3 and 4, the lines obtained were not a good fit, particularly when plateaus in the data had occurred. Therefore, to estimate the rate of change over the 1-min timings the data were re-plotted onto linear graphs and these are shown in Figures 5 and 6 with the number of timings completed on the x-axis. The y-axis represents number of each skill completed per-minute on a linear scale.

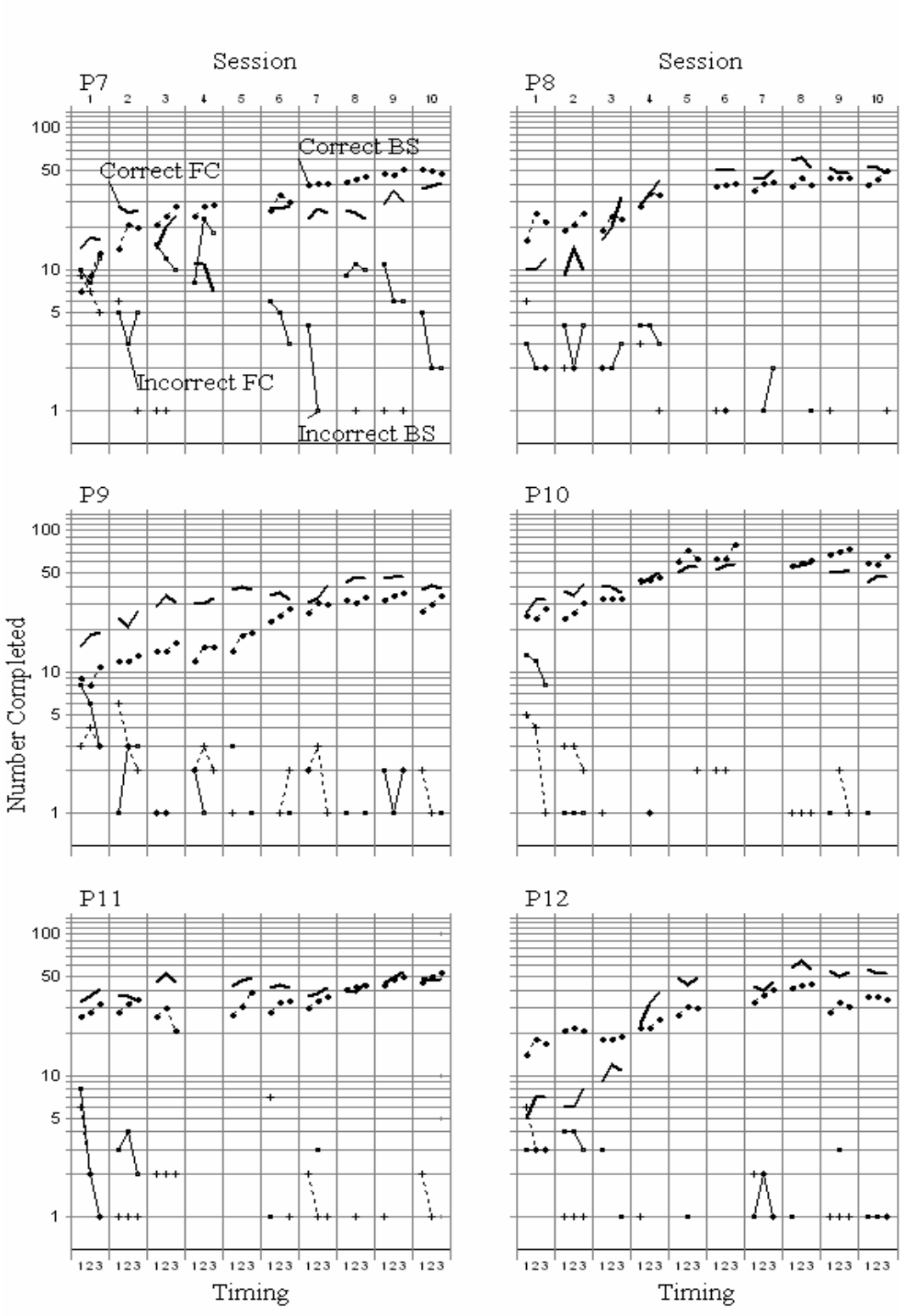

Figure 4. Number of correctly and incorrectly completed forward crosses (FC) and back scissors (BS) performed in one minute for six participants in Group 2 (P7 to P12) across ten sessions. Each session included three 1-min timings, i.e. trials. Participants in this group were charting their back scissors.

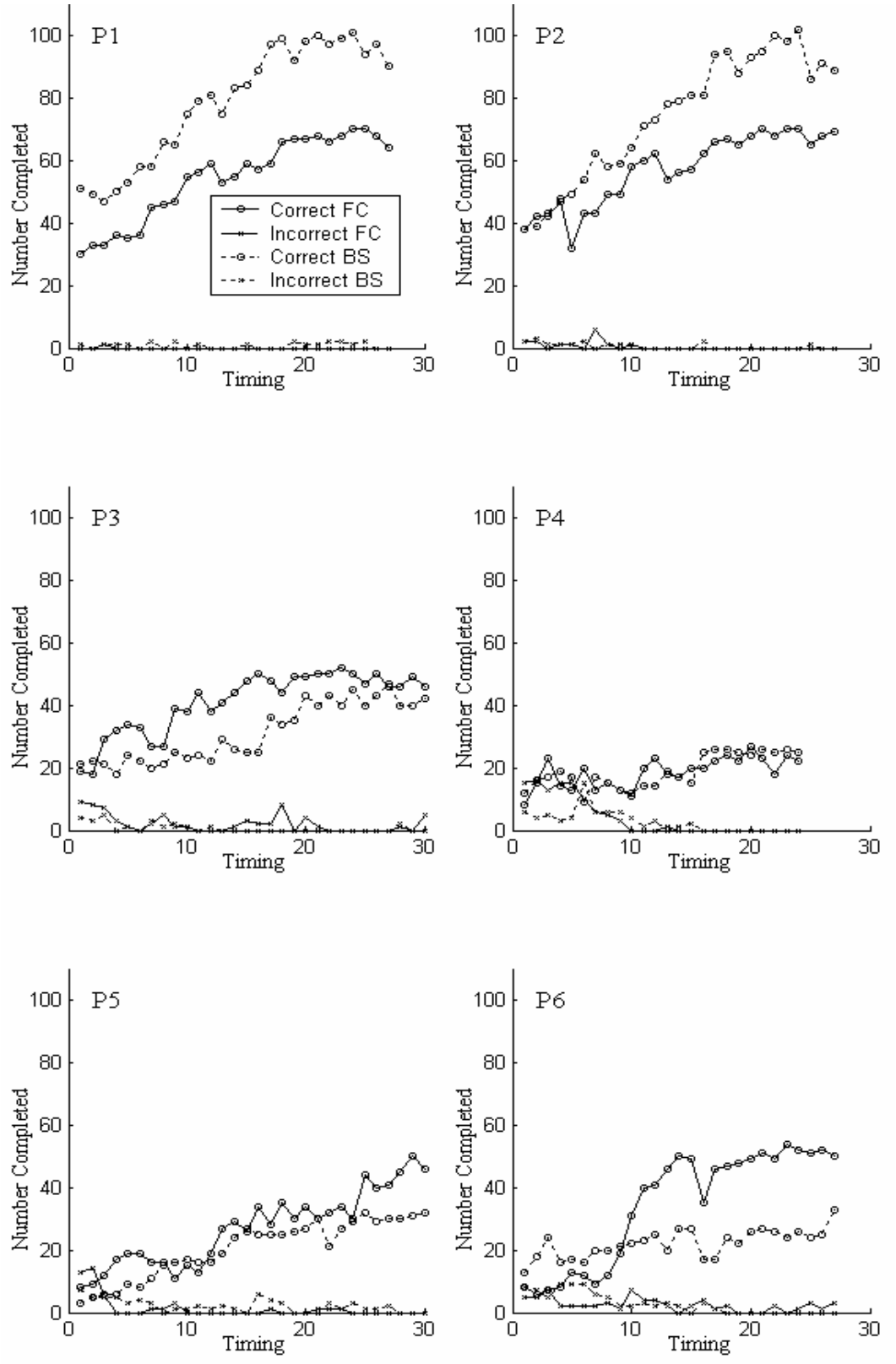

Figure 5. Number of correctly and incorrectly completed forward crosses (FC) and back scissors (BS) performed in one minute for six participants in Group 1 (P1 to P6) across ten sessions. Each session included three 1-min timings, i.e. trials. Participants in this group were charting their forward crosses.

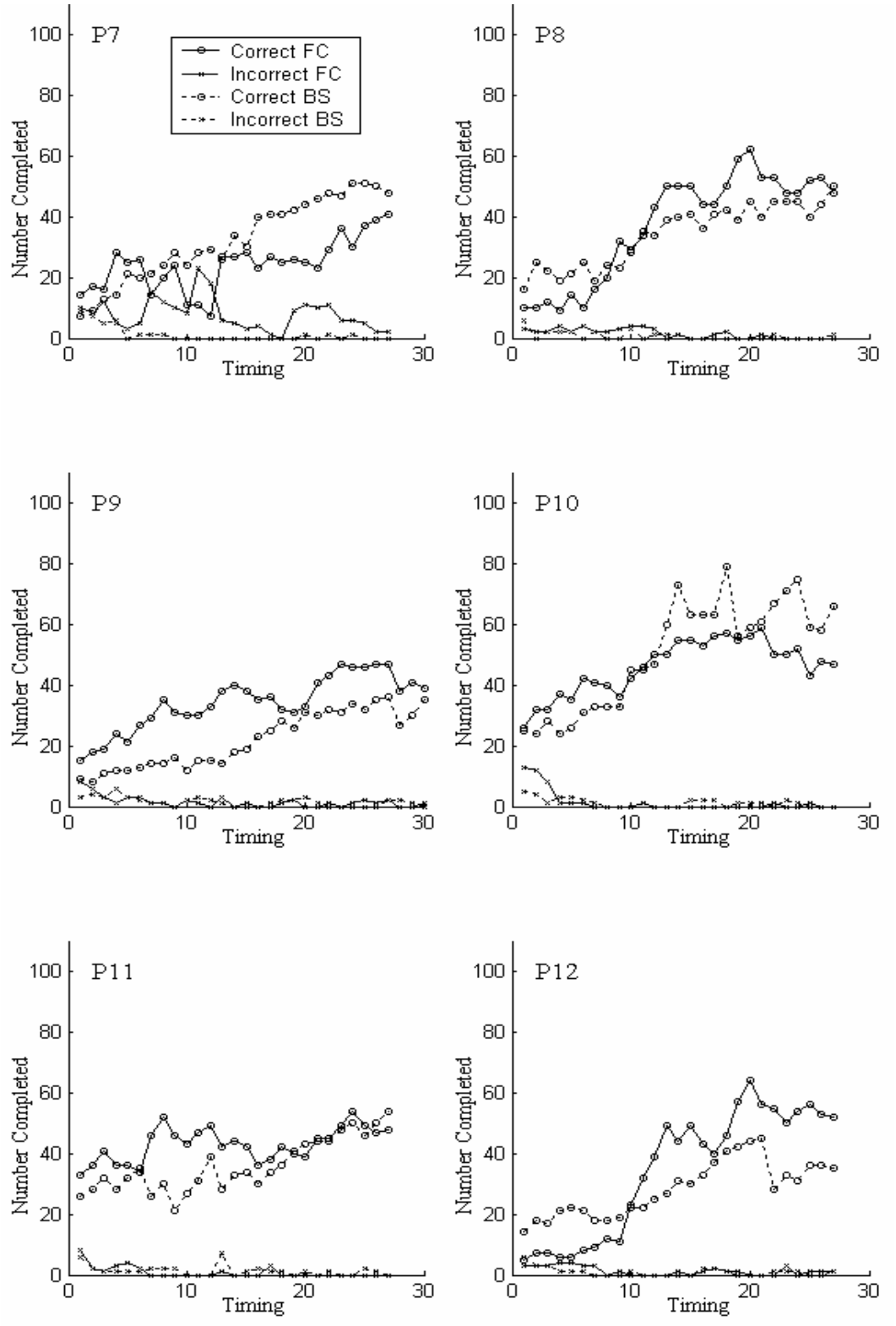

Figure 6. Number of correctly and incorrectly completed forward crosses (FC) and back scissors (BS) performed in one minute for six participants in Group 2 (P7 to P12) across ten sessions. Each session included three 1-min timings, i.e. trials. Participants in this group were charting their back scissors.

Solid lines represent forward crosses and broken lines represent back scissors. Circle markers represent correct repetitions of each skill while crosses represent incorrect repetitions. A decision was made to omit sessions where participants had been absent because missed sessions did not appear to have a large effect on the general trends observed in Figures 3 and 4. Lines were fitted to these data in Figures 5 and 6 by the method of least squares regression. Table 2 shows the slopes and intercepts of the lines for individual skaters for both skills.

Comparison of the slopes for the two skills shows that for Group 1 only two skaters (P5 and P6) improved faster on the charted skill (forward crosses) than the uncharted skill (back scissors). In Group 2, four skaters (P7, P9, P10, and P11) improved faster on the charted skill (back scissors) than the uncharted skill (forward crosses). Overall the data show that four skaters in each group improved faster on back scissors than on forward crosses regardless of whether charting was used or not. Generally, however, the obtained slopes were similar for both skills for both Group 1 and 2, with differences greater than 1 between the slopes for forward crosses and back scissors being seen in data from only 4 individuals. A repeated measures ANOVA confirmed that, with alpha set at .05, there was no significant difference in slope between the two skills, $F(1, 105) = 0.013$, or between groups, $F(1, 10) = 0.010$. A box plot showing the average slopes for each group can be found in Appendix C.

Table 2. Slopes and intercepts for each participant for forward crosses (FC) and back scissors (BS) and the differences between skill intercepts and slopes for each participant.

Participant (group)	FC Intercept	FC slope	BS Intercept	BS slope	FC-BS Intercept	FC-BS slope
P1 (1)	32.251	1.580	47.735	2.217	-15.484	-0.637
P2 (1)	38.405	1.331	40.977	2.385	-2.573	-1.054
P3 (1)	26.885	0.926	15.938	0.985	10.947	-0.059
P4 (1)	12.732	0.465	11.286	0.610	1.446	-0.146
P5 (1)	7.108	1.281	5.170	0.993	1.938	0.288
P6 (1)	5.390	2.089	16.598	0.402	-11.208	1.687
P7 (2)	13.792	0.750	8.815	1.691	4.977	-0.940
P8 (2)	9.353	1.985	17.630	1.183	-8.276	0.803
P9 (2)	20.740	0.877	6.517	0.992	14.223	-0.115
P10 (2)	34.547	0.826	23.476	1.940	11.071	-1.114
P11 (2)	37.558	0.383	22.635	0.949	14.923	-0.566
P12 (2)	0.803	2.411	15.097	0.948	-14.294	1.463

The first and last timings were also compared using a split plot ANOVA (mixed design analysis of variance) comparing groups, skills and timings. With alpha set at .05, the interaction of these three variables was not statistically significant $F(1,10) = 0.356$ (partial $\eta^2 = .034$, observed power = .084). There was also no significant difference between skills, $F(1,10) = 0.559$ (partial $\eta^2 = .053$, observed power = .104), or between groups, $F(1,10) = 0.235$ (partial $\eta^2 = .023$, observed power = .072). However, a significant difference was found between first and last timings, $F(1,10) = 166.93$ (partial $\eta^2 = .943$). A box plot showing the average rates of performance recorded for both skills during the first and last timings for each group can be found in Appendix D.

Interobserver reliability was determined by finding the mean percentage agreement between observers using the total number of correct and incorrect observed forward crosses or back scissors in each timed minute. All observations were done by three observers watching a video that had been taken at the beginning and end of the study. The following formula was used to find each percentage agreement:

$$\frac{\text{Smaller number observed}}{\text{Larger number observed}} \times 100$$

Interobserver reliability results are presented in Table 3. Percentage agreement is not presented for observations of incorrect occurrences as lower numbers of errors occurred (averaging 3.7 across observers) and therefore any small differences gave large variances in the interobserver measures. In all cases of correct observations, interobserver reliability was high with 89% being the lowest value obtained.

Table 3. Interobserver reliability between the main observer (O1) and two other observers (O2 and O3), across 21 observations and two skills.

	N	Minimum	Maximum	Mean	Std. Deviation
O1 vs O2 Forward crosses	21	89.13	100.00	97.10	3.37
O1 vs O3 Forward crosses	21	90.00	100.00	98.16	2.99
O1 vs O2 Back scissors	21	90.48	100.00	98.01	2.68
O1 vs O3 Back scissors	21	90.48	100.00	97.22	3.37

The club coach assessed all skaters in the beginner class. Beginner skaters typically progress 1 level per 10 week term but this assessment determined that 9 of the 12 skaters in the study had progressed two levels during the ten weeks of the beginners' class. The remaining 3 skaters in the study had progressed one level, as had the 7 beginner class skaters who had not participated in the study. Anecdotal observations made by the club coach were that those skaters in the study more easily and confidently performed a range of skating items and that this was attributable to the extra training. It appeared that once skaters were more confident at skating both forward and backward, their balance and coordination also improved on other skating tasks (such as spinning and jumping) which often require forward or back skating immediately before and/or after the task.

DISCUSSION

The main purpose of this experiment was to separate out one component of precision teaching, charting, to determine how effective this component was. Overall, charting did not result in greater improvement for one skill over the second uncharted skill. That charting alone had little effect is inconsistent with the generally reported view that charting contributes to the effects of precision teaching (Lindsley, 1990). However, the results presented here are similar to previous research done by Brandstetter and Merz (1978) who examined the effects of charts on reading rates for 4th graders. Differences found in their study were small, although non-logarithmic charts showed a bigger effect. This contrasts with Yawkey and O'Meara (1974) who found, when the teacher used celeration charts with children, that mathematical performances were better than when they were not using celeration charts. However, as already pointed out, these results were confounded as teachers used the celeration charts to make suggestions on specific follow up activities that the children could engage in to decrease errors. The present findings suggest that the extra activities in Yawkey and O'Meara's study may have contributed to children in the charting phase outperforming those that were not, rather than this being an effect of charting alone.

Because there is very little research into the effects of charting within the precision teaching literature, no research currently exists on the effects of charting when a motor skill is targeted, e.g., skating. Therefore the possibility exists that while charting did not affect the performance rates of the motor skill targeted

here, charting may be more effective for other types of skills that are more academic in nature. The main procedural difference resulting from the use of charts is the provision of visual feedback. Dvorak, Merrick, Dealey and Ford (cited in Joyce and Moxley, 1988) state that charts provide students with feedback that allows them to compete with their own record and see their results and this may, in and of itself, change the behaviour of students. However, given the similar results found for both charted and non-charted skills here, charts did not appear to provide an advantage. Had the charts been publicly posted so that additional social feedback also occurred, different results may have been obtained.

One effect of charting may be to allow skaters to compare their performances with those of others and with their previous performances. Here, as both skills were being counted, it was easy for skaters to compare the rates of the two skills, even without charts. Skaters may have used this information to keep the rate of the uncharted skill either above or close to the rate of the charted skill. Therefore charting may have helped to accelerate rate of performance for both skills. It was not clear if this was the case. Even if it was, it does imply that the visual feedback was not required to help improve performance.

Using charts resulted in another procedural difference between conditions in this study. This was the degree of talk between researcher and student and the potential for social feedback that may come from viewing charts with other people. For example, because a performance aim had been set and was drawn onto each participant's celeration chart, it was common for the researcher and participant to discuss how close the current rate was to the performance aim. This resulted in both more discussion between the skater and researcher, and more opportunities for social reinforcement relating to progress on that skill. However, this did not result in greater fluency gains than when the performance aim was discussed in the absence of a celeration chart.

While it is argued here that the data suggest charting alone had no effect, there is another aspect of the study worth discussing. White and Haring (1980) suggest that while feedback is important for precision teaching, feedback alone will not result in continued interest in the set task. Performance aims, or goals, are an integral part of precision teaching and charting (Koorland, Keel, & Ueberhorst, 1990). The provision of these performance aims may have accelerated performance over and above that which would have been seen if only feedback

had been given. Results of the present experiment show that once many of the skaters had reached, or come close to, the initial performance aim of 50 for one skill, their progress levelled off for both skills even though a new performance aim was set (refer to Figures 4 and 5). This was true for seven of the skaters who reached the performance aim for forward crosses and three of the skaters who reached the performance aim for back scissors. It is possible that skaters either found it difficult to go beyond this performance aim, or further performance aims had no effect. However, three skaters progressed well beyond the performance aim of 50 for both skills with a leveling off finally appearing at around 70 for forward crosses and 100 for back scissors. Thus it was possible to achieve a higher performance rate. Perhaps if a higher performance aim had been set to start with, the plateaus seen in some of the skaters' results in Figures 4 and 5 here may not have occurred.

Another aim of this experiment was to determine whether precision teaching methods, a form of fluency training, could be used with a sport such as roller skating. The current results suggest that this is possible as fluency training resulted in improvements across all skaters and both skills. Furthermore the progress on standard skating assessments was greater for skaters who used fluency training than for other skaters attending the beginners' class who did not. This may indicate that increasing performance-rate through fluency training on essential skills, such as those targeted here, may have resulted in better general skating performance where those essential skills are used. However, this assumption should be viewed cautiously as extra practice effects were not controlled for here.

In conclusion then, providing visual feedback through charting on one skill did not result in greater performance gains for that skill over the other uncharted skill. However, skaters participating in this study did become more fluent at performing forward crosses and back scissors, increasing the rate of correct skills per minute. While charting may increase discussion between teacher and student, and provides visual feedback, this does not appear to influence the rate of performance over sessions directly. However, it is possible that in both conditions the performance aims may have influenced skaters' progress. This is likely because performance rates appeared to plateau for many skaters when the original performance aims were reached even though higher rates were possible.

Given this, the next study explored the effect of goal difficulty on the performance rates of skaters.

EXPERIMENT 2

Performance aims, or goals, are regularly drawn onto celeration charts (Brandstetter & Merz, 1978; Joyce, 1988; Koorland et al., 1990; West et al., 1990; White & Haring, 1980), and students are not started on learning a new skill until those performance aims been achieved. However, no research exists in the precision teaching literature examining the effectiveness of these performance aims alone on performance rates. In contrast, considerable literature exists on goal setting in the areas of cognitive and sport psychology which suggest that by setting goals performance is improved (Anderson, Crowell, Doman, & Howard, 1988; Boyce, Johnston, Wayda, Bunker, & Eliot, 2001; Brett & VandeWalle, 1999; Burton & Naylor, 2002; Fairall & Rodgers, 1997; Gilliland & Landis, 1992; Hatzigeorgiadis & Biddle, 1999; Kanfer & Ackerman, 1994; Kozlowski et al., 2001; Latham & Kinne, 1974; Rizzo et al., 2003; Thill & Cury, 2000; Wanlin, Hrycaiko, Martin, & Mahon, 1997; Weinberg, 2002). Latham and Baldes (1975) suggest that goals lead to an increase in performance because they make it clear to individuals what is expected. The provision of a goal also makes it clearer to the individual what progress they have made as well as what progress they could be expected to make in the future given their previous results. It seems logical that Latham and Baldes' assumptions regarding the use of goals could be applied to performance aims within precision teaching as well.

In the previous experiment it was found that additional verbal and visual feedback associated with the use of charts was not effective in accelerating performance rates over and above those found when charts were not used. Locke and Latham (1979) report that feedback alone is not effective in improving performance and state that feedback must be combined with goals to have any effect. For example, using a computational task with 61 university students, Locke and Bryan (1968) found Knowledge of Score, a form of feedback, enhanced performance as compared with no Knowledge of Score, but only when those participants in the Knowledge of Score condition set goals. Their analyses showed that while there was no main effect for Knowledge of Score, there was a significant effect of goals on performance, i.e., the Knowledge of Score group

performed better overall only because more participants in this group chose to set a “do best” or “reasonably fast” goal and fewer participants chose a “no effort” goal. The opposite was true for those in the no Knowledge of Score group. In Experiment 1 of the current research then, it is possible that skaters improved through the use of performance aims, or goals, which were set for both skills.

One way to categorise goals is by dividing them into performance goals and mastery goals (Turner et al., 2002). Performance goals focus on demonstrating ability and outperforming others. Mastery goals focus on understanding, intellectual development, and improvement. Steinberg, Singer and Murphey (2000) compared the achievement benefits for golf-participants who set these different types of goals. Their results showed that a combination of both performance and mastery goals was most effective in enhancing putting performance. No changes were seen for those participants who used only a mastery goal or performance goal, or for those participants who set no goal. The performance aims described in the precision teaching literature are a combination of both these types of goals. These aims direct the learner to focus on both demonstrating their ability and in showing improvement. Performance aims, or goals, in precision teaching are determined by the rate of performance that is needed for the student to be able to perform the skill fluently (Johnson & Layng, 1996).

Different performance aims within precision teaching have been established for specific skills within a number of curriculum areas (Binder & Watkins, 1990). Commitment by students to achieving these established performance aims has not been researched but within the goal-setting literature Locke and Latham (1990) suggest that an individual’s commitment to a goal will affect task performance. One determinant of goal commitment, as reported by Locke and Latham, is peer group influence although they do not outline how this might determine goal commitment. Public posting of performance is an example of how a peer group can come to influence future behaviour and performance. However, there does not appear to be any substantial support for the positive effect of public posting in the literature. Anderson, Crowell, Doman and Howard (1988) showed that the average hit-rate for individuals in a University hockey team increased with goal setting but their results also indicated that mean hit-rate did not increase more with publicly posted individual feedback, although

Anderson, Crowell, Doman and Howard reported to the contrary. Ward and Carnes (2002) reported that publicly posting the goals of five collegiate football players resulted in positive effects on their athletic performance. In their study each football player met or exceeded their pre-set goal of an approximate 20% improvement on what they were doing before the intervention was introduced. However, since Ward and Carnes failed to separate out goal setting from public posting it is possible that the improved performance could have been a result of goal setting alone. In terms of precision teaching, their results indicate that even if progress was posted in class or shared with peers, it may be other characteristics associated with setting performance aims that would be effective in improving performance.

In precision teaching the performance aims are set by the teachers. They determine what rate of performance must be reached to achieve fluency in that skill. The fact the teachers rather than the pupils set the goals might alter the effectiveness of those goals. However, Locke (1990) states goal commitment is not affected by whether a goal is assigned, set participatively or self-set. Latham and Locke (1979) state that it is not important who sets the goals and that goal difficulty has far more influence on the performance of individuals. They report a laboratory study which involved participants brainstorming uses for wood. In one group individuals set their own goals while in another group individuals were given the goals set by participants in the first group. There was no difference in performance between the groups, but both groups performed better than a third "do your best" group.

Latham and Marshall (1982) completed a study using 57 government employees who also completed a brainstorming task. There were three experimental groups, namely, participatory, self-set, and assigned goals. Results showed that there was no significant difference among the three groups regarding actual performance. Fairall and Rodgers (1997) found similar results in their study. They randomly assigned 67 track and field athletes to one of three goal-setting groups. The first group participatively set goals with their coach. The second group set their own goals, and the third group was assigned their goals. Statistical analysis demonstrated that there were no performance differences between the groups of athletes.

There is one study that contradicts these findings. Boyce et al.(2001) found that both instructor-set and self-set goals enhanced students' performance on a tennis serving task but that by the second trial, instructor-set goals were superior to self-set goals. However instructor-set goals for one group were not matched with the self-set goals of the second group. Therefore it may have been different characteristics of the goals themselves that led to the instructor-set goals group performing better. It seems reasonable to assume then, given the results of all four studies, that within precision teaching, performance aims should not be less effective simply because teachers have set them as student commitment may not be an influencing variable.

Much of the literature on goal setting falls under the heading of 'goal setting theory'. Goal setting theory attempts to explain the way in which performance on work tasks is regulated by conscious goals (Locke, 1993). Locke (1991) reports that "the efficacy of goal setting in improving task performance is one of the best established findings in management and psychology" (p.311). Goal setting theory has also been used to explain performance within academic and sporting fields. Locke and Latham (1985) claim that goal setting may be an even more effective intervention in sports than in typical organizational settings. Others disagree. Boyce, Wayda, Johnston, Bunker and Eliot (2001) report that while approximately 90% of the goal setting research in the Industrial/Organizational field has demonstrated that goals are effective, only 70% of the research studies within the area of Sport and Physical Activity show the same.

Latham and Locke (1979) outline the critical components of goal-setting. They suggest goals should be specific and whenever possible there should be a time limit for accomplishment of the goal. They suggest that, when goals are specific, individuals may expend greater effort, and even devise better or more creative tactics, to attain the goal than they would have in the absence of goals. Precision teaching does set specific, time-based goals (Johnson & Layng, 1996; Joyce, 1988; Koorland et al., 1990; Meacham & Wiesen, 1969; Polson, 2003; White & Haring, 1980) and it may be that these performance aims, or goals, contribute to the effectiveness of precision teaching.

Latham and Locke (1979) state that the goal should be challenging, yet attainable. They suggest that if goals are perceived as unreachable, individuals

will not accept them. In accordance with this, they also suggest that individuals with low self-confidence or ability should be given more easily attainable goals than those with high self-confidence and ability. Precision teaching approaches this differently because it aims to attain fluency. Fluency is best achieved by setting the goal at what a competent person could do regardless of what self-confidence or ability the learner currently holds. If that level of fluency is unattainable, precision teaching assumes that this is due to deficiencies in the base skills that are used in performing the skill that is being targeted (White & Haring, 1980).

Locke and Latham (1990) report that there is a linear relationship between degree of goal difficulty and performance which they refer to as the "*goal difficulty function*" (p. 27). They say that, assuming the goals are accepted by the individuals, "hard goals lead to greater effort and persistence than easy goals" (p. 29). For example, Earley and Lituchy (1991) completed two studies which separated out goal difficulty from other factors. Their first study involved students performing maths problems and the second involved working on complex game situations. Both of these tasks were completed under conditions of easy or challenging goals. The easy goal was set at 2.0 standard deviations below the mean performance level of participants who had completed a pilot study, while the hard goal was set at 2 standard deviations above this mean. They found that participants given challenging goals completed more problems. Lee, Sheldon and Turban (2003) also found that goal level was positively related to the performance of students enrolled in a university management paper. Those students with more difficult performance goals gained, on average, higher grades for their courses. Latham and Seijts (1999) suggest that a difficult goal is one that only 10% of the participants can attain under normal conditions where goal setting is not specifically used. As a result, most participants are aiming for something that is above their normal level of performance (Locke & Latham, 1990). In precision teaching, if performance aims are effective, this might be because performance aims are set high i.e., performance aims are challenging as they are set above what the individual is currently performing.

Locke and Latham (1990) report that a higher level of performance is achieved when goals that are specific and difficult are used rather than vague, non-quantitative goals such as "do your best". They reported mean effect sizes

ranging from .42 to .80 for studies which compared hard, specific goals to “do your best” goals (Locke & Latham, 1990; Locke & Latham, 2002). Precision teaching performance aims are based on the performance of a competent person, and so are normally achievable but should be challenging for the learner (Koorland et al., 1990). Therefore it is argued that precision teaching performance aims fall within the definition of a difficult goal.

Some research contradicts the finding that harder goals result in better performance. For example, Earley, Connolly and Ekegren (1989) report findings from three laboratory experiments using a stock prediction task where specific difficult goals either had no effect or a negative effect on task performance. University students were asked to make predictions concerning the value of 100 companies’ stock. Goals ranged from “do your best” to the difficult goal of making a prediction within $10 of the actual stock price. The difficult goal had the effect of reducing prediction accuracy for the stock predictions. In another study with basketball players who practiced shooting hoops, Getz and Rainey (2001) showed that short term flexible goals were superior to rigid, harder goals and concluded that in the face of setbacks and plateaus it is easier to maintain motivation when the goal is closer.

Latham and Seijts (1999) suggest that as the complexity of a task increases, the magnitude of goal effects decreases. One example of this was found by Kanfer and Ackerman (1989) who conducted a study involving a computer driven task that simulated activities performed by air traffic controllers and involved 10 10-min trials. They found that a “do your best goal” was more effective than a specific hard goal. They suggested that when the task is complex, a specific difficult goal distracts attention from the necessary task of developing appropriate strategies to perform that task. Latham and Seijts (1999) argue that this can be overcome as long as proximal goals that are instrumental in achieving a distal goal are set. Precision teaching specifically breaks down complex tasks and sets performance aims for each component. Therefore this may be another reason that precision teaching is so effective in changing rates of behaviour.

It was found in Experiment 1 that charting alone did not accelerate the performance of skaters as similar performances were observed when charting was not used. However, significant improvements were seen by the final session. It is not clear what aspects of the training gave rise to the performance increases. A lot

of research on goal-setting supports its effectiveness in improving performance over and above that which occurs when no goals are used. Thus it seems possible that the performance aims used in Experiment 1 may, at least in part, have been responsible for the improvement in performance.

Most of the goal-setting literature states that specific, hard or difficult goals are most effective. As pointed out, precision teaching uses performance aims which generally meet these criteria. It was argued earlier that, in the previous experiment, the goals set may not have been hard enough. This argument was post hoc and based on the fact that a few skaters went far beyond the initial performance aims, while others failed to improve once they reached it. It was reasoned that this occurred because the initial performance aim was too easy. The next experiment aimed at exploring the effect of the difficulty of a performance aim on the performance rates of a skating skill. To avoid the potential confounds from one condition to the other, as may have occurred in the previous experiment, two different groups and one skill were used. Otherwise all other procedures were the same as in the condition in the first experiment in which charting was not used. A new skill to train was selected and it was decided to use back crossfronts as the skill, which was a slightly more advanced skill than back scissors but a skill that no skaters in the beginners' class had previously been taught. This allowed skaters from Experiment 1 to participate. To test the effect of goal difficulty on performance, two different goals were set. One group was given a hard performance aim that met the criteria of being challenging, yet attainable. It was expected that only a few skaters would achieve this across the time-frame of the experiment. The goal was set close to the maximum of what was achieved in the first experiment on forward crosses as the movements involved in both forward crosses and back crossfronts are similar in size. The easy goal was based on what each skater was already achieving currently and so it was expected that skaters could easily reach this goal most sessions. It was expected that those skaters who were given a hard goal, or difficult performance aim, would outperform those who were simply trying to equal their previous performance.

METHOD

Participants

Ten children (P1-P10) from the local beginner roller-skating class participated. Eight of these skaters had participated in Experiment 1. The 5 participants in Group 1 (P1-P5) were girls aged between 7 and 9 years at the start of the study with an average age of 7.8 years. The participants in Group 2 (P6-P10) were aged between 8 and 12 years with an average age of 7.8 years. There were 4 girls and 1 boy. All participants completed the study.

Apparatus

A stopwatch was used to time each 1-min interval. Some of the skating sessions were recorded on video using a Sony Handycam Vision camcorder.

Procedure

Back crossfronts were the skill targeted for this experiment. They allow skaters to skate backwards around corners and include the crossing action of one skate across the front of the other. Skaters perform this accurately, while moving backward, by lifting the first skate off the skating surface and placing it back on the rink surface either directly in front of the second skate or to the outside of the second skate so that the skaters' little toes are now next to each other. Then the second skate is lifted from the skating surface so that they are now rolling on the first skate only. If the skater does not cross the first skate far enough over the second skate or falls at any point then that repetition of the skill is counted as an "attempt" rather than a "correct".

The general procedure used is shown in Figure 7 below. Initially all skaters attending local beginner classes who could skate backwards, i.e., perform back scissors correctly, were given an information sheet and consent form to hand on to their parents. The information sheet was similar to that used in Experiment 1 as was the procedure for gaining consent. Consent forms were obtained for 10 participants and these skaters were then randomly assigned to either Group 1 or Group 2. Participants in the study were required to commit to attending two 10-min sessions each week at the skating rink for five weeks.

At the first session each skater was told that over the next five weeks they would be learning to skate backwards around corners and that at the end of this

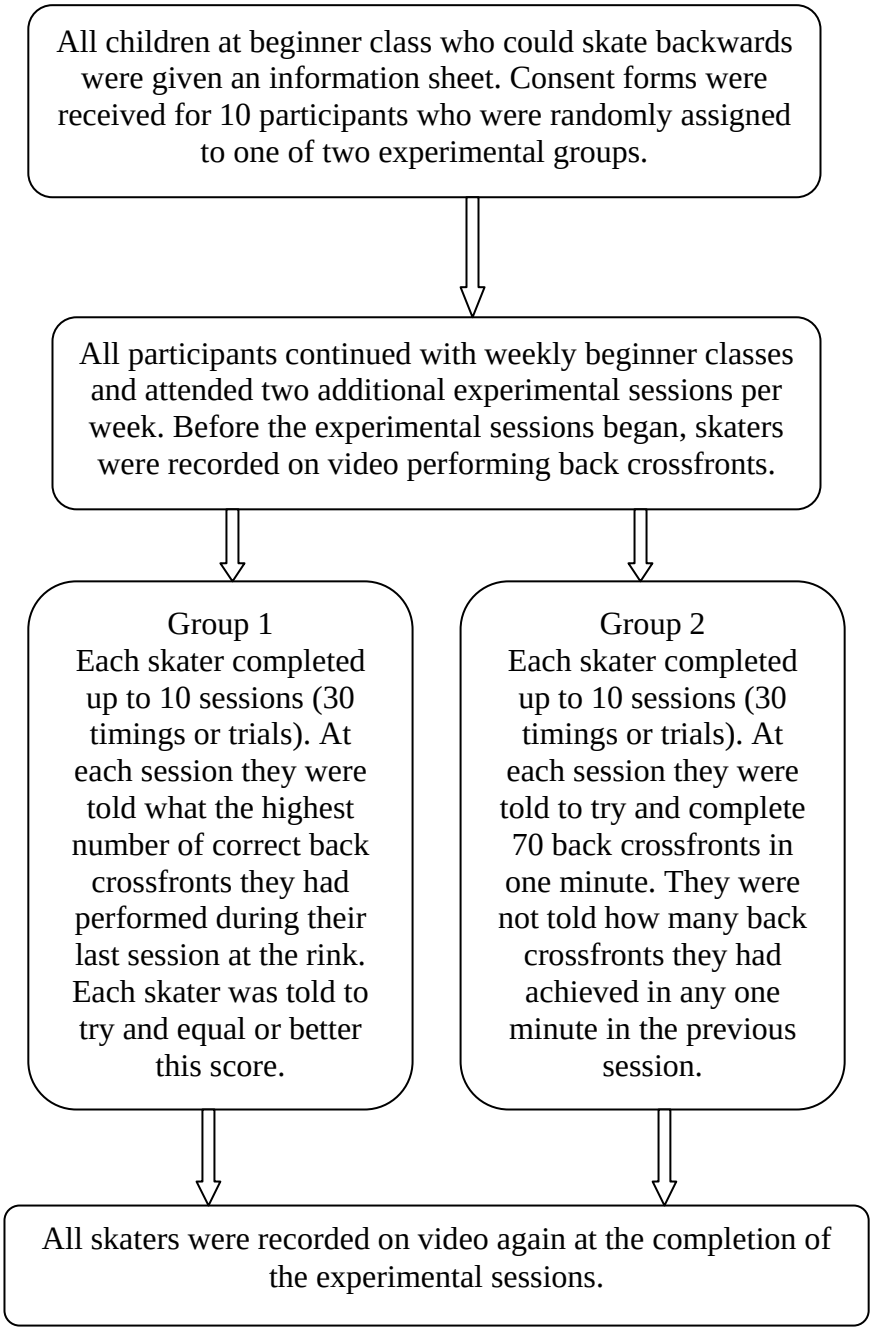

Figure 7. Flow diagram of procedure used in Experiment 2.

time they should be able to do this skill faster and more easily. All skaters were then told that, in order to see how much faster they were getting, we would count how many back crossfronts they were doing in one minute and that they would have three attempts at doing this in each 10-min session. Before each of the three timings the researcher would observe the skater performing the skill and if

necessary provide feedback to them until they had done it correctly. All sessions took place over the same 5-week time period. The tenth session coincided with the start of school holidays, during which all skating activities at the rink ceased and so the experiment stopped at this point. All skaters completed at least 9 sessions and 4 skaters completed 10 sessions.

From Session 2 onwards, at the start of the 10-min session, Group 1 skaters were told the highest number of correct back crossfronts they had performed in a minute in the previous session. They were told to aim at completing the same or more than this in the current session. Group 2 skaters were given the harder goal of 70 correct back crossfronts per minute at the beginning of each session. After each of the 1-min timings, skaters were told how many they had completed in that minute and the researcher recorded the data. Skaters were not shown charts of their progress.

Following the completion of the last session, each skater was recorded on video during a 1-min practice. To establish the level of interobserver reliability, the experimenter and two other observers watched the video taken of each skater and recorded the number of correct and incorrect executions.

RESULTS

Once the data was transferred onto charts, celeration charts failed to show a linear progression across timings and so linear graphs were again used to analyse the data. Figure 8 shows the number of correct and incorrect back crossfronts completed for Group 1. The x-axis represents consecutive 1-min timings with three 1-min timings in each 10-min session. The y-axis represents number completed per minute. Correct back crossfronts are represented in a solid black line with round markers and incorrect back crossfronts are represented by a solid line with triangle markers. A broken line from timing 4 onwards shows the goal set for each session. The goal was determined by the highest score in the previous session.

From Session 2 on, all skaters in Group 1 were aiming to equal or better their best performance from the previous session, i.e., complete the same number of back crossfronts or more in one minute than they had in the last session. For all skaters the goal increased from one session to the next in the majority of sessions. However, there were also times when the goal had to be lowered in the next

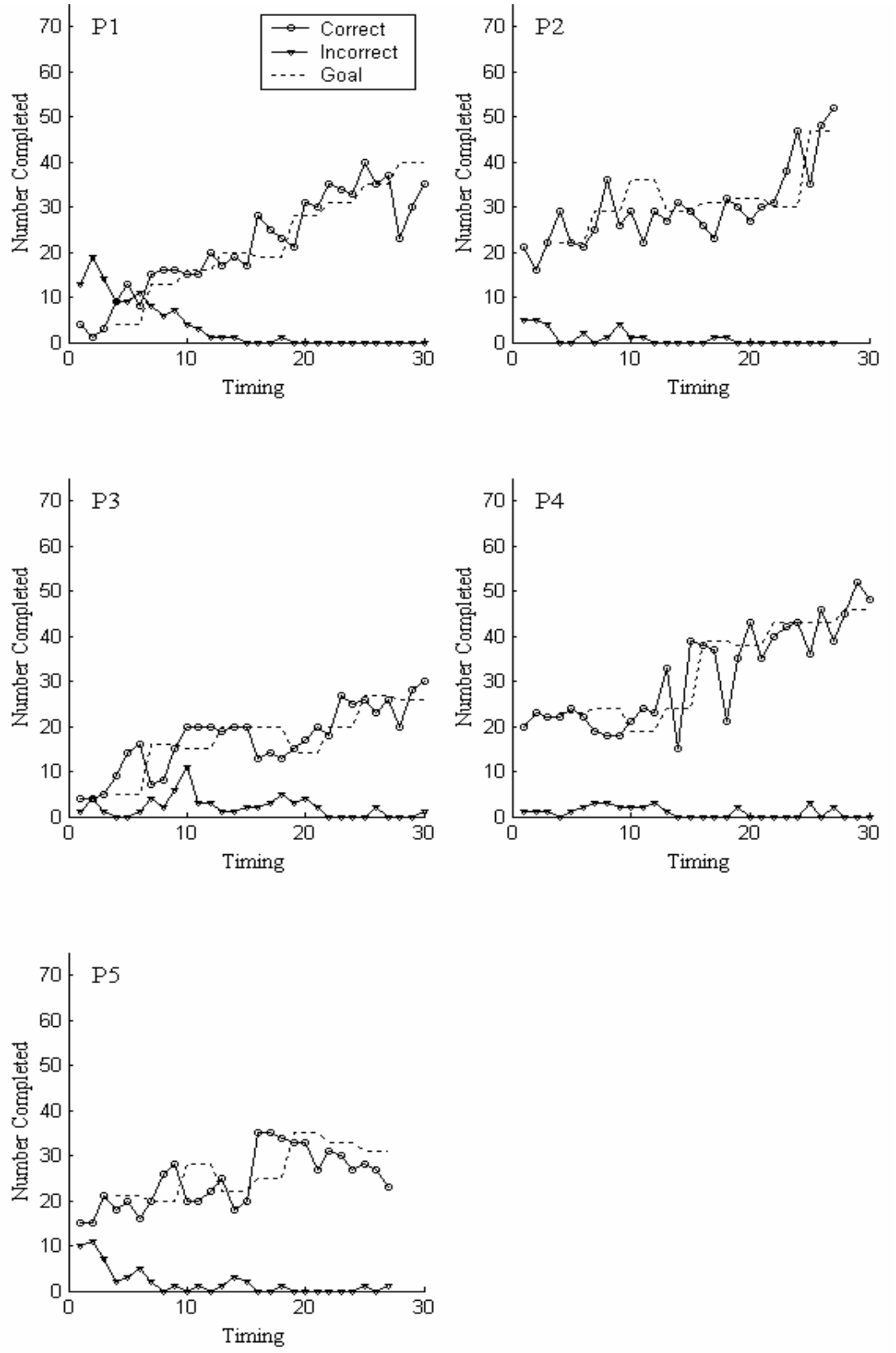

Figure 8. Number of correct back crosses (circles) and incorrect back crosses (triangles) completed by individual skaters in Group 1. The goal they were aiming for in each timing from the fourth timing onwards is represented by a broken line.

session because the skater had not reached the goal at all for a session. One skater, P5, had their goal lowered for each of the last three sessions because their performance rate kept falling, making it necessary to set a lower goal each time.

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Figure 9 shows the number of correct and incorrect back crossfronts completed for Group 2 on similar graphs to those used in Figure 8. From Session 2 onwards all skaters in this group were aiming for 70 correct back crossfronts per minute. One skater managed to achieve this in his very last timing. The performance of the remaining skaters remained a clear distance below this goal.

Straight lines were fitted to the data in Figures 8 and 9 by the method of least squares. Table 4 shows the slopes and intercepts of the lines for individual skaters for both skills. Overall the slopes were very similar between Group 1 (M = .844, SD = 0.254) and Group 2 (M = .907, SD = 0.163). There was a numerical difference between the intercepts for Group 1 (M = 12.263, SD = 6.494) and Group 2 (M = 22.924, SD = 11.256). An independent samples t-test found that, with alpha set at .05, there was no significant difference between slopes, $t(8)$ = 0.464, or intercepts, $t(8)$ = 1.835. A box plot showing the average slopes for each group can be found in Appendix E.

The first and last timings were also compared using a repeated measures ANOVA comparing groups and first timings with last timings. With alpha set at .05, there was a significant difference from first to last timing, $F(1, 8)$ = 124.749 (partial η^2 = .940), but no significant difference between groups, $F(1, 8)$ = 3.583 (partial η^2 = .309, observed power = .385). The interaction of groups and timings was also not statistically significant $F(1, 8)$ = 1.908 (partial η^2 = .193, observed power = .230). A box plot showing the average rates of performance recorded during the first and last timings for each group can be found in Appendix F.

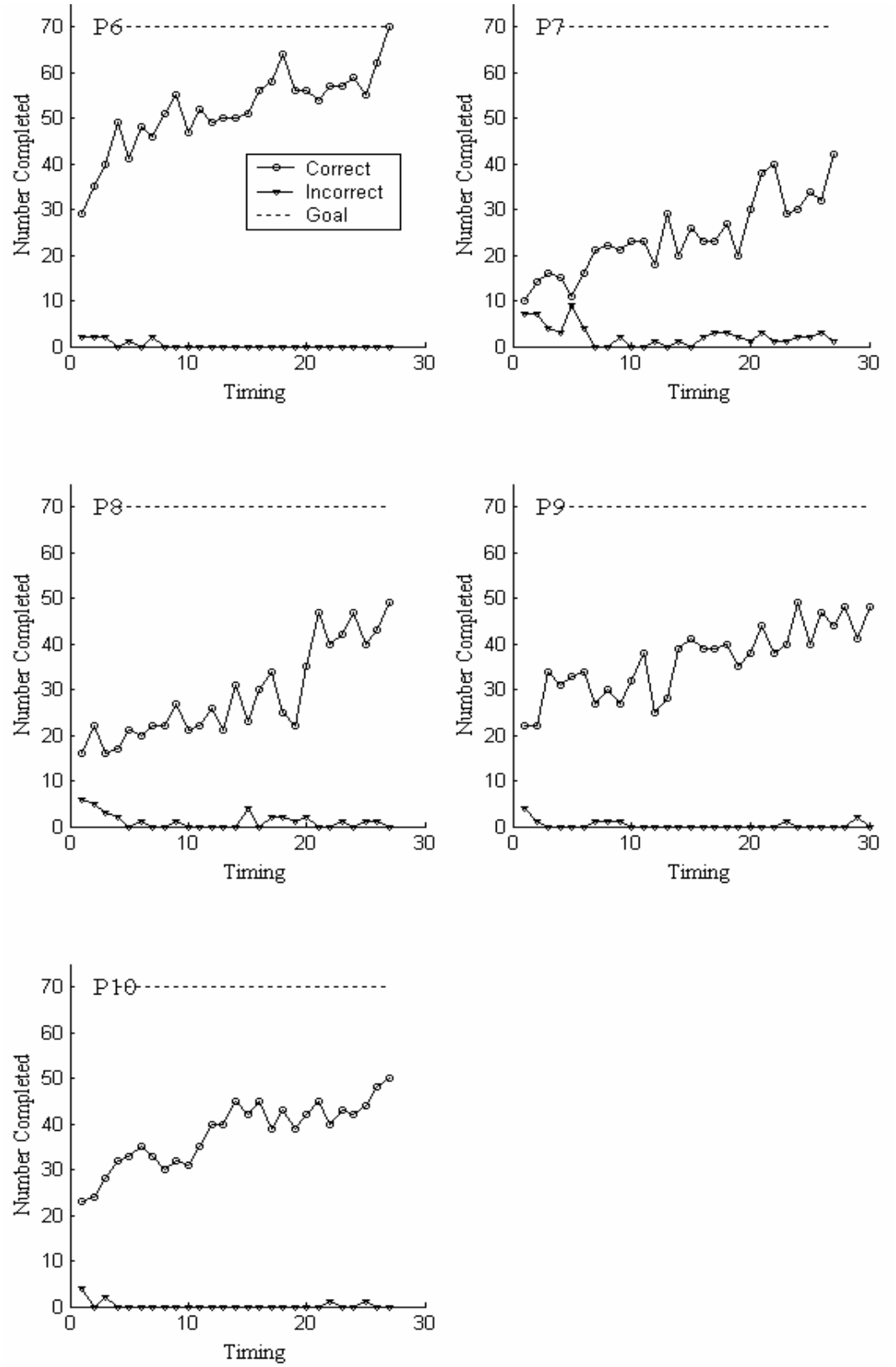

Figure 9. Number of correct back crosses (circles) and incorrect back crosses (triangles) completed by individual skaters in Group 2. The goal of 70 that they were aiming for in each timing from the fourth timing onwards is represented by a broken line.

Table 4. The slopes and intercepts from lines fitted to Figures 8 and 9 using the method of least squares regression.

Skater	Group	slope	intercept
P1	1	1.133	4.035
P2	1	0.822	18.274
P3	1	0.681	6.648
P4	1	1.058	15.030
P5	1	0.530	17.328
P6	2	0.934	38.664
P7	2	0.927	11.202
P8	2	1.150	12.823
P9	2	0.723	25.223
P10	2	0.799	26.709

Interobserver reliability was determined for two observers, the experimenter and a local club coach, by finding the mean percentage agreement between them. The same formula as that used in Experiment 1 was used to do this. Overall interobserver reliability is high for correct observations (M = 93.42%, ranging from 78.72% to 100%). Again percentage agreement for incorrect observations is not calculated as low numbers of errors occurred (M = 4.65).

DISCUSSION

This experiment examined the effects of two different types of performance aims, a hard goal and an easy goal, on skater's rate of performance of a roller skating skill. Overall, differences in performance aims did not accelerate the performance of one group over the other, although improvements were seen in both groups over sessions, confirming again that simple practice built rate.

The similarity in results between the two goal-setting groups was unexpected given that previous goal-setting research has found that hard goals led to better performance than easy or no goals (Earley & Lituchy, 1991; Latham & Baldes, 1975; Lee et al., 2003; Locke, 1968; Locke & Bryan, 1966; Locke & Latham, 1990; Seijts, 2001; Smith & Lee, 1992; Strang, Lawrence, & Fowler, 1978; Vancouver, Thompson, & Williams, 2001). As presented earlier, Earley and Lituchy (1991) completed a study where maths tasks were completed under conditions of easy or challenging goals. Their easy goal was set at 2 standard

deviations below the mean performance level of participants who had completed a pilot study, while their hard goal was set 2 standard deviations above this mean. It is likely that the easy goal in the current study, of trying to equal or better your previous session's best, is comparably harder than the easy goal used in Earley and Lituchy's study, which may account for why they found differing results for their two goal groups where no difference was found here.

Strang, Lawrence and Fowler (1978) also separated out goal difficulty from other variables, in a study giving university students mathematical equations to solve. In two of their experimental conditions, participants had to solve equations accurately within a set period of time and were told after each trial if they had achieved this. Those in an easy-goal condition had to perform more quickly than their slowest time recorded during baseline. Participants in the hard-goal condition had to perform better than their mean performance time recorded during baseline. This hard goal appears to be easier than the goal set in the easy-goal condition in the current study, where participants were asked to equal or better their previous session's highest score. Those in the hard-goal group of Strang, Lawrence and Fowler's study did solve equations faster, unlike the present findings where no difference was found between goal groups. Taking both of the above studies into account, a fuller assessment of how difficult both the easy and hard goals were in the current study is worth pursuing.

Earley and Lituchy (1991) found that across their two studies 87% and 89% of the participants respectively achieved at least the easy goal but only 6% and 12% respectively of the participants achieved the difficult goal. It is hard to do a direct comparison for goal difficulty but the current results showed that, in the last session, 3 of the 5 participants (60%) in Group 1 achieved the easy goal and 1 of the 5 (20%) of the participants in Group 2 achieved the hard goal. These data suggest that, even though there were clear differences between levels of goal difficulty, it is possible that the easy goal was still not easy enough as only 60% achieved it. It has been reported by Boyce (1990) and Weinberg, Bruya, Jackson and Garland (1986) that moderate goals are as effective as hard goals. If the 'easy' goal in the current study was moderately difficult rather than 'easy', the findings of this study would support their statements that moderate goals are as effective as hard goals. A future study could address this by having a "do your best" condition as is frequently described in the literature.

Other factors aside from goal difficulty may have impacted on the easy goal group to improve their performance rates. One factor studied previously in the literature is feedback. Locke and Latham (1990) have reported that goals appear to be more effective when there is feedback, or "Knowledge of Results" and that hard goals with no feedback do not result in better performance than other goals. In the current experiment both groups were given feedback following each timed minute. However, Group 1, the easy-goal group, was also told at the beginning of each session what their best score had been in the previous session. This additional feedback may have provided a confound if it influenced skaters in this group to work harder in each session over and above the effects of goal difficulty.

Getz and Rainey (2001) and Latham and Seijts (1999) have shown flexible short term goals are more effective than rigid long term goals. It was not the intention of this study to set a short term goal for one group and a long term goal for the other. However, as the hard-goal group was given the same goal each session, and had been told there would be ten sessions, it is possible this goal was a long term one, i.e., that needed to be completed by the end of the study. In contrast, the easy-goal group was given a new goal each session. Such goals meet the criteria of short-term flexible goals described by Getz and Rainey (2001). However, this analysis would predict that participants in the easy-goal group should have performed better than those in the hard-goal group and this did not occur. Thus, this analysis does not fully account for the present data.

Earley, Connolly and Ekgren (1989) found that easy goals were more effective than hard goals but argued that task complexity influenced the participants' behaviour. Latham and Seijts (1999) agree that as the complexity of a task increases, the magnitude of goal effects decreases. In the current study the task was a simple one in which participants were asked to complete in the same manner repeatedly for a minute each time. Therefore this simple task did not change in complexity and hard goals should have led to better performance.

That the hard goal here was so difficult to achieve is worth further discussion. For 4 out of 5 skaters in Group 2, the difference between their performance and the actual goal of 70 was still large at the completion of the ten sessions. This difference between actual performance and the set goal has been termed goal-performance discrepancy (Donovan & Williams, 2003) or goal-

discrepancy feedback (Vance & Colella, 1990). It is postulated that individuals often set lower personal goals when this discrepancy is large (Locke & Latham, 1990). As already stated, skaters in Group 2 were not asked if they set other goals and there is no other way of finding out if they did. Certainly if they did set lower goals, closer to the easier one set for Group 1, this could account for the similar results in both groups. Consideration should be given for any future studies, to ensuring that the goal set is not so high that there is likely to be a large discrepancy between the goal and actual performance at the end.

Other reports in the literature state that individuals may set personal goals regardless of what goal is assigned to them (Locke, 1991). Even though different types of goals were given to each group, it is not certain that individuals within both groups were not setting alternative goals. For example, it was suggested above that individuals in Group 2, with an assigned goal of 70, may have set easy personal goals for each session. However Group 1, who were asked to improve on their last session's highest score, may also have had individuals who set themselves a harder goal than this, more in line with the goal of Group 2 as has occurred in previous studies (Hall, Weinberg, & Jackson, 1987). It is not clear if skaters set their own additional goals as they were not asked whether they did so. Therefore this should be considered in further research.

In summary, improvements overall were seen from the first to the last session when fluency building methods were used with roller skaters. However, as both experimental groups showed similar improvement in performance, it is not possible to ascertain from these results whether the use of performance aims aided this improvement. Therefore another study, addressing some of the methodological concerns expressed regarding goal difficulty in this study, was needed to confirm the effectiveness of performance aims alone in precision teaching.

EXPERIMENT 3

As reported earlier, Latham and Locke (1979) state individuals simply do not do their best when told to. In the majority of studies reviewed, a specific challenging goal led to better performance than when participants were asked to "do your best". Furthermore, as stated earlier, performance feedback must be given with goals for them to be effective, i.e., if no feedback is given then goals

alone do not result in better performance (Locke & Latham, 1990). Latham and Baldes (1975) collected data on the net weight of 36 logging trucks over a period of 12 months, including an initial 3 months in which logging truck loaders were simply told to "do their best". Logging workers were then assigned the goal of loading trucks up to an average of 94% of the truck's maximum weight limit. They found that introducing this hard goal after the "do your best" condition immediately led to improved performance on the task. This improvement was then maintained over the period of the study. Other studies have also compared the effect of specific goals with a 'do your best' condition (Boyce, 1990; Earley et al., 1989; Locke, 1968; Smith & Lee, 1992; Weinberg, Bruya, Longino, & Jackson, 1988). In most cases the goals led to better performance levels. Given this, it seems sensible to compare the effects of a goal condition with a 'do your best' condition to determine more clearly whether the addition of performance aims leads to improved performance over and above that seen when performance aims are not used.

The first aim of this next study, then, was to confirm that goals, or performance aims, do enhance performance when using fluency building methods. To achieve this, a "do your best" condition was completed, with no feedback provided on rate of performance. It was expected that there would be some improvement during this condition as practice alone is known to result in improvement (Kuhn & Stahl, 2003; Mayfield & Chase, 2002). Therefore this first condition was in effect until performance rates were stable for three sessions, i.e., performance rates were no longer increasing, before a performance aim was then introduced in a second condition. Although precision teachers typically set a performance aim at the rate that a person fluent in that skill could perform, care was taken to ensure that the goal chosen here was hard, yet achievable within the time frame of the study to avoid the confounding effects of goal-performance discrepancy. It was expected that if performance aims were effective, participants would increase their rate of performance following the introduction of the challenging goal. One skill was used for these two conditions.

A second skill was also included. Participants were always told simply to 'do their best' with this skill with the exception of one case which is outlined later. The aim was to monitor the effects of introducing the goal for the first skill on this second skill. In Experiment 1, two skills were used to see if charting

improved performance rates over and above that seen when charting was not used. However, since there were no baseline sessions with both skills uncharted, as charting was introduced from Session 1, it was not possible to conclude that charting one skill had not affected the other skill. In this present experiment, the baseline condition where there were no set goals for either skill was used to overcome this. The aim was to look for any confounds. It was expected that the addition of the goal for a skill would give increased performance rates for that skill only and that the performance rate of the alternative skill would not change.

METHOD

Participants

Eight children (P1-P8) participated who were attending the local beginner classes. None had participated in the previous study. The participants were 7 girls and 1 boy ranging in age from 4 to 10 years, the average age being 7.4. The same procedures were used to inform parents and gain consent as in Experiment 1.

Apparatus

A stopwatch was used to time each 1-min interval.

Procedure

The general procedure used is shown in Figure 10 below. The same two skills, forward crossovers and back scissors, as used in Experiment 1, were used for this experiment. A similar procedure to Experiment 1 was also used, except that the participants did not count or use charts. In Condition 1, the researcher plotted data onto linear graphs after each session but ensured that participants did not see these. When a minimum of six sessions had been completed, and the performances of both skills for a skater were judged visually stable by the researcher, i.e., no improvement in either skill was visible for at least three sessions, Condition 2 started with a goal introduced for one skill. This goal was to aim for 20 more correct repetitions of the skill (rounded to the nearest 5) than they had been performing previously in each minute to a maximum of 65 forward crosses and 90 back scissors. Four of the participants (P5-P8) did not participate long enough for their behaviour to be judged stable and for the goal to be introduced. Of the four participants whose behaviour was judged stable, three (P1,

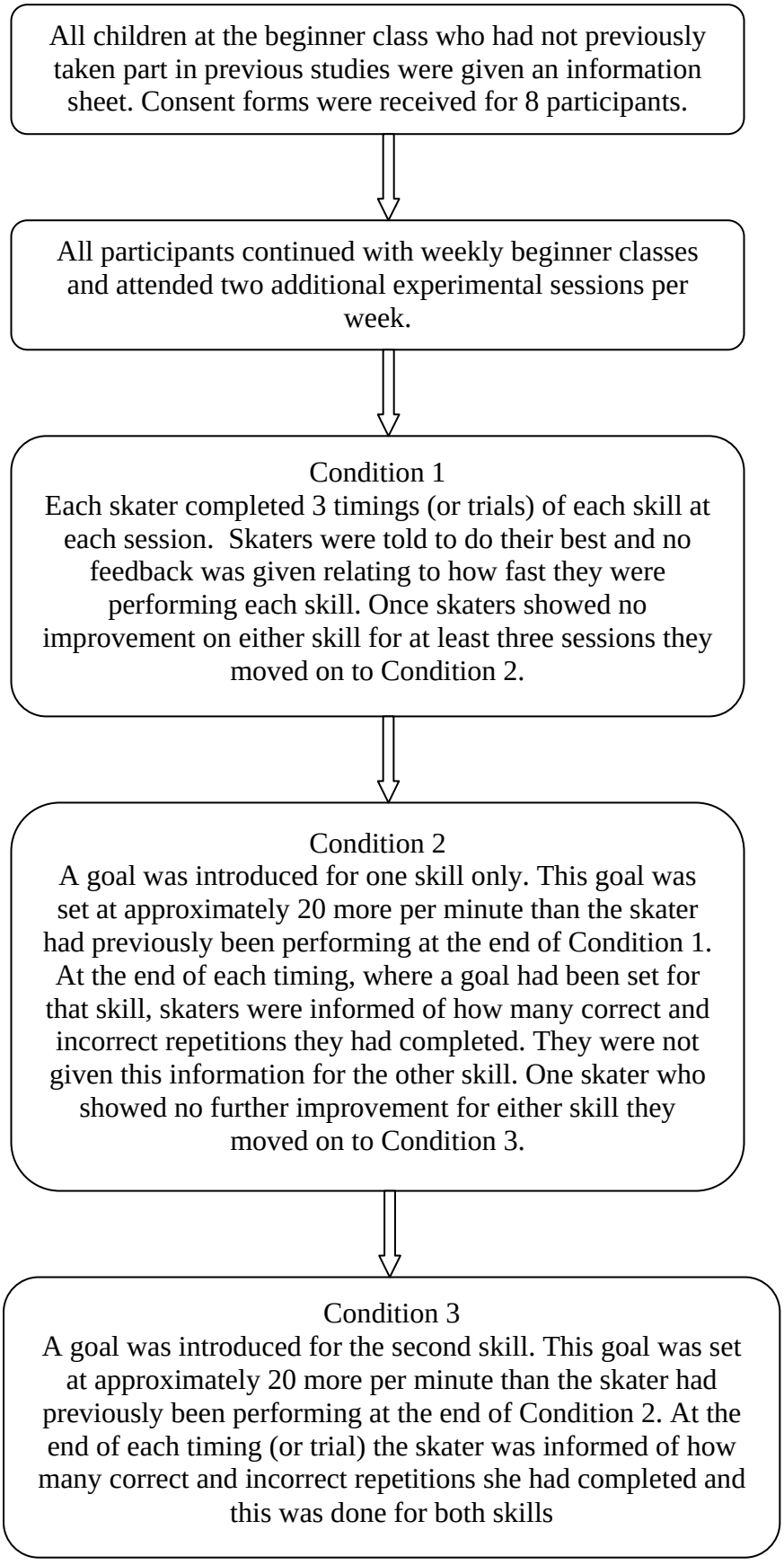

Figure 10. Flow diagram of procedure used in Experiment 3.

P2 and P3) had a goal introduced for forward crosses. Because a fourth participant (P4) was close to the maximum rate for forward crosses, as determined by the set goals above, a goal was set for back scissors for this participant. Once goals were introduced, all participants were told at the end of each timed minute how many correct and incorrect repetitions they had done for that skill only. They were also told the set number of correct repetitions for the targeted skill they were aiming for. One participant, P1, changed skates in Condition 2 but remained in the study long enough to start a third condition where a goal was introduced for the second skill. P2 withdrew after Session 12 and P4 withdrew after Session 13.

RESULTS

Figures 11 and 12 show the number of correct (solid lines) and incorrect (broken lines) back crossfronts completed in a minute for each skater (P1-P4 in Figure 11 and P5-P8 in Figure 12) in Experiment 3. The x-axis represents 1-min timings with three of these in each session. Bold vertical lines indicate changes in condition. A broken vertical line for P1 indicates where this skater changes from roller blades to roller skates. A broken horizontal line shows the goal set for forward crosses. A smaller broken horizontal line shows the goal set for back scissors.

With the exception of two skaters (P5 and P6), all skaters improved their rate of performance on both skills from the first session over Condition 1 where no numerical feedback was given. P5 was the youngest skater and completed only five sessions before she withdrew. During this time she did not show any improvement in rate of either skill although she was performing both of these skills with less hesitation by Session 5. P6 did not show any improvement over the first six sessions and a goal would have been introduced in Session 7, however, it was at this point that P6 started to show an increase in the rate at which she performed her back scissors. She ceased skating after Session 12 before the data could be considered stable. Her forward crosses also showed a slight rate increase in Session 7 but then remained at this level for the rest of her participation in the experiment. As P7 and P8 showed rate improvements across condition 1, goals were not introduced before P7 ceased skating in Session 10 and P8 ceased skating in Session 11.

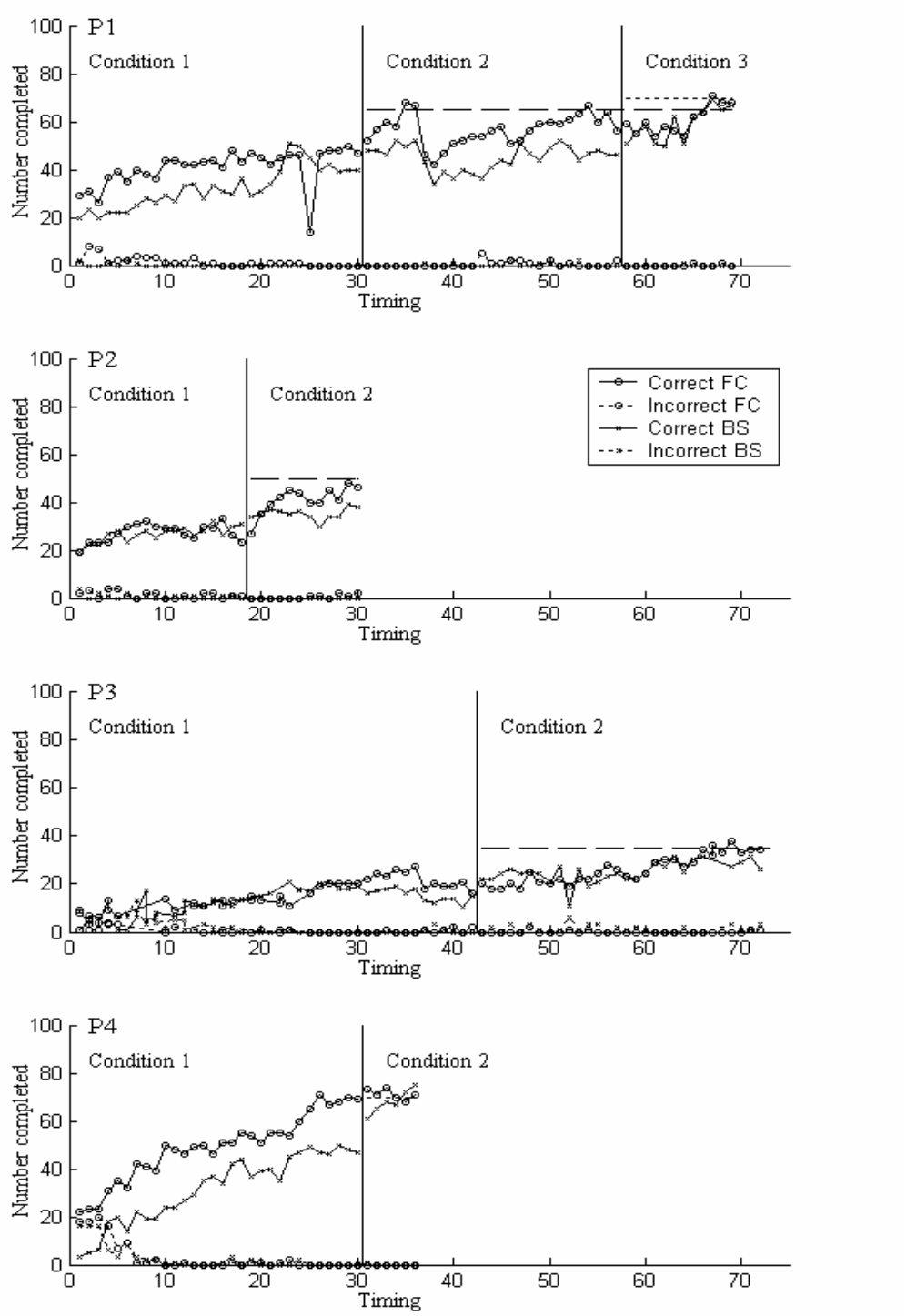

Figure 11. Number of correctly (solid lines) and incorrectly (broken lines) completed forward crosses (circles) and back scissors (crosses) performed in one minute for the first four participants (P1-P4) in Experiment 3 across three conditions (Condition 1: no goal, Condition 2: set goal for one skill only, and Condition 3: set goal for both skills). Only one participant (P1) completed three conditions. Set goals are represented by broken horizontal lines (long dashes for forward cross goals and short dashes for back scissor goals).

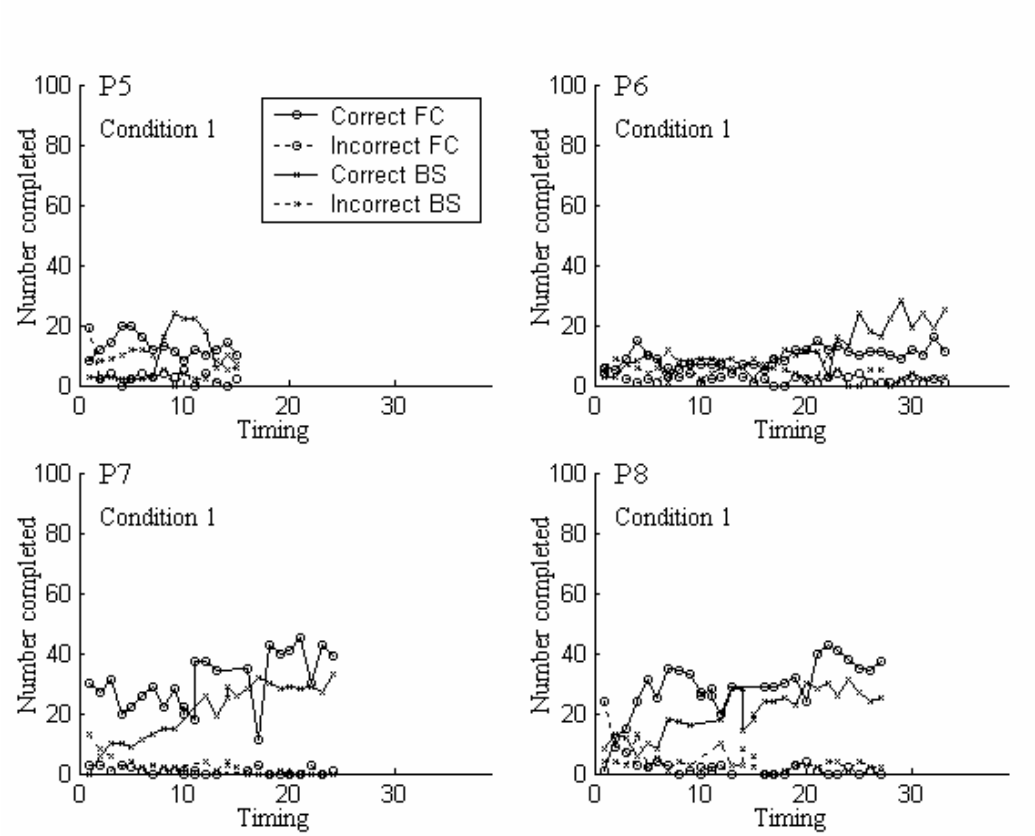

Figure 12. Number of correctly (solid lines) and incorrectly (broken lines) completed forward crosses (circles) and back scissors (crosses) performed in one minute for the second four participants (P5-P8) in Experiment 3 across one condition where no goals were set. There were three timings in each experimental session. Participants did not attend enough sessions to participate in more than the initial condition.

P2 showed a marked increase in rate on forward crosses once a set goal was introduced for this skill in Session 8 and a smaller increase in rate was also seen in the rate of back scissors. This showed that, although her rate of performance was very similar for both skills prior to the change of condition, once the set goal was introduced, she clearly performed forward crosses at a higher rate than backward scissors.

P3 differed from other participants in that, before the set goal was introduced, she herself counted how many repetitions of a skill she did each minute in many instances, although not consistently and not always with both skills. Other participants may have also done this covertly but it was certain with

P3 as she sometimes reported at the end of a minute how many she thought she had done and was usually fairly accurate. When a goal was introduced for forward crosses in Session 15, improvement was initially seen only for her back scissors but this difference disappeared across Condition 2. Eight sessions later she reached her goal of 35 forward crosses. Her rate of performance on back scissors was lower at that time.

P4 showed greater improvement throughout Condition 1, compared to the other skaters, eventually reaching the maximum rate possible for forward crosses as determined in Experiment 1 without any set goals being introduced. Although his rate was still improving for back scissors, it was decided that a set goal would be introduced for this skill in Session 12. An immediate rate increase was seen and he surpassed his goal within two sessions.

P1 was the only participant to complete three conditions. Once a goal was set for forward crosses in Session 11, a marked increase in the rate of forward crosses occurred immediately. The goal was reached within two sessions of the condition change, in Session 12. P1 changed from roller blades to roller skates in Session 13, and a drop was seen in the rate of both skills as a result. However, her rate of forward crosses continued to increase and she reached the set goal again in session 18. When a goal was introduced for back scissors in Session 20, an immediate increase in rate was seen for this skill so that the rate of both skills was now similar.

Lines were fitted to the last 6 timings of Condition 1 and the first 6 timings of Condition 2 using the method of least squares and compared over 4 skaters (P1-P4), to see if there was a significant difference on rate of performance once a goal was introduced for one skill in Condition 2. With alpha set at .05, a significant difference was found for the targeted skill, $t(3) = 4.185$ ($M = 2.450$, $SD = 1.195$), but not found for the untargeted skill, $t(3) = 0.250$ ($M = 0.157$, $SD = 1.254$).

DISCUSSION

Experiment 3 examined the effects of goals, or performance aims, on skater's rate of performance for two roller skating skills. Initially, all skaters showed improvement during a baseline phase where no goals had been introduced. Following the introduction of a goal, there were accelerated performance rates for the targeted skill, and also some smaller improvements for

the untargeted skill for two skaters. Therefore goals did appear to increase the rates of performance of both skills over and above those seen when no goals were used.

Latham and Baldes (1975) found that when a hard goal was given to logging truck drivers, following a baseline condition where they were asked to "do their best", their performance improved immediately, a result similar to that here. In the sporting area, Anderson, Crowell, Doman, and Heward (1988) who, after a baseline condition, introduced feedback then goals with ice-hockey skaters, found that legal body checking rates (hit rate) increased immediately, a finding similar to that in the current experiment. Thus the general results of this study add further support to the large body of literature regarding the effect of goals.

The main procedural change resulting from the introduction of a goal here was the amount and type of feedback being given. The introduction of a goal meant that the skater was given the number of correct and incorrect repetitions of the targeted skill completed in the timed minute. Often, after this, they drew comparisons between their current performance of that skill and the goal. This comparison and feedback occurred only for the targeted skill. However, the results also showed that the introduction of a goal may have impacted on both skills for two skaters. While this change was not as large on the untargeted skill for 1 skater (P2), it was greater for that skill for the other skater (P3). The introduction of a goal for one skill may not have impacted on the untargeted skill for the last skater possibly because he was already performing this skill as at high a rate as he was able. Contrary to the present results, Ward and Carnes (2002) previously found that the introduction of goal-setting with one skill did not affect other skills being monitored. One difference between the two studies which may have led to the differing results is in the nature of the goals used. The participants in Ward and Carnes' study were focused on performing accurately each time they were given an opportunity to perform the targeted skill. In contrast, the participants here were focused not only on performing the skill accurately, but also on performing the skill faster. It is possible that the resulting speed with which participants in this study performed one skill may have carried over to the untargeted skill for some skaters, even in the absence of definitive feedback showing how much faster they were performing it.

Unfortunately the withdrawal of four participants before a goal could be introduced resulted in a reduction of possible comparisons between baseline and goal- setting, leaving only 4 participants where the effects of goal setting could be evaluated. However, it is possible to make some comparisons between the results in Condition 1 here and the results from Experiment 1 as all skaters were selected in a similar way and the same two skills were used in both experiments. Experiment 1 participants completed at least eight sessions, as did six of the eight skaters in the current study (P1, P3, P4, P6, P7 and P8), during the baseline condition where no goals or feedback were given. So, excluding P2 and P5 from the current study leaves one group of six skaters where goals had not been introduced. There are two groups of six skaters from Experiment 1, where goal-setting was used, that could be used for comparison. Although no difference was found in Experiment 1, it was decided to keep the two groups separate and compare them with the baseline group here. This comparison of eight session's data for each skater in these three groups meant that the effect of goal-setting, over and above progress resulting from timed minute practices, could be evaluated.

Slopes were fitted to the data for both forward crosses and back scissors for each participant for the first eight session's data using least squares regression. One-way ANOVAs showed that, with alpha set at .05, there was no significant difference in slope between the three groups for forward crosses, $F(2, 15) = 1.744$, (partial η^2 =.189 and observed power .308), or for back scissors, $F(2, 15) = 0.772$, (partial η^2 =.093 and observed power .157). A box plot showing the average slopes for each group can be found in Appendix G.

The first and last timings were also compared between groups using a repeated measures ANOVA. With alpha set at .05, the interaction of group and timings was not statistically significant for forward crosses, $F(2,15) = 1.556$, (partial η^2 =.172, observed power = .278) or back scissors, $F(2,15) = 0.247$, (partial η^2 =.032, observed power = .082). There were also no significant differences between groups for forward crosses, $F(2,15) = 0.831$, (partial η^2 =.100, observed power = .166), or for back scissors, $F(1,10) = 1.949$, (partial η^2 =.206, observed power = .340). However, a significant difference was found between first and last timings for both forward crosses, $F(1,15) = 81.299$, (partial η^2 =.844) and back scissors, $F(1,15) = 65.280$, (partial η^2 =.813). A box plot

showing the average rates of performance recorded for both skills during the first and last timings for each group can be found in Appendix H. These results show then that the ‘do your best’ group in the current experiment performed as well as the goal-setting groups used in Experiment 1.

One reason that skaters may have progressed so well in the absence of goals is that other components of the rate building method were effective. Precision teaching uses short, timed practice periods. This would fit within the definition of deliberate practice (Ericsson & Charness, 1994). Ericsson and Charness argue that deliberate practice allows individuals to perform at the same level as experts. In essence, this is what precision teaching is aiming to achieve as it encourages students to perform at the same level as a person fluent in that skill. Therefore, it is argued that deliberate practice may be responsible for the increase in performance rates seen in the absence of performance aims.

While no difference was found for the three groups over the first eight sessions, when goals were introduced after behaviour was stable in the ‘do your best’ condition in the current study, goal-setting appeared to lead to increases in performance rates for 2 of the 4 skaters. Accuracy was fairly high at this stage, as seen by low numbers of errors in Figures 8 and 9, and so these changes in performance rate reflect an increase in fluency alone. More interesting, a goal was introduced for P4 even though his performance had continuously increased in the absence of set goals and had not yet stabilized and an immediate increase was seen in his performance rate for this skill. This demonstrates that, even though the fluency building method in general was resulting in increased performance rates similar to those seen in Experiment 1, introducing a goal resulted in even greater increases. It is not clear however, why goals should be more effective following a period of ‘do your best’, as seen here, while not resulting in greater changes earlier, as in Experiment 1. There are no obvious differences between groups of subjects that would mask such a difference.

Participants in the previous experiment were asked to attend only ten sessions and all completed at least eight. In contrast, the current experiment involved stability and required a large number of sessions. Over the course of the experiment all but two of the eight participants withdrew with four of the participants withdrawing prior to a goal being set. It is possible that the number of sessions required alone or the absence of feedback might have contributed to this

loss. During baseline the intervening training given when there were many errors provided some feedback on performance, this feedback reduced as the skill was mastered and errors decreased. As a result, later sessions involved practicing the same two skills over and over again with little feedback. All skaters in this experiment became less willing to participate as the number of sessions grew and feedback decreased. It may be that keeping sessions to a lower number, and providing consistent feedback separate from the performance aim, may help keep participants in the experiment which would overcome this problem in future.

In summary, results showed that the setting of goals with one skill may have impacted positively on a second skill that had no set goals and it is possible that this was due to the goal placing an emphasis on rate of performance. Overall though, the general finding was that the results of this experiment are consistent with other studies that have found goal-setting to be effective, as the introduction of goals did increase performance rates following a period of 'do your best'. However, it was also observed that considerable increases in performance rates were seen in the absence of goals. It is argued that this may have occurred because of the effects of 'deliberate practice'. Therefore the next study was aimed at addressing both of these issues. Two experimental groups engaged in at least 8 sessions of deliberate practice and were compared to a control group that engaged in only two sessions. One of the two experimental groups was also given a hard, specific goal.

EXPERIMENT 4

In the previous experiment it was found that skaters improved their performance rates in the absence of performance aims, or goals. It was argued that this may have occurred because of the short timed periods of practice that were used. As outlined initially, fluency is more than just accuracy. It is a combination of accuracy and speed (Binder, 1987; Le-Grice et al., 1999). Kuhn and Stahl (2003) state that the transition from accuracy to fluency is through extensive practice. However, it is also possible that the type of practice done may affect how soon fluency occurs. Deliberate practice is defined as "an effortful activity motivated by the goal of improving performance. Unlike play, deliberate practice is not inherently motivating; and unlike work, it does not lead to immediate social and monetary rewards." (Ericsson & Charness, 1994, p.738). One of the

components of precision teaching is the use of short timed periods, performing clearly defined simple tasks to bring about fluency. In short, it uses deliberate practice.

It has been recognised that experts are fluent in what they do (Ericcson and Charness, 1994). According to Ericcson and Charness (1994) expert level performance in a domain is created through deliberate practice. They define exceptional performers as those individuals who are performing at least two standard deviations above the mean level in the population. Furthermore, they state that extended training, involving deliberate practice, results in advances occurring in the performance of everyday work and leisure tasks for individuals that cannot be attributed to physiological changes in humans across generations. An example they use is the winning time for the first Olympic Marathon. This time is now achieved by thousands of amateurs each year in order to qualify for the Boston Marathon and can be attributed to the type of training these amateurs do. In this instance, there is a clear goal, i.e., to run faster than the qualifying time, that is likely to be associated with the deliberate practice performed by individuals training for this marathon. The amateur runners however, cannot run as fast as professional athletes who train full time, and whose training methods are continuously refined by professional coaches and trainers. Ericcson and Charness argue that the ability to achieve expert, or fluent, performance is not innate. It is the result of deliberate practice that is motivated by goals to perform better. Therefore it is argued here that, because deliberate practice aims to improve performance, deliberate practice has an inherent “do your best” goal.

Ericsson and Charness (1994) argue that it is generally thought by others that to excel in a given activity, it is necessary to have talent or giftedness in that area, yet they claim that the role of early instruction followed by a sustained high level of training appears to be much more important than innate talent. However, if it is the amount of deliberate practice that leads to elite performance, then factors affecting how much practice is done will affect the success of the individual. For example, Ericcson and Charness (1994) suggest that although talent is not heritable, it might be that motivation is the heritable influence that affects how much practice is done.

Earley and Lituchy (1991) certainly disagree with the suggestion that motivation to practice is heritable. They argue that goals provide individuals with

a sense of task mastery and bolstered efficacy which increases an individual's subsequent aspirations and strengthens their perseverance resulting in an individual engaging in more practice. Goals then, according to Earley and Lituchy, may affect performance more than any supposed heritable motivation. As outlined earlier, Locke, Shaw, Saari, and Latham (1981) and Locke and Latham (2002) have also stated that specific challenging goals lead to higher performance than easy goals, "do your best" goals, or the setting of no goals at all.

While deliberate practice as defined by Ericcson and Charness (1994) has an inherent goal of "do your best", precision teaching sets very specific goals, or performance aims. It is possible that the setting of specific, difficult goals could result in fluency occurring earlier than it would if deliberate practice was used without specific goals or aims. However, there is mixed evidence of the effect of goals and goal difficulty from the previous three experiments here. For example, comparisons of Experiment 1, where goals were used, and the first condition of Experiment 3, where skaters were asked to simply do their best, suggested that goals did not improve performance rates, yet when a specific goal was introduced in Experiment 3, an immediate rise in performance rate was seen.

Peladeau, Forget and Gagne (2003) have suggested that the type of practice engaged in may affect response latency, but not retention and academic achievement, when overlearning has taken place. They report that precision teaching uses timed periods where students are instructed to increase their correct-response rate per minute, referred to by them as paced practice, and that this type of practice may lead to a reduction in response latency. In their study, students who participated in paced practice, using computerized flashcard software, multiplied their initial correct response speed by a factor of 4.0 as compared with a factor of 3.4 for the non-paced group, despite a slightly higher number of trials being completed by the non-paced group. They also reported however that this difference did not result in either higher academic achievement for the paced practice group or better retention of the learnt material.

This next study used a new skill, dribbling a soccer ball, which is a skill that soccer players need. It used novice soccer players to extend the research to another sporting area. The first aim of this experiment was to compare the performance of one group completing ten sessions of deliberate practice with a second group completing only two sessions of deliberate practice, one at the

beginning and one at the end of the study. A group design was used, in preference to the single-subject multiple-baseline design used in the previous experiment, so that a smaller number of sessions was needed, which in turn reduced the likelihood of participants withdrawing. Both groups were novice soccer players from the same soccer club. It was expected that, if deliberate practice does result in faster performance, that the group completing a greater number of sessions would improve more.

The second aim of this experiment was to examine the effect of goals when they were used in tandem with deliberate practice. Therefore a third group was given a goal of improving on their previous best score, i.e., individuals were instructed to engage in paced practice. This goal was determined by results in the previous experiments where firstly it was found that participants differed greatly in what they could achieve within the time frame of the study, and secondly a 'beat your previous best' goal appeared to be equal to a 'hard' goal in terms of observed performance rate improvements. In the previous experiment it appeared that there may have been a possible confound for some participants in the practice only group who became aware of the introduction of a goal for other participants. Therefore, in this study, the third group was comprised of novice soccer players drawn from a local school rather than from the same soccer club. It was expected that, if hard specific goals are effective in increasing performance rates, the group that was set this type of goal would be able to dribble a soccer ball more fluently by the end of the study than the group asked to simply do their best. It was recognized that there was a possible confound as a result of participants being drawn from two differing populations. However, it was expected that, if deliberate practice and an additional hard, specific goal were effective, this third group would outperform the soccer group engaging in only two sessions of deliberate practice. It was also expected that this third group may also perform at least as well as the soccer group who completed ten sessions of deliberate practice only.

METHOD

Participants

Participants were 19 boys and 4 girls aged between 8 and 10, with a mean age 8 yrs 8 mths who were novice soccer players. Participants from Groups 1 and 2 attended the local soccer club. Each group was composed of a team that

practiced and played games together but the selection of participants within each team was random, i.e., they were not selected on ability. Participants from Group 3 attended a local school and were randomly selected. As all participants were children, the same guidelines were used to inform parents and gain consent as had been followed in Experiment 1.

Apparatus

A stopwatch was used to time each 1-min interval. Six red cones approximately 20cm in diameter and 30cm in height were used with a Size 6 standard soccer ball.

Procedure

Soccer is normally played from April to August. This study started three weeks into the soccer season and finished in early July. All children from Groups 1 and 2 played formal soccer games each Saturday and had a formal training session mid-week. The school children in Group 3 played soccer informally. The general procedure used is shown in Figure 55 below. At the first session each player was told that they would be practicing how to dribble a soccer ball between cones. Those in Group 1, who were told to simply do their best, and Group 3, who were set a hard goal of beating their previous highest score, were told that by the end of the study they should be able to do this very well. Participants in Groups 1 and 3 were required to complete two sessions a week. Every session the researcher would outline how to do this skill correctly and then they would be given three opportunities to practice the dribbling skill for 1-min. There were ten sessions of three 1-min practices for participants in Groups 1 and 3. Some participants were unable to attend all ten, but all participants completed at least 8 sessions. Each session took 15-20 minutes to complete.

Participants in Group 2 were required to complete one session of deliberate practice at the beginning of the study, and one session of deliberate practice at the end of the study. They were told at both sessions that the researcher was interested in seeing how fast they could dribble a ball between cones. They were not told at the first session that they would have a follow-up session at the end of the study. This was to ensure that participants in this group were not encouraged by the information to do extra deliberate dribble practice during the study time period.

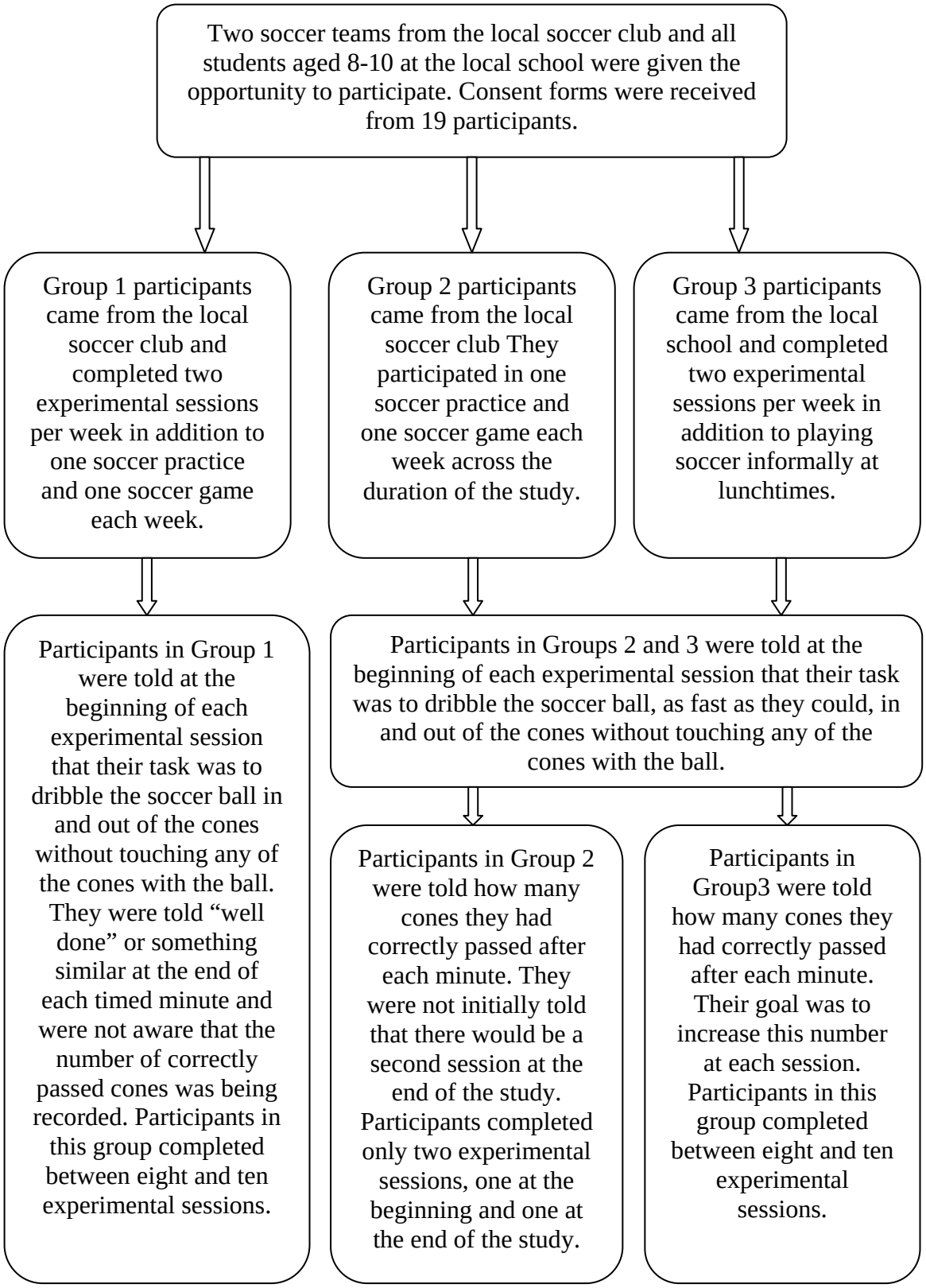

Figure 13. Flow diagram of procedure used in Experiment 4.

The researcher ran all sessions for all three groups. A difference that emerged during the study was that some parents attended these sessions. Five parents regularly attended sessions held for Group 1 and three parents attended both sessions held for Group 2 but no parents were present for Group 3 as sessions were held during school time. At the start of each session six cones were set out in a straight line with 1.5 m between each one. Participants were required to dribble the soccer ball in and out of the cones, circling the end cone and then dribbling in and out of the cones back to their starting point. They repeated this as many times as possible in one minute and completed three of these 1-min timings each session. Each time they passed a cone this was scored as 1 correct. If they missed or touched a cone, this was scored as 1 incorrect.

All sessions involved each participant being reminded that they were trying to dribble the soccer ball between the cones, without touching them. Those participants in Group 1, the do your best group, were told “well done” or something similar at the conclusion of each 1-min interval. Participants in Groups 2 and 3 were asked to dribble the ball as fast as they could and were told at the end of each timed minute how many correct and incorrect repetitions they had done. Each participant in Group 3 was also informed of their goal at the beginning of each session. This goal was to improve on their previous best score.

To obtain a measure of interobserver reliability, the main researcher and two other observers observed eight 1-min intervals simultaneously with each other.

RESULTS

Figure 14 shows the first and eighth sessions’ data for participants in Group 1 and the first and second sessions for participants in Group 2. The eighth session was used in Groups 1, rather than the final session whenever there were more than this, so that the number of sessions between measures was the same for all participants. On each graph the x-axis represents consecutive 1-min timings with three 1-min timings in each of these sessions. A bold vertical line separates the sessions. The first row of graphs shows data for each participant in Group 1 and the last graph shows the average for this group. It can be seen that the numbers of correctly passed cones for the three timings in the eighth session were higher than those in the first session for four of the seven participants (P3, P5, P6

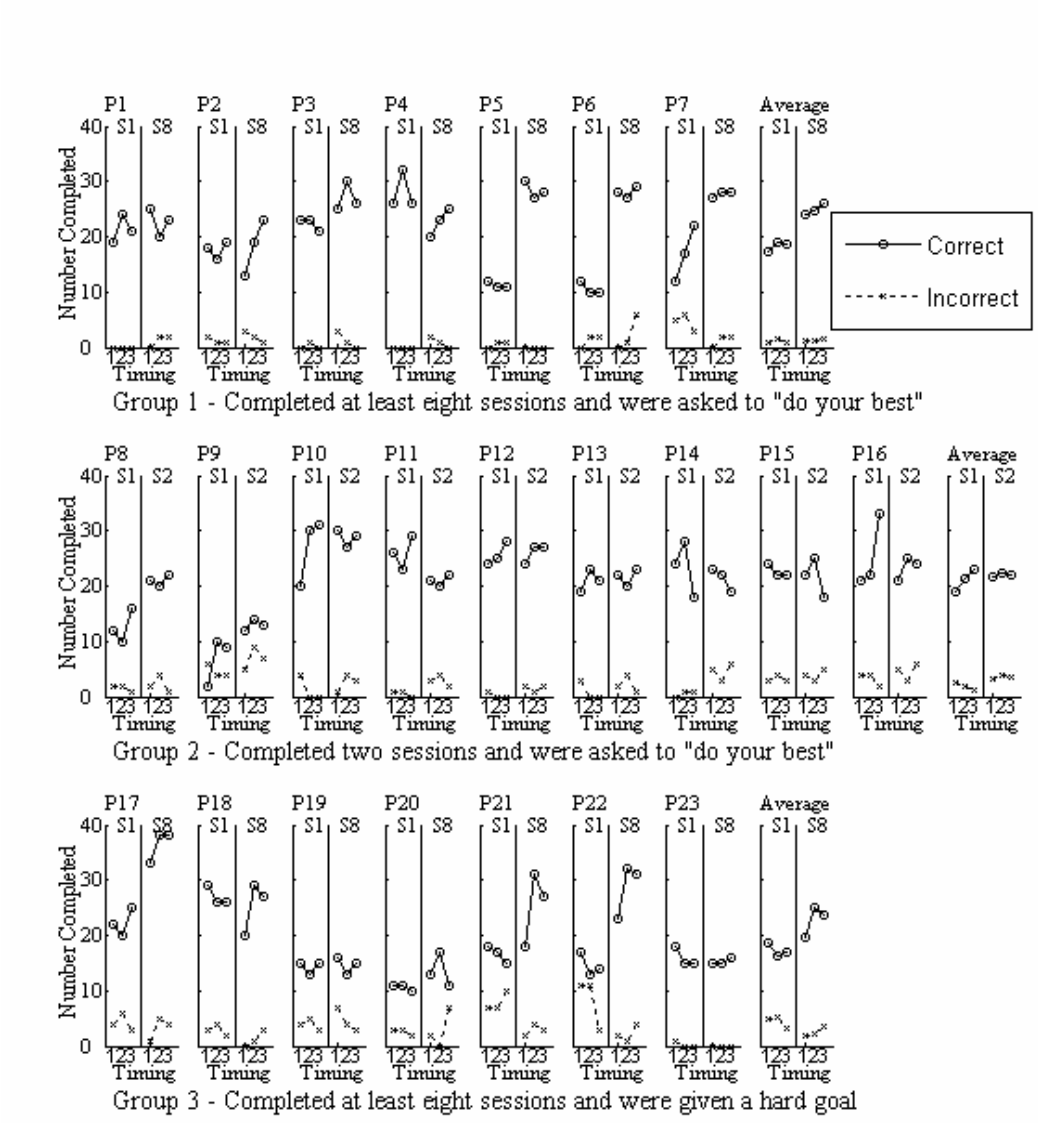

Figure 14. Number of correctly passed (circles) and incorrectly passed (crosses) cones completed in a minute for timings in the first and eighth sessions for Groups 1 and 3, and in both completed sessions for Group 2. There were three timings in each session.

and P7) and lower for one participant (P4). The average number of cones passed correctly in each timing by participants in Group 1 was 18 (M = 18.238, SD = 3.690) in the first session and 25 (M = 25.095, SD = 3.690) for the last session. The average number of cones passed incorrectly in each timing was 1 (M = 1.429, SD = 1.548) in the first session and 1 (M = 1.095, SD = 1.013) for the last session.

The second row of graphs shows data for participants in Group 2, who completed two sessions only of deliberate practice, with the last graph showing the average for this group. Two of the nine participants (P8 and P9) passed more cones correctly in the second session as compared to the first session. One participant (P11) passed fewer cones correctly in the second session. The average number of cones passed correctly in each timing by participants in Group 2 was 20 (M = 20.481, SD = 4.187) in the first session and 22 (M = 22.148, SD = 3.724) for the last session. The average number of cones passed incorrectly in each timing was 2 (M = 2.407, SD = 0.878) in the first session and 3 (M = 2.926, SD = 0.846) for the last session.

A repeated measure ANOVA for unequal group size compared the average number completed in Session 1 with the average number completed in Session 8 for participants in Group 1 and the average number completed in Session 1 with the average number completed in Session 2 for participants in Group 2. The average of each session was used for each participant as there were large variations within sessions for some participants. It was found that, with alpha set at .05, there was a significant difference in number of cones passed correctly from the first to last timing ($F(1, 31) = 10.900$), no significance between groups ($F(1, 31) = 0.772$), but a significant interaction effect ($F(1, 31) = 4.660$). The significant interaction makes the ANOVA results harder to interpret. However, further t-tests found that Group 1 ($t(6) = 3.023$) showed a significant difference from the first to last session while Group 2 ($t(8) = 1.272$) did not, thus showing that Group 1 did perform better over the study than Group 2.

For comparison, Group 3 data are also shown in the third row of Figure 14. The data shown are for the first and eighth sessions for participants in Group 3 with the last graph showing the average for this group. Again the eighth session was used so that the number of sessions between measures was the same for all participants. Four of the seven participants (P17, P20, P21 and P22) passed more cones correctly in the eighth session than in the first session. The average number

of cones passed correctly in each timing by participants in Group 3 was 16 (M = 16.333, SD = 3.517) in the first session and 18 (M = 18.190, SD = 2.588) for the last session. The average number of cones passed incorrectly in each timing was 5 (M = 4.667, SD = 1.515) in the first session and 2 (M = 2.333, SD = 0.861) for the last session. A repeated measure ANOVA for unequal group size compared the average number completed in Session 1 for each participant with the average number completed in Session 8 for participants in Groups 1 and 3 and Session 2 for participants in Group 2. It was found that, with alpha set at .05, there was a significant difference in number of cones passed correctly from the first to last timing ($F(1, 45) = 7.580$) but no significance between groups ($F(2, 45) = 0.140$) and no significant interaction effect ($F(2, 45) = 0.800$). A further t-test found that Group 3 (t (6) = 1.694) did not show a statistically significant difference in performance rate from first to last session. Taken together, the data for all three groups indicates that while more improvement occurred for Group 1 than occurred for Group 2, the group completing only two sessions of deliberate practice, similar improvements were seen for Group 2 and Group 3. A box plot showing the average rates of performance recorded during the first and last timings for each group can be found in Appendix I.

It was possible to make further comparisons between Groups 1 and 3, similar to those made in the previous three experiments. Figure 15 shows the number of cones each of the 7 participants in Group 1 dribbled a soccer ball past, either correctly (circles) or incorrectly (crosses), and the average for this group. The x-axis represents consecutive 1-min timings with three 1-min timings in each session. The y-axis represents number completed per minute. Five of the 7 participants in Group 1 (P1, P3, P5, P6 and P7) increased the number of cones they passed correctly across sessions. One participant (P4) decreased the number of cones passed correctly across time. All participants kept their errors in each minute to between 0 and 8 throughout the experiment.

Figure 16 shows the number of cones each of the 7 participants in Group 3 dribbled a soccer ball past plotted on graphs similar to those in Figure 15. Three of the 7 participants in Group 3 (P17, P21 and P22) increased the number of cones they correctly passed across sessions. The remaining 4 participants did not improve their number correct over sessions. Participant’s errors per minute ranged from 0 to 18, higher than those seen in Group1.

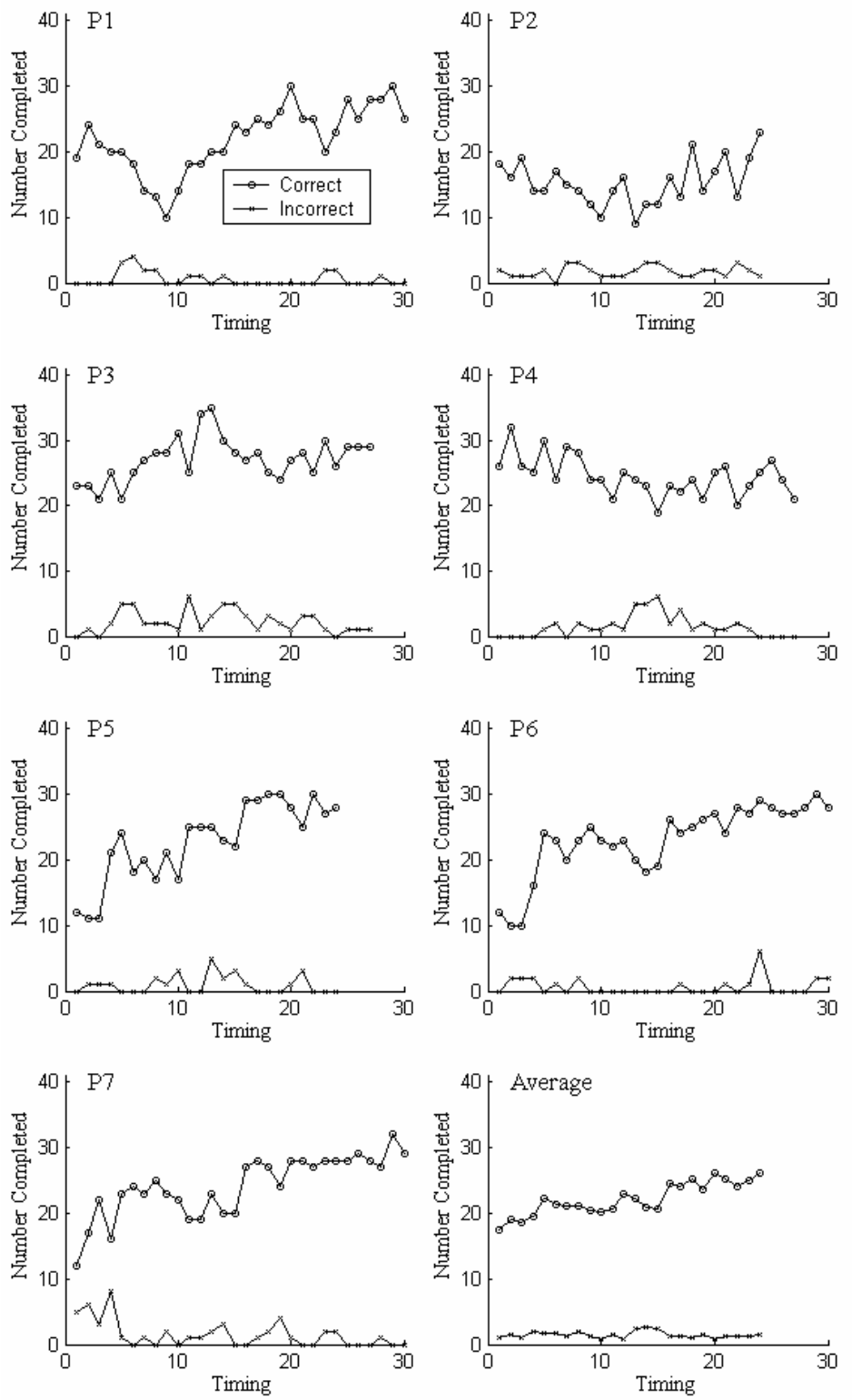

Figure 15. The number of correctly passed (circles) and incorrectly passed (crosses) cones completed in each minute across timings for Group 1, the do your best group. Three timings were completed in each session.

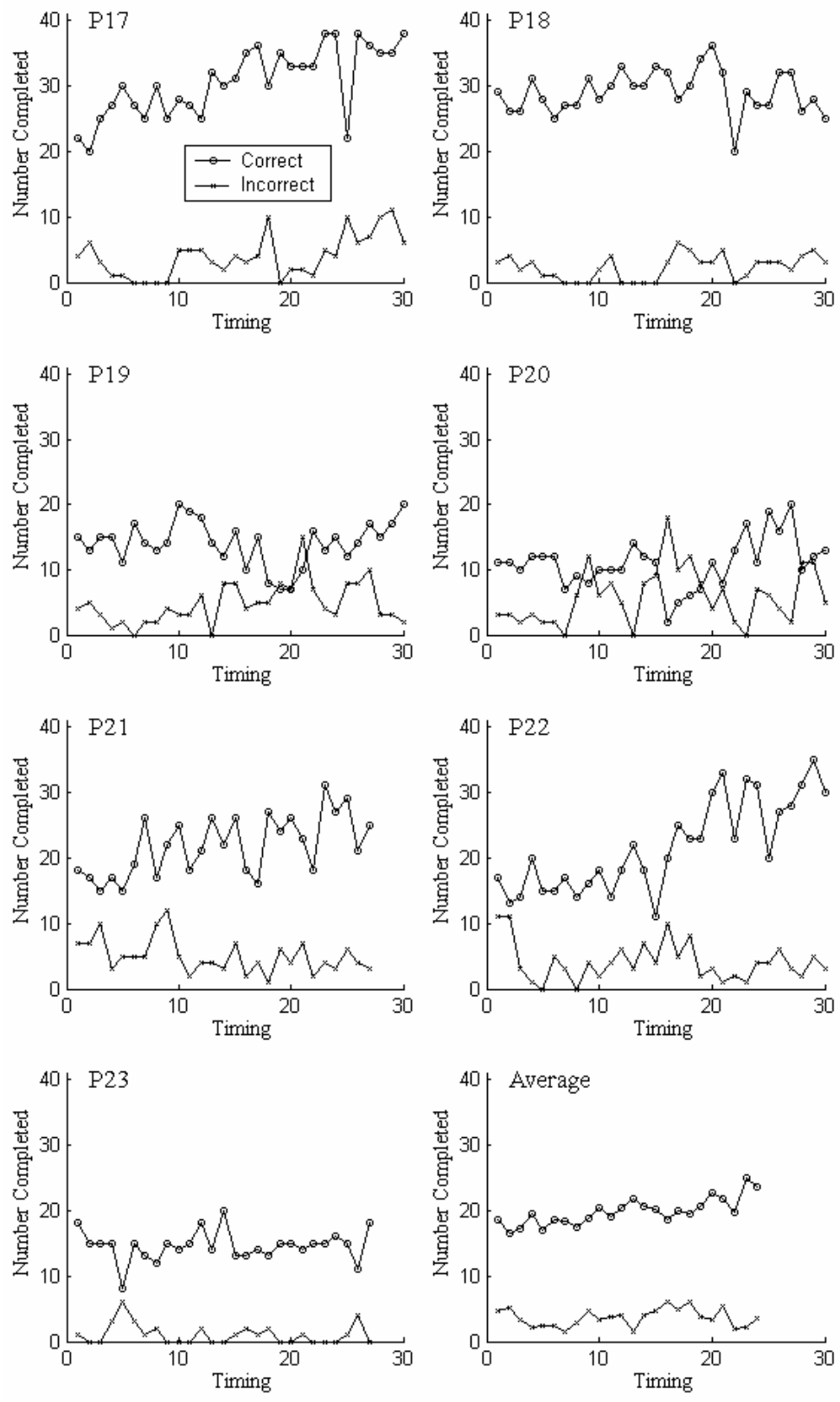

Figure 16. The number of correctly passed (circles) and incorrectly passed (crosses) cones completed in each minute across timings for Group 3, the hard goal group. Three timings were completed in each session.

Lines were fitted to the data in Figures 15 and 16 by the method of least squares to estimate the rate of change over timings. Table 5 shows the resulting slopes and intercepts for each participant and the average for each group. In terms of slope, a small difference between the average of Group 1 (M = 0.303) and Group 3 (M = 0.229) can be seen. The average intercept of Group 1 (M = 18.352) was higher than that of Group 3 (M = 16.947). However, with alpha set at .05, one-way ANOVAs determined that there was no significant difference between Groups 1 and 3 for either slope ($F(1, 13) = .258$) or intercept ($F(1, 13) = 0.178$). A box plot showing the average slopes for Groups 1 and 3 can be found in Appendix J.

Table 5. Slopes and Intercepts for each participant in Group 1 (do your best) and Group 3 (beat your previous high score) and the average for each group.

Participant	Group	Intercept	Slope
P1	1	15.858	0.392
P2	1	13.953	0.110
P3	1	24.732	0.167
P4	1	27.088	-0.186
P5	1	13.909	0.714
P6	1	15.329	0.499
P7	1	17.593	0.426
Average	1	18.352	0.303
P8	3	23.616	0.453
P9	3	28.832	0.015
P10	3	14.108	-0.003
P11	3	8.777	0.141
P12	3	17.114	0.336
P13	3	11.860	0.639
P14	3	14.319	0.020
Average	3	16.947	0.229

Interobserver reliability was determined by finding the mean percentage agreement between observers. The following formula was used to find each percentage agreement:

$$\frac{\text{Smallest number observed}}{\text{Largest number observed}} \times 100$$

Percentage agreement was not calculated for incorrect observations as errors occurred in low numbers across observations therefore any discrepancy in observations between observers would result in a low percentage agreement value. In all cases of correct observations, interobserver reliability is high, ranging from 92.3% to 100%, with a mean of 97.3% and a standard deviation of 3.13.

In summary, Group 1, who were asked to simply do their best, showed significant progress over time while Group 2, who completed only two sessions of deliberate practice, did not. Group 3, who were set hard goals, did not perform as well as Group 1. Further, Group 3 performed only slightly better than Group 2. Neither Group 2 nor Group 3 showed a statistically significant improvement.

DISCUSSION

This experiment had two aims. The first was to examine the effects of 1-min timings, a form of deliberate practice, on performance rates for a soccer dribbling skill. It was found that a group that completed at least eight sessions of 1-min timings, where participants were asked to simply do their best, improved their performances over sessions and outperformed a control group who completed only two sessions of 1-min timings. The second aim of this experiment was to examine the effect of goal setting when used with 1-min timings and it was found that 1-min timings combined with the goal-setting used here had less effect than 1-min timings alone.

The first of these findings, that over the time frame of the study greater numbers of 1-min timings, a form of deliberate practice, alone did lead to more fluent performance, supports the claim, as suggested by Ericcson and Charness (1994), that expert level performance, or fluency, is a result of deliberate practice. Both Groups 1 and 2 were involved in general soccer games and practice across the soccer season, but only Group 1, who completed more 1-min timings, showed increased performance rates by the end of the study, even though participants in both groups would have used the skill of dribbling a soccer ball throughout the season. Therefore this finding supports the idea that the component of short, focused timings, or deliberate practice, used in precision teaching is effective. As was outlined at the start of this research, several authors (Binder, 1996; Binder et al., 1990; Lindsley, 1996) within the area of precision teaching have found that

students reach higher levels of performance by keeping to short, timed periods and the results here add further support to this.

In terms of Group 3, the hard goal group, the results were unexpected both because, like Group 1, this group completed at least eight sessions of 1-min timings and because there is a large amount of literature which exists suggesting that hard goals lead to improved performance. However, it is possible that the findings here support what Peladeau, Forget and Gagne (2003) have reported previously. In their study they found that instruction to focus on response rate was followed by a decrease in accuracy. Therefore, the effects of setting a hard goal here may have been moderated by the effects of paced practice.

One other hypothesis that may account for Group 1 outperforming Group 3, the hard goal group, from first to last sessions is that of Weinberg (2002). He suggests that results in sport settings may differ from results in other goal setting studies because often athletes are different in their 'motivations'. Donovan and Williams (2003) agree with them. They suggest that the results obtained in their study using University track and field athletes may have been greater than would be seen in other populations because these individuals were highly 'self-motivated' and 'intrinsically interested' in the task they were completing. This may have been a factor influencing the results in this experiment as Groups 1 and 2 came from a soccer club, while Group 3, the hard goal group came from the local primary school and did not typically engage in soccer games. Therefore Weinberg (2002) and Donavon and Williams (2003) would predict that the participants from the local school may not have been as motivated to improve their soccer skills. While Group 3, the hard goal group, was deliberately chosen from another population to avoid participants from Group 1, who were asked to their best, from being exposed to goal-setting, this also made the present comparison difficult. Future research should ensure that all participants come from similar sporting populations.

Locke (1991) suggests that if correct procedures are carried out in goal-setting studies, within the realm of exercise and sport psychology, then results showing the effectiveness of goal-setting will be found. Conversely, methodological flaws can lead to disappointing results (Locke, 1991; Weinberg, 2002). One fundamental flaw in goal-setting studies outlined by Locke (1991) and Boyce et al. (2001) pertains to goal difficulty. Failure to set specific goals at an

appropriate level of difficulty can affect performance gains. In the current experiment, participants were asked to beat their previous highest score, a goal which meets the criteria set by Boyce et al. (2001) of a specific, numerical goal. This type of goal is also considered to be a fairly difficult one in the literature, and so the level of goal difficulty should not have been a contributing factor to the unexpected results in this study.

Spontaneous goal-setting is another methodological flaw that can affect results. Locke (1991) and Boyce et al. (2001) report that unless participants are specifically prevented from setting their own goals, sporting individuals in particular are likely to set goals spontaneously in "no-goal" or "do your best" conditions, as was used in the current experiment. Attempts were made to control for spontaneous goal setting, in terms of increasing rate, by not providing participants in the do your best group with numerical feedback on how many correct repetitions of the skill they had done. However, as the number of errors was low for this group, it was possible that participants set goals to decrease or eliminate their errors, inadvertently improving on their performance, and anecdotally some participants did refer to the number of errors that they had made in a timed minute rather than the number of cones they had passed correctly. Likewise, Brett and VandeWalle (1999) also found that, even in the context of an external goal, individuals chose their own goals which differed from those of the training program. Therefore, spontaneous goal-setting cannot be ruled out in the current experiment for either of the experimental groups and this confound may have contributed to the unexpected results obtained here.

Differences in the amounts of soccer play engaged in each week were also considered as a possible confound. Groups 1 and 2 attended other soccer practices each week and played in soccer matches while Group 3 did not. The lack of improvement seen in Group 2 indicated that engaging in general soccer practice and soccer matches did not impact on the fluency of the skill targeted in this experiment as the performance rates did not increase. Hence it seems likely that differences between Groups 1 and 3, in terms of improvement from the first to last session, were attributable to factors other than additional soccer play.

Another factor that may have influenced results is that proposed by Weinberg (2002) who suggests that there is strong evidence in the psychological literature that social support influences the motivation and persistence of

individuals and that social support can play a crucial role in helping individuals to achieve their goals. Social support provides additional opportunities for social reinforcement which may change behaviour. In the current experiment 5 of the 7 participants in Group 1, who were asked to simply do their best, had parents attending their sessions. These were also the same five participants who made the most progress over time in that group. Three participants in Group 2 had parents attending both their sessions but these participants did not appear to perform better than the other participants in the same group. However, there were only two sessions for this group and so this may not have been enough to show any effects of the presence of parents. No participants in Group 3, who were given a hard goal, had parents attending as the sessions were run at school during lunchtimes. Overall then, it is possible that social support was an influencing factor which should be considered in future studies.

Where participants had increased the number of correct executions per min across the study, this progress flattened out at around 35 correct executions per min (see Figures 11 and 12). Observations made by the researcher were that once participants were nearing 30 correct repetitions, they generally demonstrated good co-ordination of their feet and control of the ball. The researcher also observed that more overall control of the ball was shown in Group 1, who were asked to simply do their best. This is likely to have been the result of participants focusing on the reduction of errors. As explained earlier, participants were not instructed to count but because errors were few, and they were focusing on performing the skill well for the duration of each minute, it was possible for them to keep track of how many errors they had done. Certainly, three of the participants in this group commented at least once during the experiment when they managed to complete a minute without touching any cones. In contrast, the participants in Group 3, who were given a hard goal, regularly counted for themselves how many cones they passed including ones that had not been passed correctly. Furthermore, instructions given by the researcher to the group on how the skill was to be done correctly often did not appear to affect the manner in which the skill was practiced in the next minute. The only clear exception to this was P23 who regularly reported how many errors she had made at the end of each minute. Overall, her numbers of errors per minute were smaller than for the other participants in her group and similar to those seen for Group 1.

In summary, participants who were given a hard goal did not perform as well as those participants asked to simply do their best who completed the same number of sessions. Further, there were no statistically significant differences between the hard goal group and the group who completed only two sessions of 1-min timings who were told to do their best. These results suggest that, in this instance, goal-setting combined with 1-min timings, a form of deliberate practice, did not result in faster performance while sessions of 1-min timings alone did. It is possible, however, that confounding factors such as spontaneous goal-setting and social support may have contributed to the results and thus further research was needed which deliberately considered these factors.

This next experiment involved a group design, using roller skaters, with two experimental groups and a control group. However, this time all participants were involved in similar related sporting activity each week and each participant was asked what personal goals, if any, they set during the study. Participants were moved away from other skaters and parents during sessions and parents were not informed of the participant's progress until after the final session. Roller skating was targeted so that one of the skills used in two of the previous experiments could be used and methodological concerns raised earlier could be addressed.

EXPERIMENT 5

As previously mentioned, Locke (1991) says that the core finding in the goal setting literature is that hard specific goals lead to better performance. However, the previous four experiments did not find that such goals accelerated performance rates, over and above those seen when goals were not used, with fluency building methods. There were some methodological problems raised with the previous experiments which might account for this discrepancy. In addition there are a range of other methodological problems that need to be considered when designing research in this area. Therefore it was decided to design an experiment that took account of all known methodological problems.

Locke (1991) has outlined three major flaws that often occur with goal-setting research in sports. The first of these is failure to eliminate spontaneous goal-setting in any 'do your best' conditions. Locke (1991; 1994) has suggested that spontaneous goal-setting can be avoided by not giving feedback to participants or by varying the feedback so that current performances cannot

accurately be compared with past performances. Efforts were made to try to reduce feedback in the previous experiment with the 'do your best' group for this reason. However, as suggested earlier, it was possible that the task itself, i.e., correctly dribbling a soccer ball past cones, gave participants clear feedback, at least on errors. This in turn may have led to participants setting their own spontaneous goals to reduce errors. This next experiment then tried to eliminate spontaneous goal-setting by asking the participants in a practice-only group to count 1 then 2 repetitively while they did the timed practices so that they would not spontaneously count either errors or corrects. A second experimental group that used deliberate practice and goals was also asked to do this to ensure that the repetitive counting itself did not give one experimental group an advantage or disadvantage over the other.

A second major methodological issue outlined by Locke (1991) is the need to assess whether or not participants have set personal goals. Locke argues that personal goals may have more influence than experimenter set goals so that when participants are classified according to their personal goals, i.e., whether individuals set themselves an easy or hard personal goal rather than by their membership to a particular experimental group, the subsequent results will show that hard goals lead to better performance. That is, he argues that many experiments do not manage to manipulate goals as planned. Locke suggests that post hoc analyses of personally set goals can help clarify findings. Therefore, this next experiment also assessed the personal goals, if any, each participant set. In order to reduce the likelihood that this assessment would prompt personal goal setting, participants were asked questions relating to personal goals at the conclusion of their final session.

The third major methodological issue outlined by Locke (1991) is the need to set goals that are specific and at an appropriate level of difficulty. As in the last experiment, care was taken in this next experiment to ensure that the hard goal set for the goal group was specific and at a level that was achievable for participants but not easily so.

The design of this next study then, attempted to take account of the main methodological issues that can raise problems in sporting studies as outlined by Locke (1991). Locke (1991) has also outlined other methodological issues that may have impact on the results of goal-setting studies within the sporting field,

although Locke considers them as less important than those identified above. One of these is participant commitment. He argues that it is necessary to make sure that all participants are committed to achieving the experimenter set goal as otherwise the performance of those not committed to that goal may differ from the performance of those who are. As previously discussed, this may have been a confound in the previous experiment as one group were children who did not engage in competitive soccer games, and so this group in general may not have been as committed as the soccer players to improving their skill level. However, membership and regular attendance at a club involving training in targeted skills may be one indication of commitment. Therefore, in the current experiment, participants who belonged to a roller skating club and who all were engaging in similar skating activities each week were used.

Another factor suggested by Locke (1991) is the need for all experimental groups to start from similar baseline levels in the skill under study. There were no statistical differences in initial performance rates in the previous experiments so these experiments met Locke's suggestion. In the current experiment care was taken to make sure that there were similar ranges of starting abilities in each group.

A further problem that can occur as a result of competition, as reported by Locke (1991), is that participants may set personal goals based on what another participant is achieving. It was noted that in Experiments 1-4, because participants attended sessions together, that there was some competition between participants. That is, they were interested in the achievements of others and may have tried to modify their own performance as a result. This was controlled for in the current study by giving each individual in the goal setting group the same goal and insuring that participants heard only their own feedback, and not that of other participants.

As explained earlier, participants in the previous experiment were not randomly assigned across all three groups and so there had been the potential for other factors to have an impact on the results. This was overcome in this next experiment by ensuring that all three groups came from the same population. The impact of parental attendance at sessions was also avoided, as much as was practicably possible, by ensuring that parents were not involved at all in

experimental sessions and were not provided with feedback from the experimenter on the progress of their child.

In Experiment 3 results showed that introducing a goal with one skill may have impacted on a second untargeted skill for some skaters. Therefore, for clarity, only one skill was used for this study and forward crosses, a skill that had been used in two previous experiments, was selected. Given the earlier use of forward crosses with skaters of similar skating abilities, it was possible to determine accurately the performance levels that could be achieved by beginning skaters. This allowed the same difficult, but achievable, goal to be given to each participant in the group engaging in 1-min timings, or deliberate practice, with a set goal. Their collective performances could then be compared with a group which engaged in 1-min timings only, to see if results similar to those of Experiment 4 were found.

In Experiment 4, a group that engaged in 1-min timings for only two sessions, at the beginning and end of the study, did not improve at all. It was decided to see if this result would be replicated in the current experiment by having a third group which also completed three sessions of 1-min timings, with the last two eight weeks apart, and with no 1-min timings in between. The first two groups completed seven more sessions of 1-min timings, or deliberate practice, than did this group. This allowed any changes in performance, directly attributable to the additional 1-min timings to be assessed. In this experiment all three groups started with one session of 1-min timings five weeks prior to the start of their experimental condition. This was included to obtain a measure of how much each participant generally improved over this time with only club activities in the absence of any 1-min timings or goal-setting.

Given the reports in the goal setting literature, it was expected that if previous results were confounded by methodological problems, then in the current study, where these problems were controlled for, it would be found that those participants given a hard goal and 1-min timings, a form of deliberate practice, would outperform those engaging in the same number of 1-min timings in the absence of goals. Furthermore, it was expected that the two experimental groups who engaged in more sessions of 1-min timings would outperform the third group that engaged in only three sessions of 1-min timings across the period of the

study. A summary of methodological issues controlled for in this experiment are listed in Table 6 below.

Table 6. Summary of methodological issues controlled for in Experiment 5.

Methodological Issue	Previous experiment(s) where this may have occurred	Approach used in Experiment 5 to control for issue
Failure to eliminate spontaneous goal-setting	Experiments 1-4	Participants asked to count 1, 2 repetitively out loud
Participants may set personal goals	Experiments 1-4	Participants asked at conclusion of study what goals, if any, they set
Failure to set a goal at an appropriate level of difficulty	Experiment 1	Goal set on what had been achieved in similar earlier experiments
Different levels of commitment may exist between participants	Experiment 4	Participants come from same population
Participants may start at different baseline levels		Similar ranges of starting abilities in each group
Participants may compete against other participants	Experiments 1-4	Skaters in the goal-setting group had the same goal and only heard their own feedback
Parents may influence participants	Experiment 4	Parents were not involved in sessions or given feedback on their child's performance
Changes implemented for one skill may impact on a second skill	Experiments 1 and 3	Only one skill was used

METHOD

Participants

Eighteen children (P1-P18) from four beginner roller-skating classes participated. These classes were run by four roller skating clubs that followed

similar coaching programmes for beginner skaters through to competitive skaters. None of the skaters in this experiment had participated in the previous experiments. The 6 participants in Group 1 (P1-P6) were 5 girls and 1 boy from one skating club who were aged between 7 and 11 years at the start of the study with an average age of 8.7 years. The participants in Group 2 (P7-P12) were 4 girls and 2 boys from a second skating club who were aged between 8 and 12 years with an average age of 9.2 years. Group 3 (P13-P18) was comprised of skaters from two skating clubs and contained 6 girls aged between 7 and 12 years with an average age of 9.0 years at the start of the study.

Apparatus

A stopwatch was used to time each minute. Some of the skating sessions were also recorded on video using a Sony Handycam Vision camcorder.

Procedure

Forward crosses, as defined in Experiment 1, were the targeted skill for this experiment. All skaters attending local beginner classes in the four skating clubs involved were given an information sheet and consent form similar to that used in Experiment 1. The general procedure used is shown in Figure 17 below. At the beginning of the study, all skaters were told that the researcher was interested in seeing how well they could perform the skill of forward crosses. At the start of every session the researcher made sure that each participant could perform a correct forward cross before they completed three 1-min timings. If skaters had a high number of errors in any timed minute, they were given further instruction on how to do the skill correctly before the next timed minute. Initially each skater completed two of these sessions, five weeks apart. The researcher recorded the number of correct and incorrect forward crosses completed by each skater but did not share this information with any of the skaters. Following the second session, performance rates were compared for skaters to ensure that the rates were similar across potential groups. Once this had been confirmed, skaters from one of the four clubs became Group 1, a group which engaged in sessions of 1-min timings and who were given a hard goal, and skaters from a second club became Group 2 who completed the same number of sessions as Group 1 but were

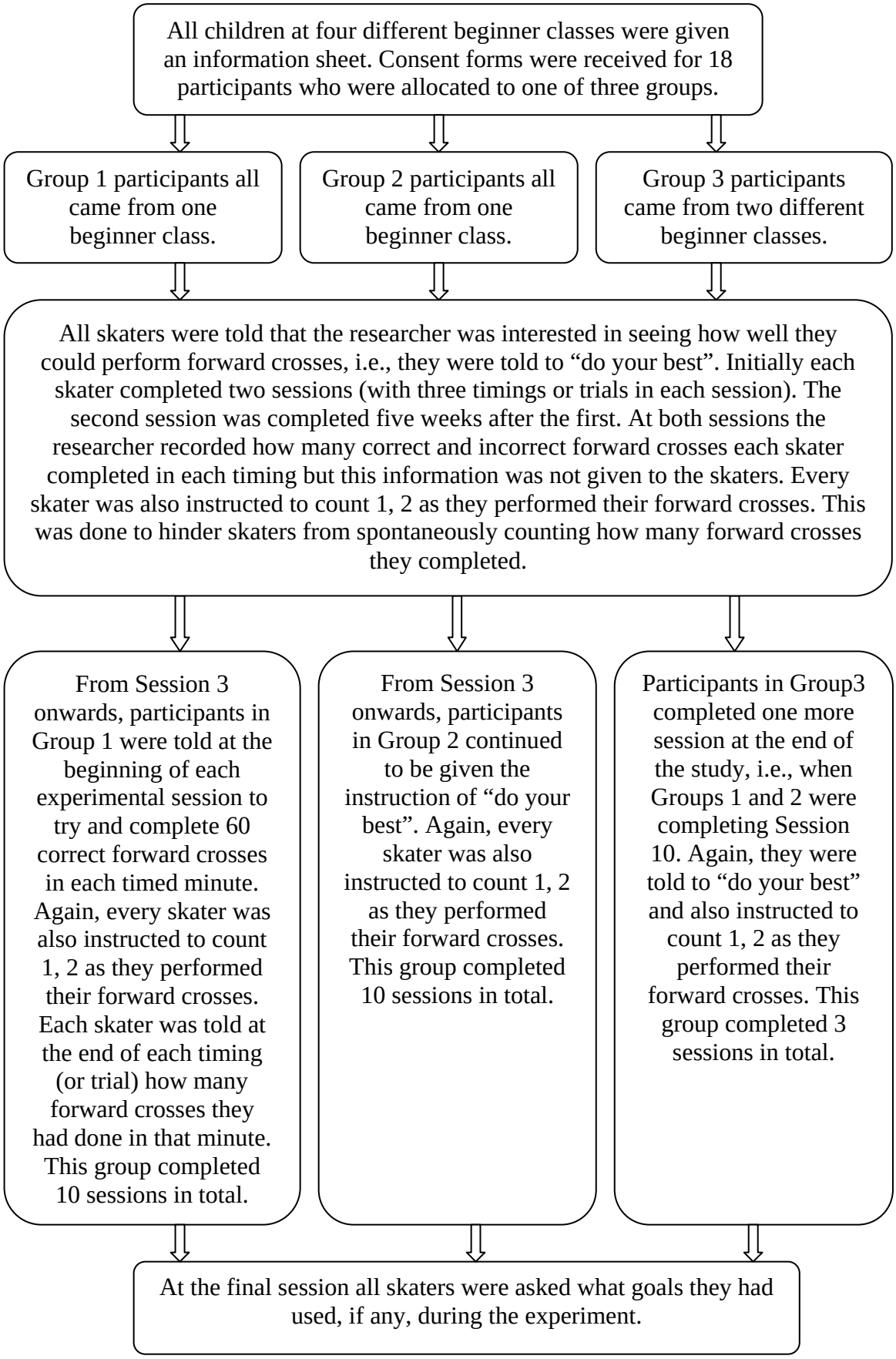

Figure 17. Flow diagram of procedure used in Experiment 5.

simply instructed to do their best. These two groups then completed eight more sessions.

At the beginning of Session 3 skaters in Groups 1 and 2 were told that they would be practising forward crosses and should be able to perform them more easily by the end of the experiment. At each following session the participants in these groups practiced the skill of forward crosses for three 1-min durations, during which they were asked to count 1,2,1,2 repetitively with each foot placement as they practiced. This was to minimise the likelihood of them counting either corrects or errors covertly during each practice minute. Group 1, the hard goal group, was informed at the beginning of each session that they were aiming to complete 60 forward crosses in a minute. They were also informed at the end of each 1-min practice how many correct forward crosses they had completed. Group 2 was instructed simply to do their best.

The remaining skaters in the other two clubs became Group 3 and completed one more session, similar to the two they had already completed, in the same week that the first two groups completed their final session. Each skater was asked at the final session what goals they had used, if any, during the experiment.

RESULTS

Figure 18 shows the data from the first two sessions and last session for each skater in Groups 1, 2 and 3 and the average for each group. The x-axis represents consecutive 1-min timings with three 1-min timings in each session. The y-axis represents number completed in each minute. Correct forward crosses are represented by circles and incorrect forward crosses are represented by crosses. Bold vertical lines separate sessions. Two of six skaters (P4 and P5) in Group 1 (who were given a hard goal in Session 3) showed small increases in their rate of performance on correct forward crosses from Session 1 to Session 2. Increases were also seen for three of the six skaters (P7, P9 and P10) in Group 2 (do your best over ten sessions) and four of the six skaters (P13, P14, P17 and P18) in Group 3 (do your best over three sessions). Overall these increases were small and similar in size for each group. From the second session to the last session, large improvements were seen for all skaters in Group 1, smaller increases were seen for five skaters in Group 2 and even smaller increases were seen for two skaters in Group 3. On average, the increases were greatest for Group

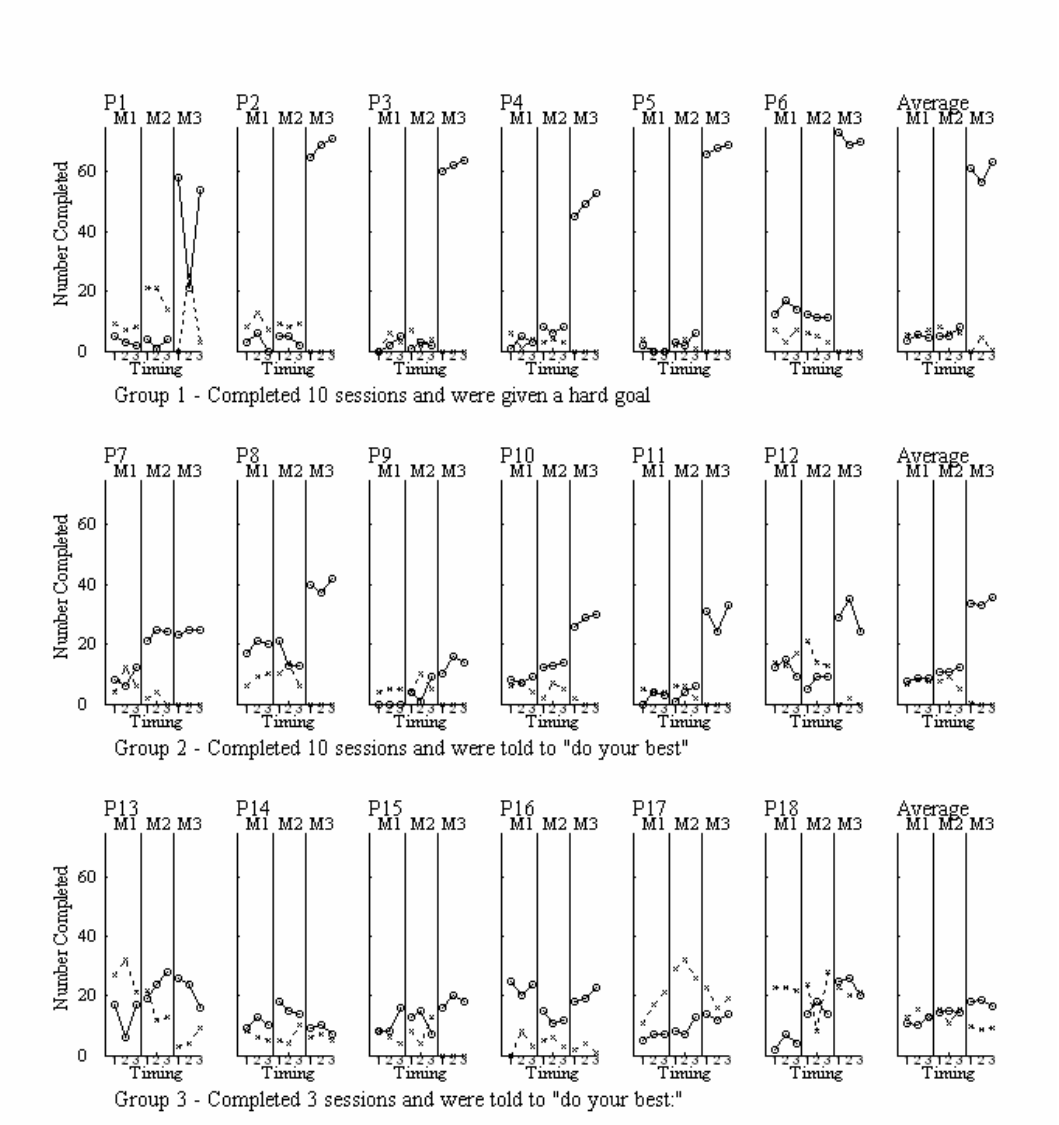

Figure 18. Individual performances and group averages are shown for the number of correctly completed forward crosses (circles) and incorrectly completed forward crosses (crosses) performed in a minute for timings in the first (M1), second (M2) and tenth (M3) sessions for Groups 1 and 2, and in all three completed sessions for Group 3. There were three timings in each session.

1 and smallest for Group 3. Paired t-tests on the data for each group showed that, with alpha set at .05, there was no significant difference between Session 1 and Session 2 for any of the groups (Group 1, $t(5) = 0.727$, Group 2, $t(5) = 1.033$, and Group 3, $t(5) = 1.049$). These analyses also showed significant differences between Session 2 and the last session for Group 1 ($t(5) = 12.573$) and Group 2($t(5) = 4.062$), but not for Group 3 ($t(5) = 1.176$).

The averages of the number correct, for each of the three sessions shown in Figure 18, were calculated for each skater and compared using a repeated measures ANOVA across groups. With alpha set at .05, there was a significant difference across sessions, $F(2,30) = 129.791$ (partial $\eta^2 = .896$) and a significant difference across groups $F(2,15) = 4.908$ (partial $\eta^2 = .396$). The interaction of groups and sessions was also statistically significant $F(4,30) = 45.153$ (partial $\eta^2 = .858$). Table 7 shows the results of Scheffe post hoc analyses completed to compare groups for each of the three sessions. These analyses showed no significant differences between any of the pairs of groups in Session 1. Significant differences were found between Group 1 (hard goal) and Group 3 (do your best for three sessions) for Session 2 but Group 2 (do your best for ten sessions) was not significantly different from either Group 1 or 3. By the last session, significant differences were found between Group 1 and the other two groups, but not between Groups 2 and 3. A box plot showing the average rates of performance recorded for forward crosses during the first, second and last timings for each group can be found in Appendix K.

Figure 19 shows the number of correct and incorrect forward crosses completed for Group 1 over all sessions and timings. The x-axis represents consecutive 1-min timings with three 1-min timings in each session. The y-axis represents number completed per minute. Correct forward crosses are represented by circles and incorrect forward crosses by crosses. A bold vertical line indicates the five week break between Sessions 1 and 2 (these data were also presented in Figure 18). When the goal of 60 was introduced in Session 3 an increase in the rate of correct forward crosses can be seen for all skaters. Over the remaining sessions, although a performance rate increase occurred for all skaters, the pattern of change differed across skaters. The performance rate of P1 and P2 dropped after they attained the goal in Session 4 and was variable across the remaining sessions. P1 and P2 stopped reciting 1, 2, around Session 4 and although they

Table 7. Scheffe post hoc analysis of group means. The hard goal group (Group 1) and the do your best 8 group (Group 2) both completed ten sessions in total while the do your best 3 group (Group 3) completed only 3 sessions in total. Statistically significant differences are marked with an *.

Session	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
First	Hard goal	do your best 10	-3.944	3.581	.558	-13.662	5.773
	Hard goal	do your best 3	-6.944	3.581	.187	-16.662	2.773
	do your best 10	do your best 3	-3.000	3.581	.710	-12.718	6.718
Second	Hard goal	do your best 10	-6.111	3.222	.199	-14.855	2.632
	Hard goal	do your best 3	-9.500*	3.222	.032	-18.244	-.756
	do your best 10	do your best 3	-3.389	3.222	.586	-12.132	5.355
Last	Hard goal	do your best 10	32.944*	5.029	.000	19.298	46.591
	Hard goal	do your best 3	42.722*	5.029	.000	29.075	56.369
	do your best 10	do your best 3	9.778	5.029	.185	-3.870	23.425

were prompted to continue with this counting each time they stopped, they would start but stop again before the timing finished. This happened over all the remaining sessions. At the end of the experiment they both reported that counting 1, 2 had “slowed them down”. They also reported that they did not focus on achieving the goal once they had “already done it” and that they had not set other personal goals. The performance rates of the remaining four skaters in this group steadily increased across sessions. These skaters all recited 1, 2, throughout the experiment and reported at the end that they had been trying for 60 correct repetitions per minute across all sessions. At the conclusion of the experiment, these skaters also reported that once a goal of 60 had been set, they had set additional personal goals of beating their previous high score. Five of the six skaters in this group reached the goal of 60 before the last session.

Figure 20 shows the number of correct and incorrect forward crosses completed for Group 2 on similar graphs to those in Figure 19. In all sessions the participants in Group 2 were told to do their best and asked to recite 1, 2 as they practised. All skaters continued to recite 1, 2, with foot placement across all sessions. No skaters in this group reached the goal of 60 that had been set for the

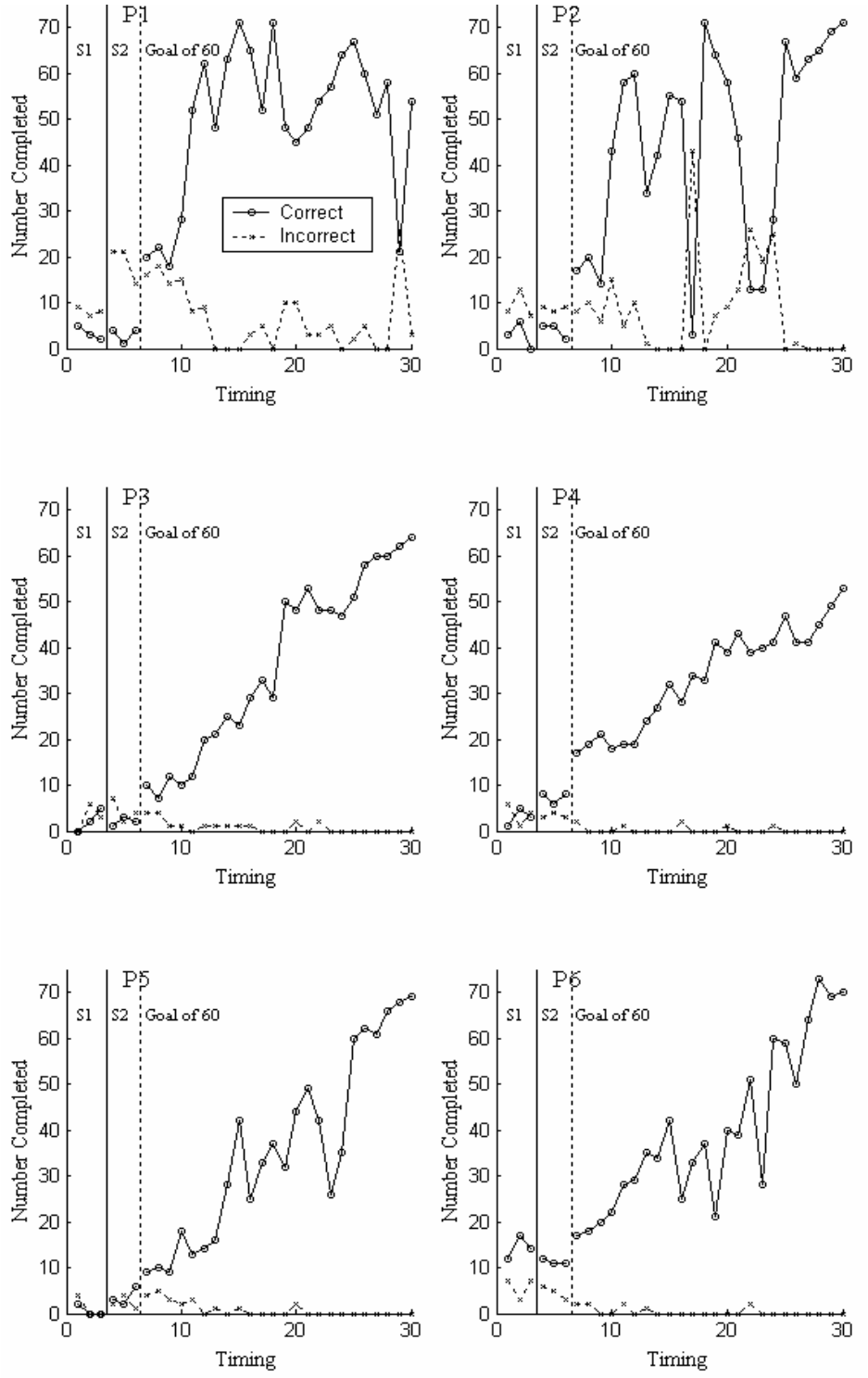

Figure 19. The number of correctly completed forward crosses (circles) and incorrectly completed forward crosses (crosses) performed in each minute across timings for Group 1. A bold vertical line between Sessions 1 (S1) and 2 (S2) signifies a five week period between sessions and a broken vertical line represents the introduction of a goal. Three timings were completed in each session with participants being set a goal from Session 3 onwards of completing 60 correct forward crosses in each minute.

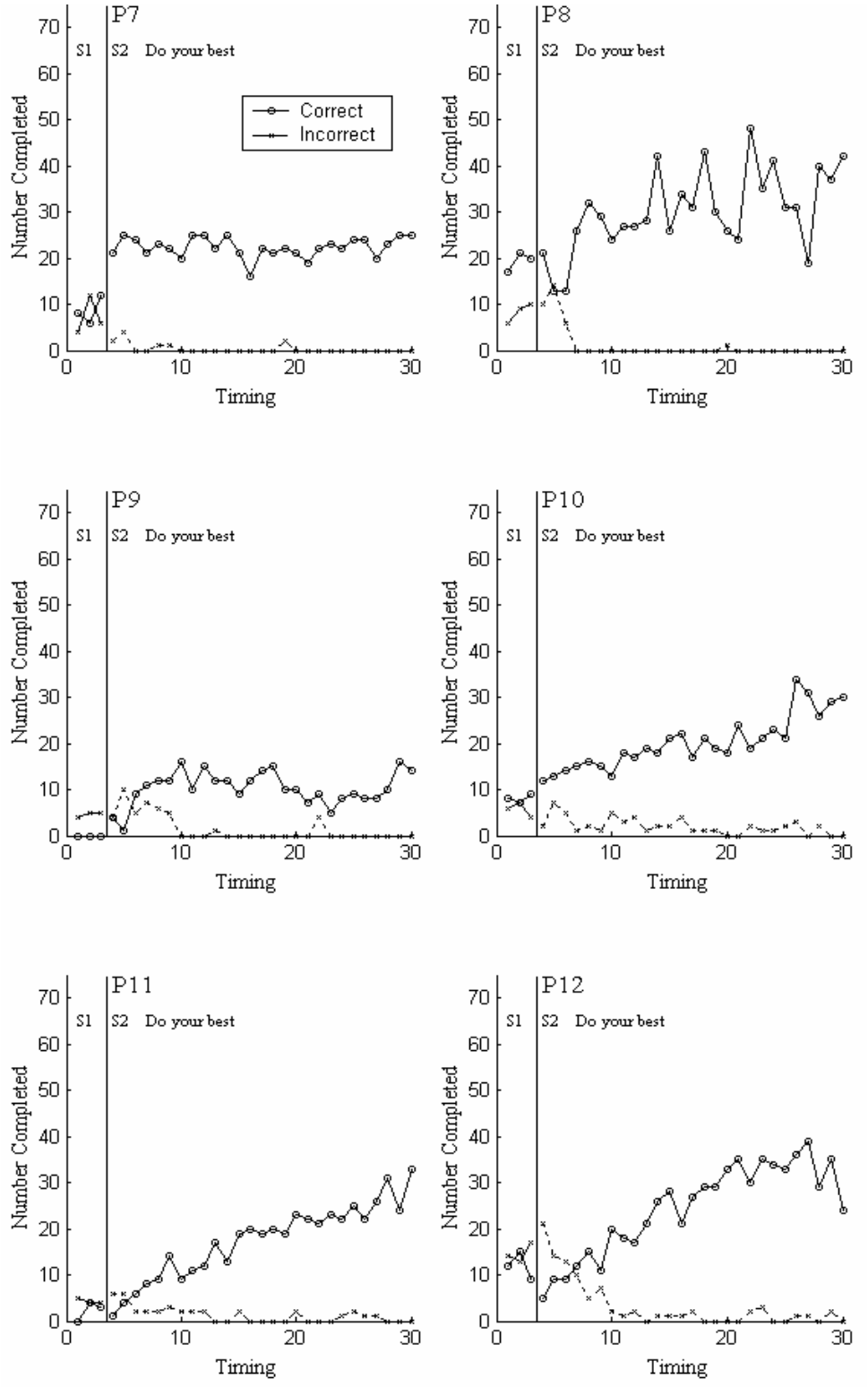

Figure 20. The number of correctly completed forward crosses (circles) and incorrectly completed forward crosses (crosses) performed in each minute across timings for Group 2. A bold vertical line between Sessions 1 (S1) and 2 (S2) signifies a five week period between sessions. Three timings were completed in each session with participants being asked to 'do your best'.

first experimental group. With the exception of P7, all skaters showed some improvement in their rate of performance across sessions. At the end of this study no skaters in this group reported setting personal numerical goals for either errors or corrects, but some skaters reported that they had set other goals such as “to keep my head up”, “to stretch my free leg”, and “to keep my arms up level”. These goals seemed to be related to the feedback given by the experimenter on how they could improve their forward crosses.

Straight lines were fitted to the data from Session 2 onwards in Figures 19 and 20 by the method of least squares. Table 6 shows the resulting slopes and intercepts of the lines for individual skaters from both Groups 1 and 2. Overall there were differences in slope between Group 1 (M = 1.877, SD = 0.705) and Group 2 (M = 0.497, SD = 0.482). The intercepts of the lines for Group 1 (M = 12.351, SD = 17.548) were similar to those of Group 2 (M = 14.380, SD = 8.576). Independent samples t-tests found that, with alpha set at .05, there was a significant difference between slopes, $t(10) = 3.956$, but no significant difference between intercepts $t(10) = 0.254$. A box plot showing the average slopes for each group can be found in Appendix L.

Table 6. Slopes and intercepts for Group 1 (set goal of 60) and Group 2 (do your best)

Skater	Group	intercept	slope
1	1	39.246	0.857
2	1	27.993	1.384
3	1	-3.954	2.626
4	1	7.943	1.634
5	1	-3.470	2.573
6	1	6.348	2.187
7	2	21.518	0.055
8	2	27.507	0.376
9	2	12.511	-0.121
10	2	11.325	0.636
11	2	4.066	0.961
12	2	9.350	1.078

DISCUSSION

This experiment examined the effects of different goals and the effects of 1-min timed practices, a form of deliberate practice, on the performance rates of

roller skaters. Overall, skaters who were set a hard, specific goal ended with higher rates of performance than those skaters asked to do their best, regardless of the number of sessions completed. Skaters who completed 10 sessions of 1-min practices also performed better than the group that completed fewer sessions of 1-min practices.

While some aspects of the results here are similar to findings in the previous experiments, other aspects are not. It is argued here that the differences resulted because the design of the current study attempted to take account of the issues raised by Locke (1991). The first of these issues was the need to try to reduce the chance of spontaneous goal-setting in 'do your best' conditions. It was found previously here that there was no difference in the slopes of the data paths between skaters in Experiment 3 who were asked to do their best and skaters from Experiment 1, who performed the same skills, and who were set a hard, specific goal. It was possible that the skaters asked to simply do their best may have been spontaneously setting harder goals. In the current experiment, skaters were asked to count 1, 2 as they practiced. None of the participants who were asked to simply do their best set numerical, or rate, goals and so it seems likely that this procedural aspect ensured that spontaneous goal-setting was not a confound here, although this does not confirm whether or not participants in previous experiments, who were asked to simply do their best, set numerical goals.

Because counting 1, 2, might affect performance rates, the group who were set a hard goal were also asked to count 1, 2, as they practiced. Two skaters in this group, P1 and P2, stopped this repetitive counting as they reported that this slowed them down. They were also the two skaters who showed the fastest progress initially over sessions, while they were still counting 1, 2, repetitively, but who showed the most variability. As a result these two skaters had the lowest slope values in general over the eight sessions of goal setting. By comparing the slopes of the data paths for those in Group 1 of this experiment (Table 8) and those in Experiment 1 (Table 2), where goals were also set for the skill of forward crosses, the resulting slopes are steeper for those skaters in the present study, particularly if P1 and P2 are not considered. This difference in slopes suggests that, overall, counting 1, 2 may have resulted in higher rates of change when repetitive counting was used with a hard goal. However, the slopes of the data paths obtained for Group 2, who were asked to simply do their best, were less

steep than both Group 1 here and the skaters in Experiment 1, showing that counting 1, 2, in the absence of goal setting did not result in faster changes in performance across time. It is likely then, that it was other differences that were responsible for the different rates of change seen in Experiments 1 and 5. One main difference is the difficulty of the goal set. The original goal for skaters in Experiment 1 was one of 50 forward crosses per minute, 10 repetitions less than the hard goal set here. If goal difficulty is indeed a major factor influencing the performance of individuals, the resulting difference in rates of change may be attributable, then, to the discrepancy in the goals and not to the additional counting. (A box plot showing the average slopes for one skill, forward crosses, for two groups (Group 1 and Group 2) in Experiment 1, one group in Experiment 3, and two groups (Group 1 and Group 2) in Experiment 5 can be found in Appendix M.)

A second major issue outlined by Locke (1991) is the need to measure personal goals in order to interpret the results. Each participant here was asked at the conclusion of the experiment if they set any personal goals. Some skaters in Group 2 reported that they set themselves personal goals such as keeping their arms up level as they practiced, or stretching their free leg. These goals do not fit within the definition of a hard, specific goal and while these actions may have improved the aesthetic performance of the skill, they did not affect the rate, i.e., fluency, at which the skill was performed, to the same degree as when a hard, specific goal was set. As no participants in Groups 2 and 3, the do your best, groups, set specific numerical goals, the classification into different groups, as suggested by Locke and Latham (2002), was not required.

Four skaters from the current experiment, who were asked to aim for a goal of 60 correct forward crosses in each minute, did set personal goals of trying to beat their previous high score of correct forward crosses. However, in the goal-setting literature this goal is also reported to be a hard, specific goal (Boyce et al., 2001) and so this goal could be taken to be similar to the set goal of 60 per minute. Overall, then, it is unlikely that, in this instance, the setting of these personal goals influenced the results. Interestingly, the remaining two skaters in this goal group, who reported that they did not set any personal goals, showed variable rates of performance once they had reached the set goal of 60. If precision teaching protocols were being followed, these two skaters would have

been set another task or goal. When these two skaters reported they were focusing on completing 60 forward crosses in later sessions, they were still able to achieve this performance aim.

Locke (1991) suggests that set goals must be specific and at an appropriate level of difficulty. The preset hard goal was certainly specific: completing 60 forward crosses in one minute. The question is whether or not it was of appropriate difficulty. In Experiment 1, also using forward crosses, a goal of 50 had been set but it was thought that the performances of individuals in that experiment indicated that this goal may have been set too low, even though it would still be regarded as a hard goal in the goal-setting literature. While many of the participants in Experiment 1 achieved the goal of 50, they failed to go on and achieve higher rates even though other participants had shown that it was possible to complete at least 70 correct forward crosses per minute. The results from the current experiment suggest that the goal of 60 correct forward crosses per minute was difficult, yet achievable, as five out of six participants given that goal achieved it. All other participants in the remaining two groups, who were asked to do their best, failed to reach 60 correct repetitions which suggests that this goal is not one that can be achieved routinely. Therefore the results of this experiment would suggest that 60 was an appropriate goal for this skill.

Another methodological issue raised by Locke (1991) is that experimental groups need to start from similar baselines and this was achieved in the current experiment. He also suggests that competition between participants can result in personal goals being set, based on what another participant is achieving. It appears that the procedure employed to reduce this occurring, i.e., participants receiving only their own feedback and not hearing the feedback given to other participants, did result in competition being kept to a minimum. As explained earlier, only four skaters set numerical personal goals in addition to the hard goal they were given, and these were based on their own performance rather than on the performance of others.

Overall then it is argued that, through better procedural designs, the issues raised by Locke (1991) and the methodological concerns of Experiments 2, 3 and 4 have been controlled for here. The combined results of all three groups in this experiment support the previous findings in the goal-setting literature, that hard goals result in better performances than when easy or no goals are used (Locke &

Latham, 2002). Skaters in the hard, specific goal-setting group were set a numerical goal, and did perform more fluently in the final session than the other two groups who were asked to do their best.

Improvements were seen for the participants in Group 2, who were asked to do their best and who completed the same number of sessions as the hard goal group. These improvements were not seen for participants in Group 3 who were also asked to do their best but completed only three sessions of 1-min timings, or practices. Therefore it appears that more than three sessions is necessary to observe effects of 1-min timings, a form of deliberate practice. This finding is similar to that in Experiment 4, where it was also found that those participants who did not have a hard, specific goal and who completed at least 8 sessions of 1-min timings did better than those who completed only two sessions of 1-min timings. However, findings in the current experiment also differed from those in Experiment 4, where it was found that participants in a group given hard goals, who completed the same number of sessions of 1-min timings, had lower performances rates than those in a group asked to do their best. It was previously suggested that this may have occurred in Experiment 4 because the group that was set hard goals came from a different population to the other two groups used in that experiment. In this experiment, care was taken to draw participants from similar populations and the resulting data are comparable to those found in other goal-setting studies. Therefore it seems likely that the differing populations in Experiment 4 may have contributed to this finding.

One final issue worth discussing is the effect of differing amounts of practice. It is likely that accumulated practice over sessions contributed to the large differences between groups that were seen in the final session. An obvious example of this is the comparison between Groups 2 and 3, where all participants were told to simply do their best but where Group 2 completed seven more sessions than Group 3. As a direct result Group 2 performed at a higher rate in the final session. It should be further noted, however, that Group 1 accumulated the greatest amounts of practice. Although they completed the same number of sessions as Group 2, they were completing more repetitions within each session once a goal was introduced. Therefore it could be argued that it was the amount of practice and not the type of practice, i.e., paced versus non-paced practice, that was responsible for the high rates of performance observed in the final session. To

investigate this further each skater could have continued sessions until they had each performed a pre-determined total number of forward crosses. However, as Binder (2004) suggests, a less time-consuming procedure is more efficient and therefore could be considered superior and in the current study the hard goal, or paced practice, group reached higher rates of performance more quickly than the group instructed to simply do their best.

In summary then, it was found that those skaters given a specific, hard goal showed greater increases in performance rates than those skaters asked simply to do their best. Further, both groups who engaged in ten sessions of 1-min timings, a form of deliberate practice, showed greater increases in performance rates over the same time period than a third group who completed only three sessions of 1-min timings. It appears then that these two components of precision teaching, goal-setting and timed practices, are effective in building fluent performance, with timed practices being more effective when they are combined with a specific, hard goal.

GENERAL DISCUSSION

The main aim of this research was to examine some components of precision teaching to consider their contribution to the overall effectiveness of the rate building procedure. The initial component studied here was the use of feedback to students through celeration charts, an integral part of precision teaching (Raybould & Solity, 1982; West et al., 1990; White, 1986). While charts are reported to serve several different functions (Lindsley, 1971), findings from this research were that giving feedback through charts did not accelerate the performance of the targeted skills over and above that observed in the absence of charting. It was possible that, due to the methodology used in Experiment 1, the effects of charting one skill may have carried over to the second uncharted skill, as such a carryover effect was seen within Experiment 3. However, the comparison of data from Experiment 1 with those from Experiment 3, where the same two skills but no charting was used, showed no differences in resulting slopes of the data paths and it can be argued that charting, as used here, was therefore not effective in accelerating performance rates, suggesting that feedback from charting is not necessary for increasing performance rates, at least with the skating skills and training environment used here. In making this statement

however, it is also recognized that the effect of public posting, i.e., making the charts available for others to see, was not done. Anderson, Crowell, Doman and Howard (1988) and Ward and Carnes (2002) have previously considered this but, as explained earlier, their findings were not conclusive. Further research then may determine if charting is effective when charts are posted and opportunities are available for discussion and comparison with peers.

The finding here is that feedback to the student from charts might not be effective but it is possible that charting may be used for other reasons and have other effects. Raybould and Solity (1988) state that

> "If you are simply using probing and charting techniques but not making changes where appropriate, either to the task or the teaching method, that may be daily monitoring, precision recording even, but it is not really precision teaching". (p33)

Likewise charting may be useful for teachers as it provides a record and/or overview of the student's progress upon which they can make decisions for further instruction. In these cases charting may provide indirect assistance in accelerating performance rates even though the data here have shown that the visual feedback from charting did not have a direct influence.

Celeration charts are semi-logarithmic, giving a linear data path when performance rates change multiplicatively over time. Here non-logarithmic plots were used to examine the change of performance over time as the data in Experiment 1 formed a straighter line on non-logarithmic charts than on semi-logarithmic charts. As presented earlier, Lindsley (1990) has stated that data obtained as a result of using precision teaching should be multiplicative resulting in a straight line on the celeration chart. One reason that this may not have occurred in Experiment 1 is that as skaters neared a point where it became more difficult physically to perform faster they often made smaller gains. In a typical precision teaching setting they would likely be given a new task or goal. However, for the purposes of research it had been decided that all participants should complete a similar number of sessions. Therefore the continued smaller improvements in the later sessions for many participants, resulting from this

methodology, were better represented on non-logarithmic graphs. Similar graphs were used in later experiments so that further comparisons could be made.

The second component of precision teaching studied here was the use of performance aims, or goals. As explained earlier, there has not been any previous precision teaching research done on the effect of performance aims, although it is stated in the precision teaching literature that high performance aims maximize learning (Koorland et al., 1990; Lindsley, 1992b). Therefore the current research referred to the vast literature in the area of goal-setting and it was clear that a precision teaching performance aim meets the criteria of being both a hard and specific goal. While there are a large number of studies supporting the use of goal-setting (Locke & Latham, 1990), mixed results were found here. However, in the final experiment, where all methodological issues outlined by Locke and Latham (1990) were addressed, as were those that that had arisen through the earlier experiments, it was found that specific, difficult performance aims did result in increased performance rates. However, it is difficult to separate out performance aims, one component of the precision teaching procedure, from the other components, in particular the components of repetitive practice and feedback. To be certain that performance aims were effective in and of themselves, it was necessary to demonstrate that greater improvement was seen when they were included in the precision teaching method and this was shown in Experiment 5.

It is not clear why setting hard goals is most effective. From a behaviour analysis perspective one interpretation of the situation might be that goals are verbal discriminative stimuli which signify that, once achieved, consequences, e.g., praise, will be available. Thus they fit the definition for a rule (Baum, 1994). Differences in goal difficulty here reflected different rules being set and as a result a hard goal here, such as achieve 60 per min, produced faster performance rates than an easy goal, such as do your best, i.e. when the rule specified a criterion that required fast performance this is what was achieved. Specifying a criterion also means that it is possible to fail and to avoid failure here required a fast performance. Under do-your-best conditions there wais no criterion specified, therefore there was no requirement for faster performance and no way to fail to achieve the goal. Thus achieving hard goals requires fast performance while do-your-best goals do not. Where ‘success’ is valued and praised, hard goals should function to change behaviour while do-your-best goals may not. It should be

noted however that substantial increases in rate were also seen in the absence of performance aims. Therefore the short, timed practice periods, a form of deliberate practice, used in precision teaching were also studied. The general finding was that short, timed practice periods resulted in the performance rates of participants increasing over sessions, although a few participants failed to increase their performance rates. These data show that time-practices alone can have an effect.

A number of authors have suggested that precision teaching should be used as a tool to measure the effectiveness of other teaching methods (Howell & Lorson-Howell, 1990; Peterson et al., 1990; White, 1986). They suggest the teaching method under study be applied and then the short, timed periods of precision teaching and charting of the results can be used to see how effective the targeted teaching method has been. The findings of this current research were that, overall, short, timed practice periods themselves build fluency without any additional teaching. It is argued therefore, that precision teaching is more than a simple measuring tool, it is a teaching tool. If precision teaching were used over a number of days to measure the effectiveness of another tool, any results would be confounded because of the effectiveness of timed practices.

Alternatively, some authors (Binder, 1996; Binder & Watkins, 1990; Brandstetter & Merz, 1978; Johnson, 1971; Kessissoglou & Farrell, 1995; Lindsley, 1990) say they use precision teaching to make other teaching methods more effective by producing fluent performance. The current findings suggest that using timed practices will produce faster, or more fluent, performance as all five experiments showed that those participants who engaged in at least 8 sessions of timed practices did increase their fluency on targeted skills. Further, in Experiments 4 and 5, those participants who completed only 2 or 3 sessions of deliberate practice and who also engaged in related activities that used the targeted skills, did not improve.

One aspect of the timed periods that was not researched here was the optimum time duration for these practices with the present skills. It has been reported by some authors (Binder, 1996; Binder et al., 1990; Lindsley, 1996) that individuals reach higher levels of performance faster by keeping to shorter timed periods of 1-min or less, at least initially. While the results here show that deliberate practice with 1-min timings are effective, it is not possible to conclude

that this length of time was the optimum. Therefore further research should address this issue.

Finally, all five experiments here used a design where the targeted skill was not changed during each experiment. As explained earlier, precision teachers make changes to their teaching program when it is apparent that there are no changes in the rate of a targeted behaviour for three consecutive sessions or if the change of rate is in the wrong direction. For the purposes of examining the effectiveness of selected components, instruction given to the participants in all five experiments was kept simple and did not change. Participants were asked simply to show that they could do one repetition correctly and were given further instruction only if they were unable to do this. Therefore, any instruction beyond retelling of the requirements to perform the skill correctly was minimal. It is possible therefore that if participants had been given extra instruction, as is often done in precision teaching when performance rates are not increasing fast enough, that even greater changes in behaviour could have been seen.

The current research was also aimed at applying precision teaching methods to sport, in this case roller skating and soccer, to examine whether its use was effective in increasing the fluency of targeted skills in this area. As stated previously, much of the literature around precision teaching has focused on academic skills (Chiesa & Robertson, 2000; Kessissoglou & Farrell, 1995; Lindsley, 1992a, 1992b). In the first experiment, where full precision teaching methods were used, skaters showed significant progress from first to last sessions suggesting that precision teaching methods may have been effective. Even when parts of the precision teaching method were removed in later experiments, such as charting and performance aims, increases in performance rates were seen, showing that other components such as repetitive practice were effective alone in increasing performance rate with the selected sporting skills.

However, taking precision teaching into a sporting area did produce a problem of setting appropriate performance aims. Johnson and Layng (1996) report that many performance aims, that reflect fluent performance, have already been found for tasks within areas such as education, therapy, developmental disabilities, and business and industry. These performance aims are found by determining what rate a skilled person would perform the skill at. It would seem that performance aims that reflect fluent performance for relevant skills accurately

within sport should be found if precision teaching is to be used with sporting skills. It is reported in the goal-setting literature that beating your previous high score is also considered to be a hard goal, i.e., a beat your previous high score goal would be of similar difficulty level to a performance aim. If this is so, it seems possible that precision teachers could use this goal when a predetermined performance aim is not available.

One problem that occurred as a result of using precision teaching and similar fluency building methods within these sporting areas was that it was not possible to carry out procedures on a daily basis, as is typically done, because participants were unable to attend the sporting venues as regularly as they attend school. It does seem unlikely however that performance gains would have been less if the sessions had been held more frequently each week. Therefore the results found here are likely to reflect what would have been found if sessions had been held daily.

In summary, the current investigation has been a step towards examining the effectiveness of selected components of precision teaching in building fluency. It has also demonstrated the relations between aspects of precision teaching and other literatures such as research on goal setting and deliberate practice. Three components, charting, performance aims and 1-min timed practices, were studied here. Overall, visual feedback to the participant from charting did not accelerate performance rates over and above what was seen when charting was not used. However, performance aims and 1-min practices did appear to have an effect with skaters showing marked increases in performance rates of targeted skills when these components were utilised. It is argued, then, that these two precision teaching components effectively change behaviour. Further, the results here have also shown that precision teaching, although most commonly used in educational fields, can also be applied to the sports of roller skating and soccer.

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APPENDIX A

Information sheet for participants and their parents.

My name is Trudy Pocock and I have been involved in the sport of rollerskating for about 14 years. I have been a skater in and captained the first N.Z. precision skating team to compete at the World Championships. I have also been a judge and referee, being one of the youngest judges in the World to attain my Class A judging qualifications. But what I enjoy the most now is coaching. I initially started coaching in Cambridge when I first came here as a primary school teacher in 1991. Since then I have had skating students reach national and international levels of skating. It takes a lot of hard work to reach this level of skating and I'm interested in how I can teach skaters the skills they need to become competent faster and more easily.

As part of my doctoral studies at the University of Waikato I am looking at methods that help young skaters to skate faster and more accurately, thereby producing fluent performance. Those of you who drive cars may well remember the difficulties you initially had when you first learnt to change gears, just as our new skaters are having difficulties keeping their feet co-ordinated. Now it is likely that you can change gears while doing other activities such as holding a conversation. You could say that your changing of gears is now fluent, as you can now perform it easily and accurately. It is this level of fluency that I would like our skaters to achieve.

The research that has been done so far on producing fluent performance shows that when basic skills become fluent, more complex skills (that use those basic skills) are learnt faster and are also done more easily. In terms of skating, two of the most basic skills (after learning to stay upright!) are skating forwards and skating backwards. Most other skills are reliant on at least one of these. For this reason I would like to start my research by teaching these two skills using two different fluency-training methods.

We do not know for certain yet which of the two methods of fluency-training will bring about fluency faster. Therefore I will be using both methods with each skater, one for forward skating, one for backward skating. It is likely that we will need up to ten sessions of half an hour each. These sessions will be entirely free of charge and will be held at a time convenient to you. By the end, all skaters should have mastered both forward and back skating, regardless of the training method. It is likely that there will be opportunities for the skaters to take part in further research if the skater would like to continue at the end of this initial study. Also you should know that the skaters' participation in this study in no way affects the opportunities they have to attend other sessions, for example the beginner sessions, which the club runs. The skater is also able to withdraw for any reason from participating in the research at any time.

If you have any questions about participating or about the study itself please feel free to contact me or my supervisors. Otherwise, if you would like your child to take part, please fill out the consent form and return this to me when you next come to the rink. On receiving the consent form I will also be asking any skater that will be participating for their personal verbal consent as they will very much be a part of the study!

Here are my contact details along with those of my supervisors:

Trudy Pocock	Home: 823 7000	Work: 838 4466 ext 6315
AProf Mary Foster	Work: 838 4466	ext 8400
Dr James McEwan	Work: 838 4466	ext 8295

APPENDIX B

University of Waikato
Psychology Department

CONSENT FORM

PARTICIPANT'S COPY

Research Project: Fluency and Precision Teaching

Name of Researcher: Trudy Pocock

Name of Supervisor: Associate Professor Mary Foster

I have received an information sheet about this research project or the researcher has explained the study to me. I have had the chance to ask any questions and discuss my participation with other people. Any questions have been answered to my satisfaction.

I agree to participate in this research project and I understand that I may withdraw at any time. If I have any concerns about this project, I may contact the convenor of the Research and Ethics Committee.

Participant's Name: _____Signature:_____ Date:_____

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University of Waikato
Psychology Department

CONSENT FORM

RESEARCHER'S COPY

Research Project: Fluency and Precision Teaching

Name of Researcher: Trudy Pocock

Name of Supervisor: Associate Professor Mary Foster

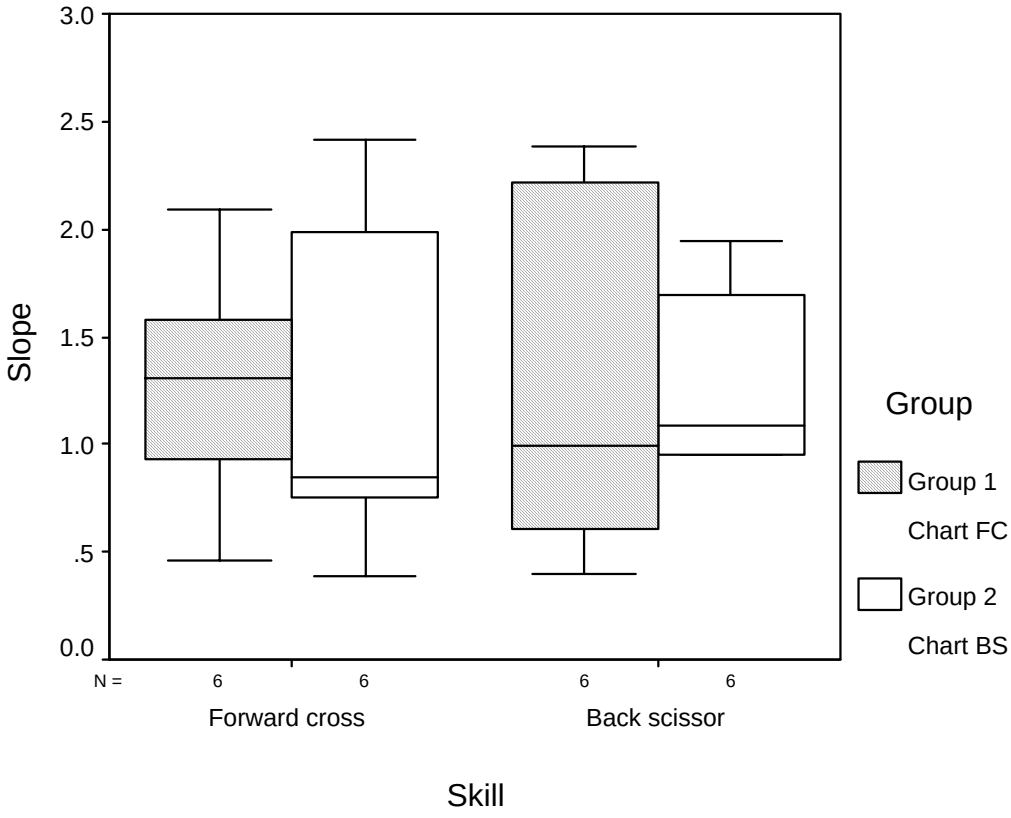
I have received an information sheet about this research project or the researcher has explained the study to me. I have had the chance to ask any questions and discuss my participation with other people. Any questions have been answered to my satisfaction.

I agree to participate in this research project and I understand that I may withdraw at any time. If I have any concerns about this project, I may contact the convenor of the Research and Ethics Committee.

Participant's Name: _____Signature:_____ Date:_____

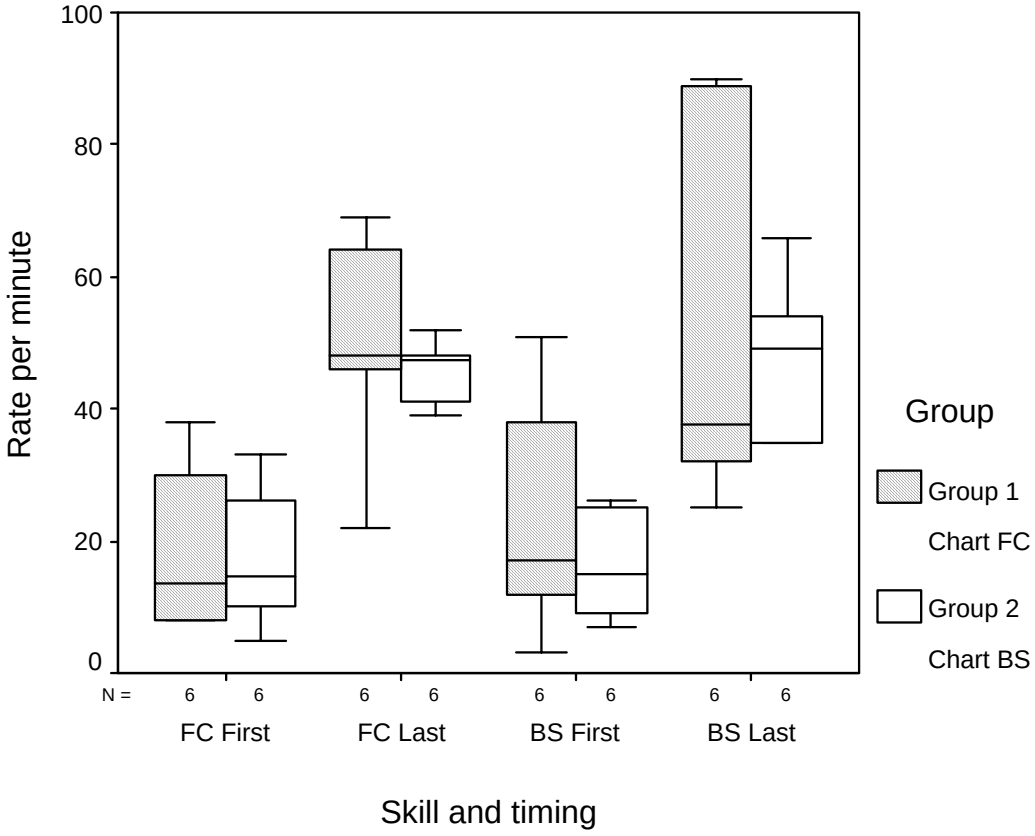
APPENDIX C

Box plot showing the average slopes for two skills, forward crosses and back scissors, for each group in Experiment 1. Group 1 charted forward crosses and Group 2 charted back scissors.



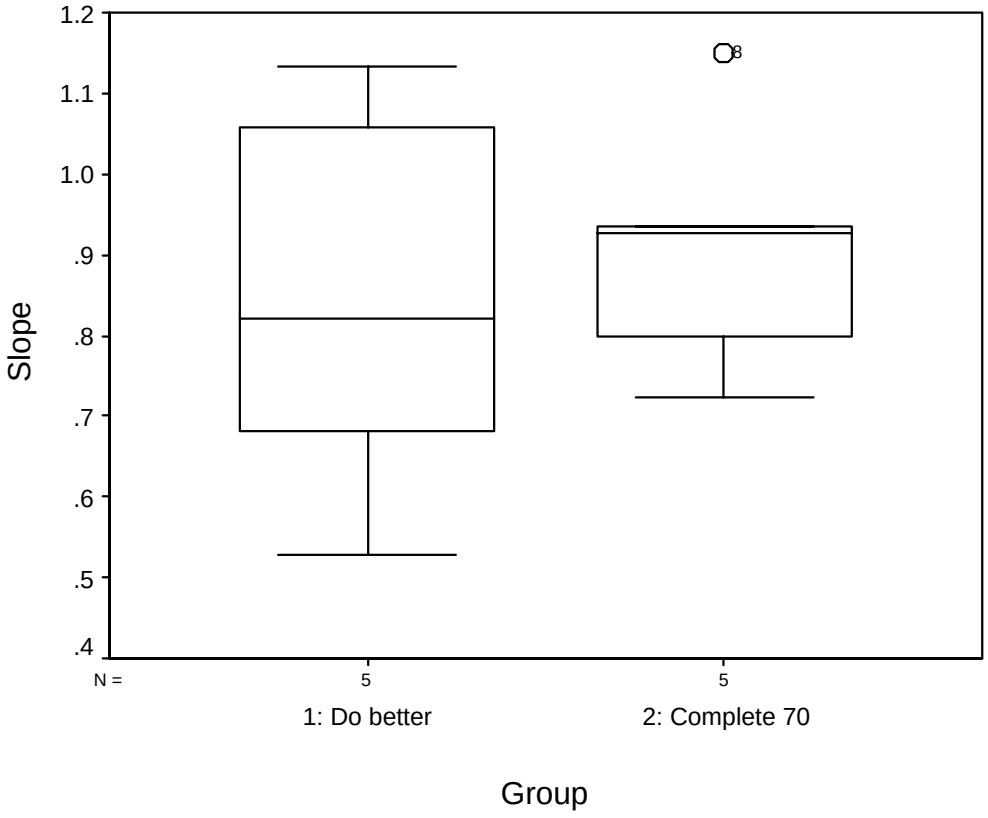
APPENDIX D

Box plot showing the average rate of performance recorded for two skills, forward crosses and back scissors, during the first and last timings for each group in Experiment 1. Group 1 charted forward crosses and Group 2 charted back scissors.



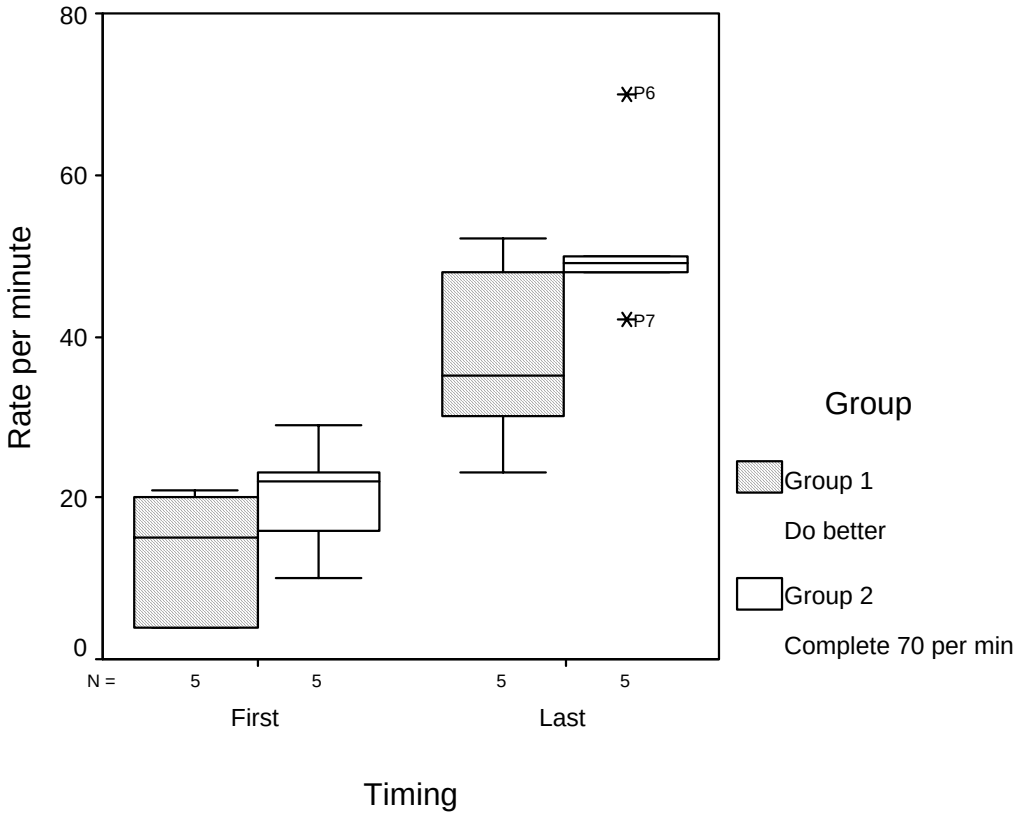
APPENDIX E

Box plot showing the average slopes for each group in Experiment 2. Group 1 were aiming to do better than their previous session while Group 2 was aiming to complete 70 back crosses in one minute.



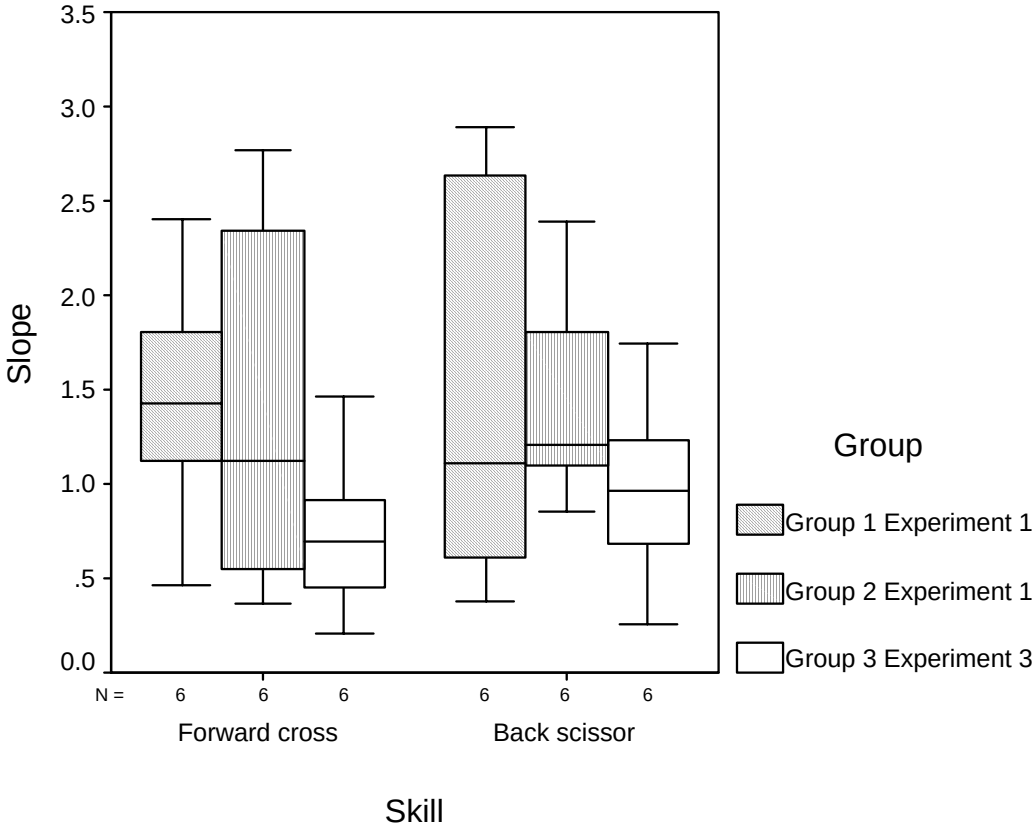
APPENDIX F

Box plot showing the average rate of performance recorded for back crossfronts during the first and last timings for each group in Experiment 2. Group 1 were aiming to do better than their previous session while Group 2 was aiming to complete 70 back crosses in one minute.



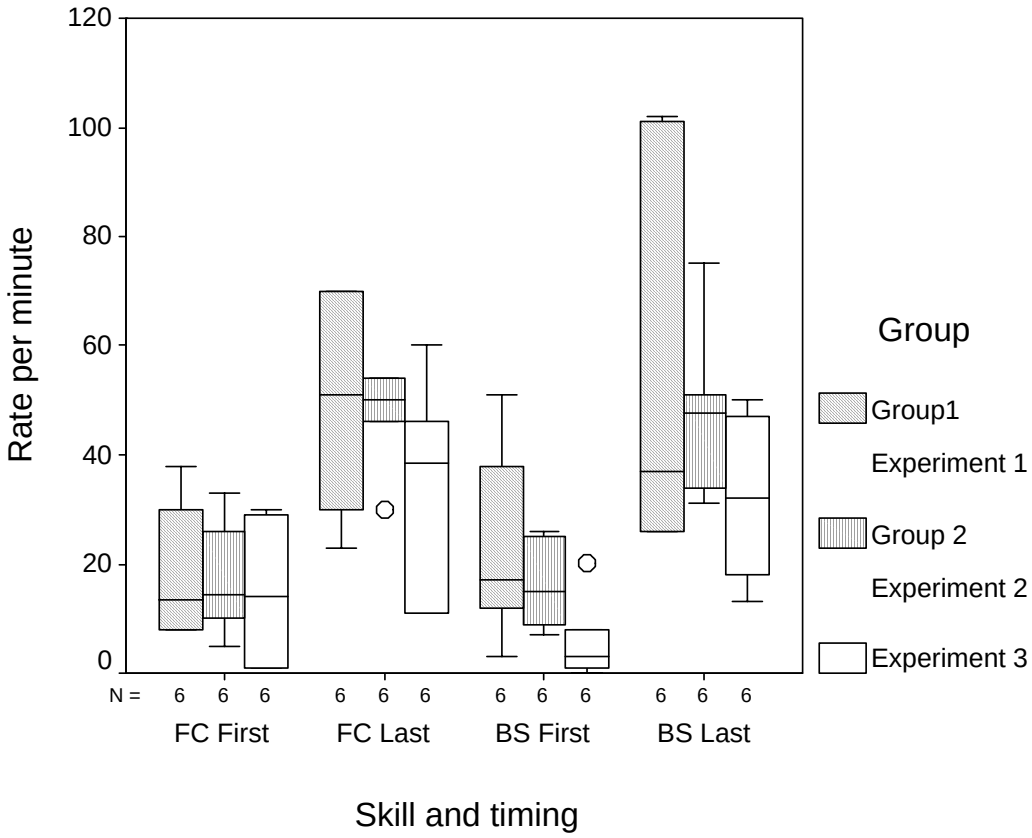
APPENDIX G

Box plot showing the average slopes for two skills, forward crosses and back scissors, for each group in Experiment 1 and for skaters in Experiment 3.



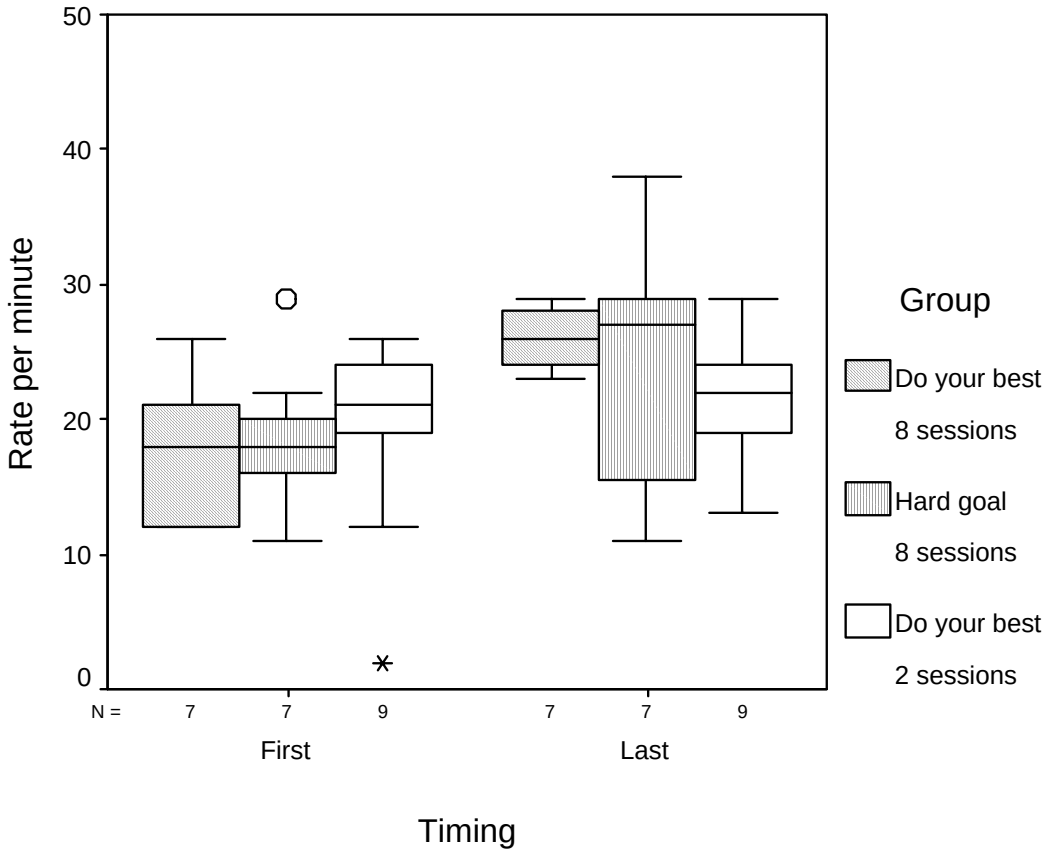
APPENDIX H

Box plot showing the average rate of performance recorded for two skills, forward crosses (FC) and back scissors (BS), during the first and last timings for each group in Experiment 1 and skaters in Experiment 3.



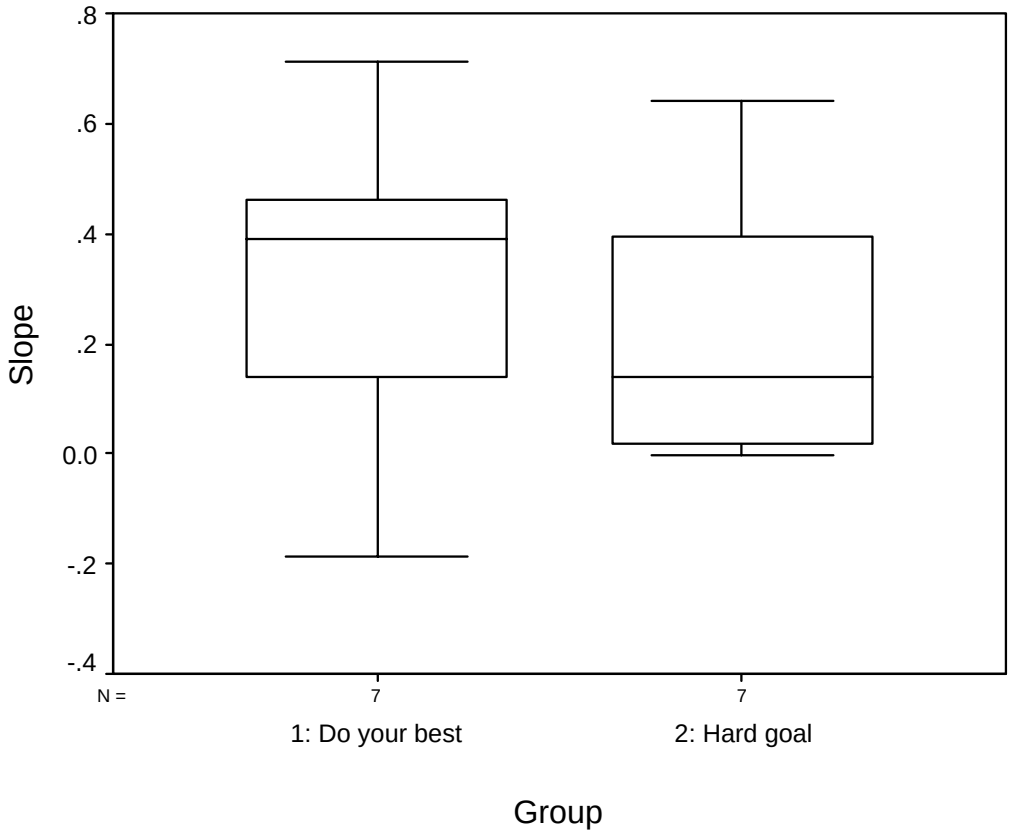
APPENDIX I

Box plot showing the average rate of performance recorded during the first and last timings for each group of participants in Experiment 4 who dribbled a soccer ball in and out of cones. Two groups were asked to do their best while the other group was given a hard goal of beating their previous highest score. Two groups, one of which was the hard goal group, completed at least 8 sessions with three 1-min timings being completed in each session while the remaining group, who were told to do their best, completed only two sessions with three 1-min timings being completed in each session.



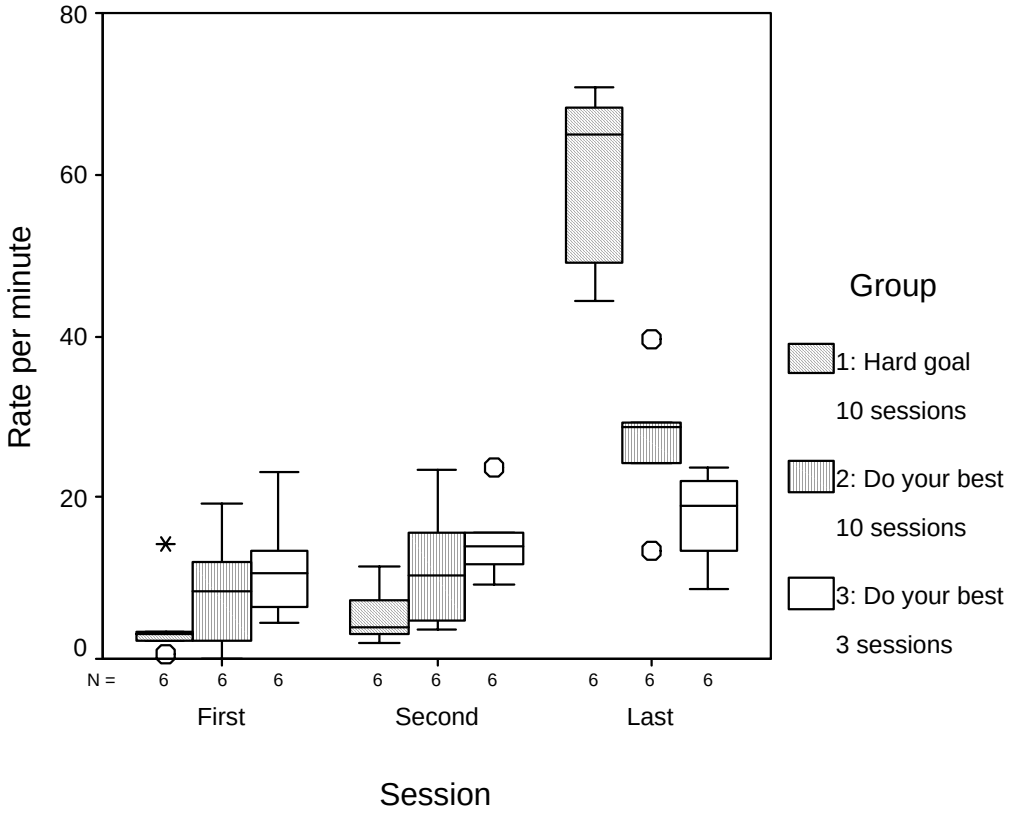
APPENDIX J

Box plot showing the average slopes for one skill, to dribble a soccer ball in and out of cones, for two groups in Experiment 4. One group was asked to do their best while the other group was given a hard goal of beating their previous highest score. Both groups completed at least 8 sessions with three 1-min timings being completed in each session.



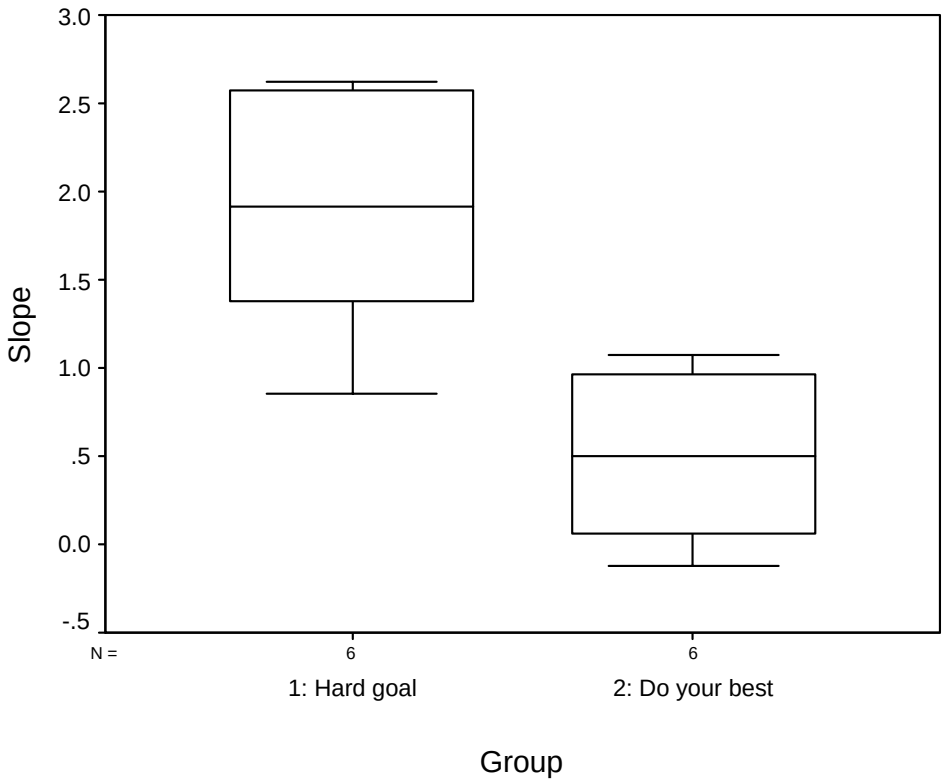
APPENDIX K

Box plot showing the average rate of performance recorded for one skill, forward crosses, during the first, second and last sessions for each group in Experiment 5. Group 1 was asked to complete 60 forward crosses in one minute while Groups 2 and 3 were asked to do their best. Groups 1 and 2 completed 10 sessions with three 1-min timings in each session while Group 3 completed only 3 sessions with three 1-min timings in each session.



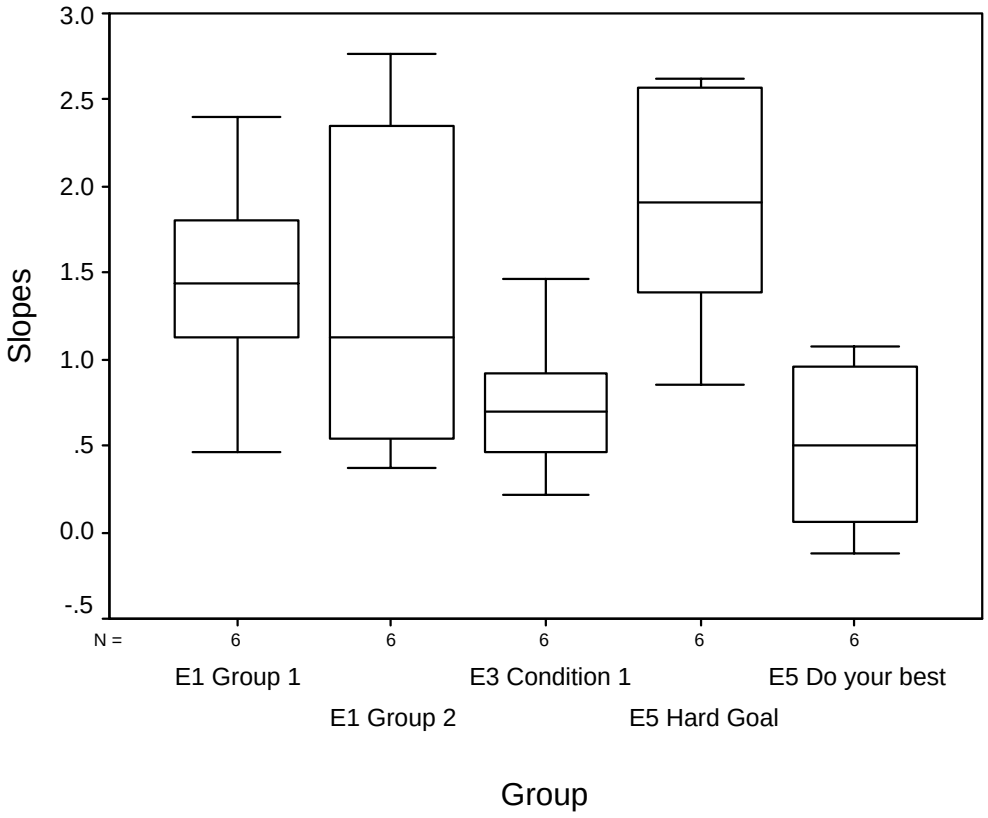
APPENDIX L

Box plot showing the average slopes, for Session 2 to Session 10, for one skill, forward crosses, for two groups (Group 1 and Group 2) in Experiment 5. Three 1-min timings were completed in each session.



APPENDIX M

Box plot showing the average slopes for one skill, forward crosses, for two groups (Group 1 and Group 2) in Experiment 1, one group in Experiment 3, and two groups (Group 1 and Group 2) in Experiment 5. Eight sessions, where three 1-min timings were completed in each session, were used in the analysis for each group.



APPENDIX N

The raw data for each participant in Experiment 1. The participant number (Participant), the experimental group (Group), the session number (Session), the timing number (Timing), the number of correct forward crosses completed in 1-min (CFC), the number of incorrect forward crosses completed in the same minute (IFC), the number of correct back scissors completed in a minute (CBS) and the number of incorrect back scissors completed in the same minute (IBS).

Participant	Group	Session	Timing	CFC	IFC	CBS	IBS
P1	Group 1	1	1	30	0	51	1
P1	Group 1	1	2	33	0	49	0
P1	Group 1	1	3	33	1	47	1
P1	Group 1	2	1	36	0	50	1
P1	Group 1	2	2	35	0	53	1
P1	Group 1	2	3	36	0	58	0
P1	Group 1	3	1	45	0	58	2
P1	Group 1	3	2	46	0	66	0
P1	Group 1	3	3	47	0	65	2
P1	Group 1	4	1	55	0	75	0
P1	Group 1	4	2	56	0	79	1
P1	Group 1	4	3	59	0	81	0
P1	Group 1	5	1	53	0	75	0
P1	Group 1	5	2	55	0	83	0
P1	Group 1	5	3	59	0	84	1
P1	Group 1	7	1	57	0	89	0
P1	Group 1	7	2	59	0	97	0
P1	Group 1	7	3	66	0	99	0
P1	Group 1	8	1	67	0	92	2
P1	Group 1	8	2	67	0	98	1
P1	Group 1	8	3	68	0	100	1
P1	Group 1	9	1	66	0	97	2
P1	Group 1	9	2	68	0	99	2
P1	Group 1	9	3	70	0	101	1
P1	Group 1	10	1	70	0	94	2
P1	Group 1	10	2	68	0	97	0
P1	Group 1	10	3	64	0	90	0
P2	Group 1	1	1	38	2	38	2
P2	Group 1	1	2	42	2	39	3
P2	Group 1	1	3	42	0	43	1
P2	Group 1	2	1	47	1	48	1
P2	Group 1	2	2	32	1	49	1
P2	Group 1	2	3	43	0	54	2
P2	Group 1	3	1	43	6	62	0
P2	Group 1	3	2	49	1	58	1
P2	Group 1	3	3	49	0	59	1
P2	Group 1	4	1	58	1	64	1
P2	Group 1	4	2	60	0	71	0
P2	Group 1	4	3	62	0	73	0
P2	Group 1	5	1	54	0	78	0
P2	Group 1	5	2	56	0	79	0

P2	Group 1	5	3	57	0	81	0
P2	Group 1	7	1	62	0	81	2
P2	Group 1	7	2	66	0	94	0
P2	Group 1	7	3	67	0	95	0
P2	Group 1	8	1	65	0	88	0
P2	Group 1	8	2	68	0	93	0
P2	Group 1	8	3	70	0	95	0
P2	Group 1	9	1	68	0	100	0
P2	Group 1	9	2	70	0	98	0
P2	Group 1	9	3	70	0	102	0
P2	Group 1	10	1	65	0	86	1
P2	Group 1	10	2	68	0	91	0
P2	Group 1	10	3	69	0	89	0
P3	Group 1	1	1	19	9	21	4
P3	Group 1	1	2	18	8	22	3
P3	Group 1	1	3	29	7	21	5
P3	Group 1	2	1	32	3	18	0
P3	Group 1	2	2	34	1	24	1
P3	Group 1	2	3	33	0	22	0
P3	Group 1	3	1	27	2	20	3
P3	Group 1	3	2	27	5	21	1
P3	Group 1	3	3	39	1	25	2
P3	Group 1	4	1	38	1	23	1
P3	Group 1	4	2	44	0	24	0
P3	Group 1	4	3	38	0	22	1
P3	Group 1	5	1	41	0	29	0
P3	Group 1	5	2	44	1	26	0
P3	Group 1	5	3	48	3	25	0
P3	Group 1	6	1	50	2	25	0
P3	Group 1	6	2	48	2	36	0
P3	Group 1	6	3	44	8	34	0
P3	Group 1	7	1	49	0	35	0
P3	Group 1	7	2	49	4	43	0
P3	Group 1	7	3	50	1	40	0
P3	Group 1	8	1	50	0	43	0
P3	Group 1	8	2	52	0	40	0
P3	Group 1	8	3	50	0	45	0
P3	Group 1	9	1	47	0	40	0
P3	Group 1	9	2	50	0	43	0
P3	Group 1	9	3	46	0	47	0
P3	Group 1	10	1	46	1	40	2
P3	Group 1	10	2	49	0	40	0
P3	Group 1	10	3	46	5	42	0
P4	Group 1	1	1	8	15	12	6
P4	Group 1	1	2	15	16	16	4
P4	Group 1	1	3	23	13	17	5
P4	Group 1	2	1	14	15	19	3
P4	Group 1	2	2	13	15	17	4
P4	Group 1	2	3	20	10	9	15
P4	Group 1	3	1	13	6	17	6

P4	Group 1	3	2	15	5	15	6
P4	Group 1	3	3	13	3	13	6
P4	Group 1	4	1	11	0	12	4
P4	Group 1	4	2	20	0	14	1
P4	Group 1	4	3	23	0	14	3
P4	Group 1	6	1	18	1	19	0
P4	Group 1	6	2	17	0	17	1
P4	Group 1	6	3	20	0	15	2
P4	Group 1	8	1	20	0	25	0
P4	Group 1	8	2	22	0	26	0
P4	Group 1	8	3	24	0	26	0
P4	Group 1	9	1	22	0	25	0
P4	Group 1	9	2	27	0	24	0
P4	Group 1	9	3	23	0	26	0
P4	Group 1	10	1	18	0	25	0
P4	Group 1	10	2	24	0	26	0
P4	Group 1	10	3	22	0	25	0
P5	Group 1	1	1	8	13	3	7
P5	Group 1	1	2	9	14	5	5
P5	Group 1	1	3	12	6	6	5
P5	Group 1	2	1	17	0	6	5
P5	Group 1	2	2	19	0	9	3
P5	Group 1	2	3	19	0	8	4
P5	Group 1	3	1	16	1	11	3
P5	Group 1	3	2	16	1	15	0
P5	Group 1	3	3	11	3	16	1
P5	Group 1	4	1	15	0	17	1
P5	Group 1	4	2	13	0	16	2
P5	Group 1	4	3	19	0	16	1
P5	Group 1	5	1	27	0	19	2
P5	Group 1	5	2	29	0	24	1
P5	Group 1	5	3	26	0	27	0
P5	Group 1	6	1	34	0	25	6
P5	Group 1	6	2	28	1	25	4
P5	Group 1	6	3	35	0	25	3
P5	Group 1	7	1	30	0	26	0
P5	Group 1	7	2	34	0	27	0
P5	Group 1	7	3	30	1	30	0
P5	Group 1	8	1	32	1	21	3
P5	Group 1	8	2	34	1	27	1
P5	Group 1	8	3	30	0	29	3
P5	Group 1	9	1	44	0	32	1
P5	Group 1	9	2	40	0	29	1
P5	Group 1	9	3	41	0	30	2
P5	Group 1	10	1	45	0	30	0
P5	Group 1	10	2	50	0	31	0
P5	Group 1	10	3	46	0	32	0
P6	Group 1	1	1	8	5	13	8
P6	Group 1	1	2	6	5	18	7
P6	Group 1	1	3	7	7	24	5

P6	Group 1	2	1	8	2	16	9
P6	Group 1	2	2	13	2	17	9
P6	Group 1	2	3	12	2	16	9
P6	Group 1	3	1	9	2	20	6
P6	Group 1	3	2	12	3	20	5
P6	Group 1	3	3	19	1	21	2
P6	Group 1	4	1	31	7	22	2
P6	Group 1	4	2	40	4	23	3
P6	Group 1	4	3	41	4	25	2
P6	Group 1	5	1	46	2	20	3
P6	Group 1	5	2	50	0	27	2
P6	Group 1	5	3	49	2	27	0
P6	Group 1	7	1	35	4	17	3
P6	Group 1	7	2	46	1	17	1
P6	Group 1	7	3	47	2	24	0
P6	Group 1	8	1	48	0	22	0
P6	Group 1	8	2	49	0	26	0
P6	Group 1	8	3	51	0	27	0
P6	Group 1	9	1	49	2	26	0
P6	Group 1	9	2	54	0	24	0
P6	Group 1	9	3	52	1	26	0
P6	Group 1	10	1	51	3	24	0
P6	Group 1	10	2	52	1	25	0
P6	Group 1	10	3	50	3	33	0
P7	Group 2	1	1	14	10	7	9
P7	Group 2	1	2	17	8	9	7
P7	Group 2	1	3	16	12	13	5
P7	Group 2	2	1	28	5	14	6
P7	Group 2	2	2	25	3	21	0
P7	Group 2	2	3	26	5	20	1
P7	Group 2	3	1	14	15	21	1
P7	Group 2	3	2	20	12	24	1
P7	Group 2	3	3	24	10	28	0
P7	Group 2	4	1	11	8	24	0
P7	Group 2	4	2	11	23	28	0
P7	Group 2	4	3	7	18	29	0
P7	Group 2	6	1	27	6	26	0
P7	Group 2	6	2	27	5	34	0
P7	Group 2	6	3	28	3	30	0
P7	Group 2	7	1	23	4	40	0
P7	Group 2	7	2	27	1	41	0
P7	Group 2	7	3	25	0	41	0
P7	Group 2	8	1	26	9	42	0
P7	Group 2	8	2	25	11	44	1
P7	Group 2	8	3	23	10	46	0
P7	Group 2	9	1	29	11	48	1
P7	Group 2	9	2	36	6	47	0
P7	Group 2	9	3	30	6	51	1
P7	Group 2	10	1	37	5	51	0
P7	Group 2	10	2	39	2	50	0

P7	Group 2	10	3	41	2	48	0
P8	Group 2	1	1	10	3	16	6
P8	Group 2	1	2	10	2	25	0
P8	Group 2	1	3	12	2	22	2
P8	Group 2	2	1	9	4	19	2
P8	Group 2	2	2	14	2	21	2
P8	Group 2	2	3	10	4	25	0
P8	Group 2	3	1	16	2	19	2
P8	Group 2	3	2	20	2	24	0
P8	Group 2	3	3	32	3	23	0
P8	Group 2	4	1	29	4	28	3
P8	Group 2	4	2	34	4	35	0
P8	Group 2	4	3	43	3	34	1
P8	Group 2	6	1	50	0	39	1
P8	Group 2	6	2	50	1	40	1
P8	Group 2	6	3	50	0	41	0
P8	Group 2	7	1	44	0	36	0
P8	Group 2	7	2	44	1	41	0
P8	Group 2	7	3	50	2	42	0
P8	Group 2	8	1	59	0	39	0
P8	Group 2	8	2	62	0	45	0
P8	Group 2	8	3	53	1	40	0
P8	Group 2	9	1	53	0	45	1
P8	Group 2	9	2	48	0	45	0
P8	Group 2	9	3	48	0	45	0
P8	Group 2	10	1	52	0	40	0
P8	Group 2	10	2	53	0	44	0
P8	Group 2	10	3	48	0	50	1
P9	Group 2	1	1	15	8	9	3
P9	Group 2	1	2	18	6	8	4
P9	Group 2	1	3	19	3	11	3
P9	Group 2	2	1	24	1	12	6
P9	Group 2	2	2	21	3	12	3
P9	Group 2	2	3	27	3	13	2
P9	Group 2	3	1	29	1	14	1
P9	Group 2	3	2	35	1	14	1
P9	Group 2	3	3	31	0	16	0
P9	Group 2	4	1	30	2	12	2
P9	Group 2	4	2	30	1	15	3
P9	Group 2	4	3	33	0	15	2
P9	Group 2	5	1	38	3	14	1
P9	Group 2	5	2	40	0	18	0
P9	Group 2	5	3	38	1	19	0
P9	Group 2	6	1	35	0	23	0
P9	Group 2	6	2	36	0	25	1
P9	Group 2	6	3	32	1	28	2
P9	Group 2	7	1	31	2	26	2
P9	Group 2	7	2	33	0	31	3
P9	Group 2	7	3	41	0	30	1
P9	Group 2	8	1	43	1	32	0

P9	Group 2	8	2	47	0	31	0
P9	Group 2	8	3	46	1	34	0
P9	Group 2	9	1	46	2	32	0
P9	Group 2	9	2	47	1	35	0
P9	Group 2	9	3	47	2	36	2
P9	Group 2	10	1	38	0	27	2
P9	Group 2	10	2	41	0	30	1
P9	Group 2	10	3	39	1	35	0
P10	Group 2	1	1	26	13	25	5
P10	Group 2	1	2	32	12	24	4
P10	Group 2	1	3	32	8	28	1
P10	Group 2	2	1	37	1	24	3
P10	Group 2	2	2	35	1	26	3
P10	Group 2	2	3	42	1	31	2
P10	Group 2	3	1	41	0	33	1
P10	Group 2	3	2	40	0	33	0
P10	Group 2	3	3	36	0	33	0
P10	Group 2	4	1	42	0	45	0
P10	Group 2	4	2	46	1	45	1
P10	Group 2	4	3	50	0	47	0
P10	Group 2	5	1	50	0	60	0
P10	Group 2	5	2	55	0	73	0
P10	Group 2	5	3	55	0	63	2
P10	Group 2	6	1	53	0	63	2
P10	Group 2	6	2	56	0	63	2
P10	Group 2	6	3	57	0	79	0
P10	Group 2	8	1	55	0	56	1
P10	Group 2	8	2	56	0	59	1
P10	Group 2	8	3	59	0	61	1
P10	Group 2	9	1	50	1	67	0
P10	Group 2	9	2	50	0	71	2
P10	Group 2	9	3	52	0	75	1
P10	Group 2	10	1	43	1	59	0
P10	Group 2	10	2	48	0	58	0
P10	Group 2	10	3	47	0	66	0
P11	Group 2	1	1	33	8	26	6
P11	Group 2	1	2	36	2	28	2
P11	Group 2	1	3	41	1	32	1
P11	Group 2	2	1	36	3	28	1
P11	Group 2	2	2	36	4	32	1
P11	Group 2	2	3	34	2	35	1
P11	Group 2	3	1	46	0	26	2
P11	Group 2	3	2	52	0	30	2
P11	Group 2	3	3	46	0	21	2
P11	Group 2	5	1	43	0	27	0
P11	Group 2	5	2	47	0	31	0
P11	Group 2	5	3	49	0	39	0
P11	Group 2	6	1	42	1	28	7
P11	Group 2	6	2	44	0	33	0
P11	Group 2	6	3	42	0	34	1

P11	Group 2	7	1	36	0	30	2
P11	Group 2	7	2	38	3	34	1
P11	Group 2	7	3	42	0	36	1
P11	Group 2	8	1	40	0	41	0
P11	Group 2	8	2	39	0	43	1
P11	Group 2	8	3	45	0	44	0
P11	Group 2	9	1	45	0	44	1
P11	Group 2	9	2	49	0	48	0
P11	Group 2	9	3	54	0	50	0
P11	Group 2	10	1	49	0	46	2
P11	Group 2	10	2	47	0	50	1
P11	Group 2	10	3	48	0	54	0
P12	Group 2	1	1	5	3	14	6
P12	Group 2	1	2	7	3	18	3
P12	Group 2	1	3	7	3	17	3
P12	Group 2	2	1	6	4	21	1
P12	Group 2	2	2	6	4	22	1
P12	Group 2	2	3	8	3	21	1
P12	Group 2	3	1	9	3	18	0
P12	Group 2	3	2	12	0	18	0
P12	Group 2	3	3	11	1	19	0
P12	Group 2	4	1	23	0	22	1
P12	Group 2	4	2	32	0	22	0
P12	Group 2	4	3	39	0	25	0
P12	Group 2	5	1	49	0	27	0
P12	Group 2	5	2	44	1	31	0
P12	Group 2	5	3	49	0	30	0
P12	Group 2	7	1	43	1	33	2
P12	Group 2	7	2	40	2	37	2
P12	Group 2	7	3	46	1	41	1
P12	Group 2	8	1	57	1	42	0
P12	Group 2	8	2	64	0	44	0
P12	Group 2	8	3	56	0	45	0
P12	Group 2	9	1	55	0	28	1
P12	Group 2	9	2	50	3	33	1
P12	Group 2	9	3	54	0	31	1
P12	Group 2	10	1	56	1	36	0
P12	Group 2	10	2	53	1	36	0
P12	Group 2	10	3	52	1	35	1

APPENDIX O

Raw scores obtained for three observers who watched 21 different timed minutes of forward crosses that had been recorded onto a video tape during Experiment 1. Observation number (Observation), number of correct forward crosses observed by Observer 1 (Ob1 C), number of incorrect forward crosses observed by Observer 1 (Ob1 I), number of correct forward crosses observed by Observer 2 (Ob2 C), number of incorrect forward crosses observed by Observer 2 (Ob2 I), number of correct forward crosses observed by Observer 3 (Ob3 C), and number of incorrect forward crosses observed by Observer 3 (Ob3 I).

Observation	Ob1 C	Ob1 I	Ob2 C	Ob2 I	Ob3 C	Ob3 I
1	31	1	33	1	32	1
2	65	1	65	1	65	1
3	22	4	22	4	23	3
4	61	3	61	2	62	1
5	22	2	23	1	23	1
6	30	11	25	19	29	17
7	16	4	19	2	20	1
8	6	12	7	13	6	12
9	40	6	43	3	44	1
10	3	2	3	2	3	2
11	37	15	47	10	47	10
12	12	13	12	13	14	11
13	34	9	40	5	40	5
14	11	0	11	0	11	0
15	41	4	47	3	47	1
16	14	4	16	4	16	3
17	33	4	36	2	36	2
18	31	3	31	1	33	2
19	48	0	48	0	48	0
20	4	2	4	2	4	2
21	52	4	60	0	60	1

APPENDIX P

Raw scores obtained for three observers who watched 21 different timed minutes of back scissors that had been recorded onto a video tape. Observation number (Observation), number of correct back scissors observed by Observer 1 (Ob1 C), number of incorrect back scissors observed by Observer 1 (Ob1 I), number of correct back scissors observed by Observer 2 (Ob2 C), number of incorrect back scissors observed by Observer 2 (Ob2 I), number of correct back scissors observed by Observer 3 (Ob3 C), and number of incorrect back scissors observed by Observer 3 (Ob3 I).

Observation	Ob1 C	Ob1 I	Ob2 C	Ob2 I	Ob3 C	Ob3 I
1	41	1	41	1	41	1
2	89	2	92	0	92	0
3	32	6	32	4	34	4
4	77	0	80	0	80	0
5	21	2	23	0	21	2
6	32	1	32	2	32	1
7	26	0	25	0	26	0
8	8	5	8	4	10	3
9	30	3	34	1	32	1
10	6	15	5	14	6	15
11	31	1	31	1	31	1
12	15	6	15	4	15	4
13	43	3	43	3	43	3
14	17	3	17	4	17	4
15	52	1	53	2	51	4
16	7	4	7	4	7	4
17	31	2	30	1	33	1
18	23	6	26	6	24	6
19	54	2	51	1	54	1
20	11	8	13	7	14	6
21	29	2	32	2	31	2

APPENDIX Q

The raw data for each participant in Experiment 2. The participant number (Participant), the experimental group (Group), the session number (Session), the timing number (Timing), the number of correct back crosses completed in 1-min (Correct), and the number of incorrect back crosses completed in the same minute (Incorrect).

Participant	Group	Session	Timing	Correct	Incorrect
P1	1	1	1	4	13
P1	1	1	2	1	19
P1	1	1	3	3	14
P1	1	2	1	9	9
P1	1	2	2	13	9
P1	1	2	3	8	11
P1	1	3	1	15	8
P1	1	3	2	16	6
P1	1	3	3	16	7
P1	1	4	1	15	4
P1	1	4	2	15	3
P1	1	4	3	20	1
P1	1	5	1	17	1
P1	1	5	2	19	1
P1	1	5	3	17	0
P1	1	6	1	28	0
P1	1	6	2	25	0
P1	1	6	3	23	1
P1	1	7	1	21	0
P1	1	7	2	31	0
P1	1	7	3	30	0
P1	1	8	1	35	0
P1	1	8	2	34	0
P1	1	8	3	33	0
P1	1	9	1	40	0
P1	1	9	2	35	0
P1	1	9	3	37	0
P1	1	10	1	23	0
P1	1	10	2	30	0
P1	1	10	3	35	0
P2	1	1	1	21	5
P2	1	1	2	16	5
P2	1	1	3	22	4
P2	1	2	1	29	0
P2	1	2	2	22	0
P2	1	2	3	21	2
P2	1	3	1	25	0
P2	1	3	2	36	1
P2	1	3	3	26	4
P2	1	4	1	29	1
P2	1	4	2	22	1

P2	1	4	3	29	0
P2	1	5	1	27	0
P2	1	5	2	31	0
P2	1	5	3	29	0
P2	1	6	1	26	0
P2	1	6	2	23	1
P2	1	6	3	32	1
P2	1	7	1	30	0
P2	1	7	2	27	0
P2	1	7	3	30	0
P2	1	8	1	31	0
P2	1	8	2	38	0
P2	1	8	3	47	0
P2	1	9	1	35	0
P2	1	9	2	48	0
P2	1	9	3	52	0
P3	1	1	1	4	1
P3	1	1	2	4	4
P3	1	1	3	5	1
P3	1	2	1	9	0
P3	1	2	2	14	0
P3	1	2	3	16	1
P3	1	3	1	7	4
P3	1	3	2	8	2
P3	1	3	3	15	6
P3	1	4	1	20	11
P3	1	4	2	20	3
P3	1	4	3	20	3
P3	1	5	1	19	1
P3	1	5	2	20	1
P3	1	5	3	20	2
P3	1	6	1	13	2
P3	1	6	2	14	3
P3	1	6	3	13	5
P3	1	7	1	15	3
P3	1	7	2	17	4
P3	1	7	3	20	2
P3	1	8	1	18	0
P3	1	8	2	27	0
P3	1	8	3	25	0
P3	1	9	1	26	0
P3	1	9	2	23	2
P3	1	9	3	26	0
P3	1	10	1	20	0
P3	1	10	2	28	0
P3	1	10	3	30	1
P4	1	1	1	20	1
P4	1	1	2	23	1
P4	1	1	3	22	1
P4	1	2	1	22	0

P4	1	2	2	24	1
P4	1	2	3	22	2
P4	1	3	1	19	3
P4	1	3	2	18	3
P4	1	3	3	18	2
P4	1	4	1	21	2
P4	1	4	2	24	2
P4	1	4	3	23	3
P4	1	5	1	33	1
P4	1	5	2	15	0
P4	1	5	3	39	0
P4	1	6	1	38	0
P4	1	6	2	37	0
P4	1	6	3	21	0
P4	1	7	1	35	2
P4	1	7	2	43	0
P4	1	7	3	35	0
P4	1	8	1	40	0
P4	1	8	2	42	0
P4	1	8	3	43	0
P4	1	9	1	36	3
P4	1	9	2	46	0
P4	1	9	3	39	2
P4	1	10	1	45	0
P4	1	10	2	52	0
P4	1	10	3	48	0
P5	1	1	1	15	10
P5	1	1	2	15	11
P5	1	1	3	21	7
P5	1	2	1	18	2
P5	1	2	2	20	3
P5	1	2	3	16	5
P5	1	3	1	20	2
P5	1	3	2	26	0
P5	1	3	3	28	1
P5	1	4	1	20	0
P5	1	4	2	20	1
P5	1	4	3	22	0
P5	1	5	1	25	1
P5	1	5	2	18	3
P5	1	5	3	20	2
P5	1	6	1	35	0
P5	1	6	2	35	0
P5	1	6	3	34	1
P5	1	7	1	33	0
P5	1	7	2	33	0
P5	1	7	3	27	0
P5	1	8	1	31	0
P5	1	8	2	30	0
P5	1	8	3	27	0

P5	1	10	1	28	1
P5	1	10	2	27	0
P5	1	10	3	23	1
P6	2	1	1	29	2
P6	2	1	2	35	2
P6	2	1	3	40	2
P6	2	2	1	49	0
P6	2	2	2	41	1
P6	2	2	3	48	0
P6	2	3	1	46	2
P6	2	3	2	51	0
P6	2	3	3	55	0
P6	2	4	1	47	0
P6	2	4	2	52	0
P6	2	4	3	49	0
P6	2	5	1	50	0
P6	2	5	2	50	0
P6	2	5	3	51	0
P6	2	6	1	56	0
P6	2	6	2	58	0
P6	2	6	3	64	0
P6	2	7	1	56	0
P6	2	7	2	56	0
P6	2	7	3	54	0
P6	2	8	1	57	0
P6	2	8	2	57	0
P6	2	8	3	59	0
P6	2	10	1	55	0
P6	2	10	2	62	0
P6	2	10	3	70	0
P7	2	1	1	10	7
P7	2	1	2	14	7
P7	2	1	3	16	4
P7	2	2	1	15	3
P7	2	2	2	11	9
P7	2	2	3	16	4
P7	2	3	1	21	0
P7	2	3	2	22	0
P7	2	3	3	21	2
P7	2	4	1	23	0
P7	2	4	2	23	0
P7	2	4	3	18	1
P7	2	5	1	29	0
P7	2	5	2	20	1
P7	2	5	3	26	0
P7	2	7	1	23	2
P7	2	7	2	23	3
P7	2	7	3	27	3
P7	2	8	1	20	2
P7	2	8	2	30	1

P7	2	8	3	38	3
P7	2	9	1	40	1
P7	2	9	2	29	1
P7	2	9	3	30	2
P7	2	10	1	34	2
P7	2	10	2	32	3
P7	2	10	3	42	1
P8	2	1	1	16	6
P8	2	1	2	22	5
P8	2	1	3	16	3
P8	2	2	1	17	2
P8	2	2	2	21	0
P8	2	2	3	20	1
P8	2	3	1	22	0
P8	2	3	2	22	0
P8	2	3	3	27	1
P8	2	4	1	21	0
P8	2	4	2	22	0
P8	2	4	3	26	0
P8	2	5	1	21	0
P8	2	5	2	31	0
P8	2	5	3	23	4
P8	2	7	1	30	0
P8	2	7	2	34	2
P8	2	7	3	25	2
P8	2	8	1	22	1
P8	2	8	2	35	2
P8	2	8	3	47	0
P8	2	9	1	40	0
P8	2	9	2	42	1
P8	2	9	3	47	0
P8	2	10	1	40	1
P8	2	10	2	43	1
P8	2	10	3	49	0
P9	2	1	1	22	4
P9	2	1	2	22	1
P9	2	1	3	34	0
P9	2	2	1	31	0
P9	2	2	2	33	0
P9	2	2	3	34	0
P9	2	3	1	27	1
P9	2	3	2	30	1
P9	2	3	3	27	1
P9	2	4	1	32	0
P9	2	4	2	38	0
P9	2	4	3	25	0
P9	2	5	1	28	0
P9	2	5	2	39	0
P9	2	5	3	41	0
P9	2	6	1	39	0

P9	2	6	2	39	0
P9	2	6	3	40	0
P9	2	7	1	35	0
P9	2	7	2	38	0
P9	2	7	3	44	0
P9	2	8	1	38	0
P9	2	8	2	40	1
P9	2	8	3	49	0
P9	2	9	1	40	0
P9	2	9	2	47	0
P9	2	9	3	44	0
P9	2	10	1	48	0
P9	2	10	2	41	2
P9	2	10	3	48	0
P10	2	1	1	23	4
P10	2	1	2	24	0
P10	2	1	3	28	2
P10	2	2	1	32	0
P10	2	2	2	33	0
P10	2	2	3	35	0
P10	2	3	1	33	0
P10	2	3	2	30	0
P10	2	3	3	32	0
P10	2	4	1	31	0
P10	2	4	2	35	0
P10	2	4	3	40	0
P10	2	5	1	40	0
P10	2	5	2	45	0
P10	2	5	3	42	0
P10	2	7	1	45	0
P10	2	7	2	39	0
P10	2	7	3	43	0
P10	2	8	1	39	0
P10	2	8	2	42	0
P10	2	8	3	45	0
P10	2	9	1	40	1
P10	2	9	2	43	0
P10	2	9	3	42	0
P10	2	10	1	44	1
P10	2	10	2	48	0
P10	2	10	3	50	0

APPENDIX R

Raw scores obtained for two observers who watched 20 different timed minutes of back crosses that had been recorded onto a video tape during Experiment 2. Observation number (Observation), number of correct back crosses observed by Observer 1 (Ob1 C), number of incorrect back crosses observed by Observer 1 (Ob1 I), number of correct back crosses observed by Observer 2 (Ob2 C), and number of incorrect back crosses observed by Observer 2 (Ob2 I).

Observation	Ob1 C	Ob1 I	Ob2 C	Ob2 I
1	31	1	33	1
2	65	1	65	1
3	22	4	22	4
4	61	3	61	2
5	22	2	23	1
6	30	11	25	19
7	6	12	7	13
8	40	6	43	3
9	3	2	3	2
10	37	15	47	10
11	12	13	12	13
12	34	9	40	5
13	11	0	11	0
14	41	4	47	3
15	14	4	16	4
16	33	4	36	2
17	31	3	31	1
18	48	0	48	0
19	4	2	4	2
20	52	4	60	0

APPENDIX S

Each participant's raw data for Experiment 3. The participant number (Participant), the condition (Condition), the session number (Session), the timing number (Timing), the number of correct forward crosses completed in 1-min (CFC), the number of incorrect forward crosses completed in the same minute (IFC), the number of correct back scissors completed in a minute (CBS) and the number of incorrect back scissors completed in the same minute (IBS).

Participant	Condition	Session	Timing	CFC	IFC	CBS	IBS
P1	1	1	1	29	1	20	2
P1	1	1	2	31	8	23	0
P1	1	1	3	26	7	20	0
P1	1	2	1	37	1	22	1
P1	1	2	2	39	2	22	0
P1	1	2	3	35	2	22	2
P1	1	3	1	40	4	25	1
P1	1	3	2	38	3	28	0
P1	1	3	3	36	3	26	0
P1	1	4	1	44	1	29	0
P1	1	4	2	44	1	27	0
P1	1	4	3	42	1	33	0
P1	1	5	1	42	3	34	0
P1	1	5	2	43	0	28	1
P1	1	5	3	44	1	33	0
P1	1	6	1	41	0	31	0
P1	1	6	2	48	0	30	0
P1	1	6	3	43	0	36	0
P1	1	7	1	47	1	29	0
P1	1	7	2	45	0	31	0
P1	1	7	3	42	1	34	0
P1	1	8	1	45	1	39	0
P1	1	8	2	46	1	51	0
P1	1	8	3	46	1	50	0
P1	1	9	1	14	0	45	0
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P1	1	9	3	48	0	42	0
P1	1	10	1	48	0	39	0
P1	1	10	2	50	0	40	0
P1	1	10	3	47	0	40	0
P1	2	11	1	52	0	48	0
P1	2	11	2	57	0	48	0
P1	2	11	3	60	0	46	0
P1	2	12	1	58	0	52	0
P1	2	12	2	68	0	50	0
P1	2	12	3	67	0	52	0
P1	2	13	1	46	0	43	1
P1	2	13	2	42	0	34	0
P1	2	13	3	47	0	39	0

P1	2	14	1	51	0	36	1
P1	2	14	2	52	0	40	0
P1	2	14	3	54	0	38	0
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P1	2	15	2	56	1	41	0
P1	2	15	3	58	1	44	0
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P1	2	16	2	52	2	51	0
P1	2	16	3	56	1	47	0
P1	2	17	1	59	0	44	1
P1	2	17	2	60	2	49	1
P1	2	17	3	59	0	52	0
P1	2	18	1	61	1	50	0
P1	2	18	2	63	0	44	2
P1	2	18	3	67	0	47	0
P1	2	19	1	60	0	48	0
P1	2	19	2	64	0	46	0
P1	2	19	3	56	2	46	0
P1	3	20	1	59	0	51	0
P1	3	20	2	55	0	55	0
P1	3	20	3	60	0	58	0
P1	3	21	1	54	0	51	0
P1	3	21	2	58	0	50	0
P1	3	21	3	56	0	62	0
P1	3	22	1	54	0	51	1
P1	3	22	2	62	1	62	0
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P3	1	3	2	9	3	6	5
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P3	1	9	1	16	0	17	0
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P3	1	16	1	19	2	14	0

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P3	2	18	1	18	0	22	2
P3	2	17	2	18	0	24	0
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P3	2	17	3	18	0	24	0
P3	2	17	3	25	2	25	3
P3	2	18	1	21	0	24	1
P3	2	18	1	20	0	21	0
P3	2	18	2	22	0	27	1
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P3	2	18	3	22	0	26	1
P3	2	18	3	22	1	19	3
P3	2	19	1	24	0	21	3
P3	2	19	2	28	0	23	0
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P3	2	20	2	22	0	22	2
P3	2	20	3	24	0	24	1
P3	2	21	1	29	0	29	0
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P3	2	22	1	27	0	25	2
P3	2	22	2	29	0	30	0
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P3	2	23	2	36	0	29	1
P3	2	23	3	33	0	31	1
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P4	1	1	3	23	20	6	16
P4	1	2	1	31	16	18	6
P4	1	2	2	35	7	20	3
P4	1	2	3	32	9	14	8
P4	1	3	1	42	1	22	3
P4	1	3	2	41	1	19	2
P4	1	3	3	39	2	19	2
P4	1	4	1	50	0	24	0
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P4	1	4	3	46	1	27	0
P4	1	5	1	49	0	29	0
P4	1	5	2	50	0	35	0
P4	1	5	3	46	0	37	0
P4	1	6	1	51	0	34	1
P4	1	6	2	51	1	42	3
P4	1	6	3	55	0	44	0
P4	1	7	1	54	1	37	2
P4	1	7	2	51	1	39	0
P4	1	7	3	55	0	40	0

P4	1	9	1	55	1	35	0
P4	1	9	2	54	2	45	0
P4	1	9	3	60	0	47	2
P4	1	10	1	65	0	49	0
P4	1	10	2	71	0	47	0
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P4	1	11	3	69	0	47	0
P4	2	12	1	73	0	61	1
P4	2	12	2	71	0	65	0
P4	2	12	3	74	0	68	0
P4	2	13	1	70	0	67	0
P4	2	13	2	68	0	72	0
P4	2	13	3	71	0	75	0
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P5	1	1	2	12	2	2	8
P5	1	1	3	14	4	3	9
P5	1	2	1	20	0	2	10
P5	1	2	2	20	2	2	12
P5	1	2	3	16	4	2	12
P5	1	3	1	12	3	3	10
P5	1	3	2	13	4	16	5
P5	1	3	3	11	3	24	0
P5	1	4	1	8	5	22	4
P5	1	4	2	12	0	22	2
P5	1	4	3	10	4	18	2
P5	1	5	1	12	1	6	8
P5	1	5	2	14	0	10	5
P5	1	5	3	10	2	7	6
P6	1	1	1	6	4	3	6
P6	1	1	2	5	5	3	9
P6	1	1	3	9	2	7	7
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P6	1	3	2	5	3	8	7
P6	1	3	3	7	4	8	6
P6	1	4	1	7	1	9	2
P6	1	4	2	7	2	9	4
P6	1	4	3	7	3	8	6
P6	1	5	1	4	4	9	6
P6	1	5	2	7	3	6	6
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P6	1	6	1	5	2	6	7
P6	1	6	2	9	0	6	9
P6	1	6	3	8	0	12	5
P6	1	7	1	12	3	10	4
P6	1	7	2	12	2	11	3

P6	1	7	3	15	1	11	3
P6	1	8	1	12	3	3	10
P6	1	8	2	13	4	16	5
P6	1	8	3	11	3	13	0
P6	1	9	1	10	4	24	0
P6	1	9	2	11	1	18	5
P6	1	9	3	11	1	16	5
P6	1	10	1	10	1	22	0
P6	1	10	2	9	1	28	2
P6	1	10	3	12	3	19	4
P6	1	11	1	10	1	24	2
P6	1	11	2	16	2	19	3
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P7	1	3	3	28	1	15	2
P7	1	4	1	20	1	26	4
P7	1	4	2	22	0	19	1
P7	1	4	3	18	1	25	4
P7	1	5	1	37	0	29	3
P7	1	5	2	37	0	26	2
P7	1	5	3	34	0	26	2
P7	1	7	1	35	1	28	0
P7	1	7	2	11	3	32	0
P7	1	7	3	43	0	30	0
P7	1	8	1	40	0	28	1
P7	1	8	2	41	0	29	0
P7	1	8	3	45	0	28	0
P7	1	9	1	30	3	29	0
P7	1	9	2	43	0	27	0
P7	1	9	3	39	1	33	0
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P8	1	1	2	12	9	13	4
P8	1	1	3	15	7	12	3
P8	1	2	1	24	3	6	13
P8	1	2	2	31	2	10	2
P8	1	2	3	25	4	8	5
P8	1	3	1	35	3	18	1
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P8	1	3	3	33	1	16	3
P8	1	4	1	27	0	18	10
P8	1	4	2	26	2	28	3
P8	1	4	3	28	1	28	3
P8	1	5	1	26	2	14	8

P8	1	5	2	20	3	18	6
P8	1	5	3	29	0	20	2
P8	1	7	1	29	0	24	0
P8	1	7	2	29	0	24	0
P8	1	7	3	30	0	25	1
P8	1	8	1	32	3	23	3
P8	1	8	2	24	4	30	3
P8	1	8	3	40	1	28	2
P8	1	9	1	43	0	30	4
P8	1	9	2	41	0	26	4
P8	1	9	3	38	2	31	1
P8	1	10	1	35	0	27	4
P8	1	10	2	34	1	24	2
P8	1	10	3	37	0	25	2

APPENDIX T

Each participant's raw data for Experiment 4. The participant number (Participant), the group (Group), the session number (Session), the timing number (Timing), the number of cones passed correctly in 1-min (Correct), and the number of cones passed incorrectly in the same minute (Incorrect).

Participant	Group	Session	Timing	Correct	Incorrect
1	1	1	1	19	0
1	1	1	2	24	0
1	1	1	3	21	0
1	1	2	1	20	0
1	1	2	2	20	3
1	1	2	3	18	4
1	1	3	1	14	2
1	1	3	2	13	2
1	1	3	3	10	0
1	1	4	1	14	0
1	1	4	2	18	1
1	1	4	3	18	1
1	1	5	1	20	0
1	1	5	2	20	1
1	1	5	3	24	0
1	1	6	1	23	0
1	1	6	2	25	0
1	1	6	3	24	0
1	1	7	1	26	0
1	1	7	2	30	0
1	1	7	3	25	0
1	1	8	1	25	0
1	1	8	2	20	2
1	1	8	3	23	2
1	1	9	1	28	0
1	1	9	2	25	0
1	1	9	3	28	0
1	1	10	1	28	1
1	1	10	2	30	0
1	1	10	3	25	0
2	1	1	1	18	2
2	1	1	2	16	1
2	1	1	3	19	1
2	1	2	1	14	1
2	1	2	2	14	2
2	1	2	3	17	0
2	1	3	1	15	3

2	1	3	2	14	3
2	1	3	3	12	2
2	1	4	1	10	1
2	1	4	2	14	1
2	1	4	3	16	1
2	1	5	1	9	2
2	1	5	2	12	3
2	1	5	3	12	3
2	1	6	1	16	2
2	1	6	2	13	1
2	1	6	3	21	1
2	1	7	1	14	2
2	1	7	2	17	2
2	1	7	3	20	1
2	1	8	1	13	3
2	1	8	2	19	2
2	1	8	3	23	1
3	1	1	1	23	0
3	1	1	2	23	1
3	1	1	3	21	0
3	1	2	1	25	2
3	1	2	2	21	5
3	1	2	3	25	5
3	1	3	1	27	2
3	1	3	2	28	2
3	1	3	3	28	2
3	1	4	1	31	1
3	1	4	2	25	6
3	1	4	3	34	1
3	1	5	1	35	3
3	1	5	2	30	5
3	1	5	3	28	5
3	1	6	1	27	3
3	1	6	2	28	1
3	1	6	3	25	3
3	1	7	1	24	2
3	1	7	2	27	1
3	1	7	3	28	3
3	1	8	1	25	3
3	1	8	2	30	1
3	1	8	3	26	0
3	1	9	1	29	1
3	1	9	2	29	1
3	1	9	3	29	1
4	1	1	1	26	0

4	1	1	2	32	0
4	1	1	3	26	0
4	1	2	1	25	0
4	1	2	2	30	1
4	1	2	3	24	2
4	1	3	1	29	0
4	1	3	2	28	2
4	1	3	3	24	1
4	1	4	1	24	1
4	1	4	2	21	2
4	1	4	3	25	1
4	1	5	1	24	5
4	1	5	2	23	5
4	1	5	3	19	6
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4	1	6	2	22	4
4	1	6	3	24	1
4	1	7	1	21	2
4	1	7	2	25	1
4	1	7	3	26	1
4	1	8	1	20	2
4	1	8	2	23	1
4	1	8	3	25	0
4	1	9	1	27	0
4	1	9	2	24	0
4	1	9	3	21	0
5	1	1	1	12	0
5	1	1	2	11	1
5	1	1	3	11	1
5	1	2	1	21	1
5	1	2	2	24	0
5	1	2	3	18	0
5	1	3	1	20	0
5	1	3	2	17	2
5	1	3	3	21	1
5	1	4	1	17	3
5	1	4	2	25	0
5	1	4	3	25	0
5	1	5	1	25	5
5	1	5	2	23	2
5	1	5	3	22	3
5	1	6	1	29	1
5	1	6	2	29	0
5	1	6	3	30	0
5	1	7	1	30	0

5	1	7	2	28	1
5	1	7	3	25	3
5	1	8	1	30	0
5	1	8	2	27	0
5	1	8	3	28	0
6	1	1	1	12	0
6	1	1	2	10	2
6	1	1	3	10	2
6	1	2	1	16	2
6	1	2	2	24	0
6	1	2	3	23	1
6	1	3	1	20	0
6	1	3	2	23	2
6	1	3	3	25	0
6	1	4	1	23	0
6	1	4	2	22	0
6	1	4	3	23	0
6	1	5	1	20	0
6	1	5	2	18	0
6	1	5	3	19	0
6	1	6	1	26	0
6	1	6	2	24	1
6	1	6	3	25	0
6	1	7	1	26	0
6	1	7	2	27	0
6	1	7	3	24	1
6	1	8	1	28	0
6	1	8	2	27	1
6	1	8	3	29	6
6	1	9	1	28	0
6	1	9	2	27	0
6	1	9	3	27	0
6	1	10	1	28	0
6	1	10	2	30	2
6	1	10	3	28	2
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7	1	1	2	17	6
7	1	1	3	22	3
7	1	2	1	16	8
7	1	2	2	23	1
7	1	2	3	24	0
7	1	3	1	23	1
7	1	3	2	25	0
7	1	3	3	23	2
7	1	4	1	22	0

7	1	4	2	19	1
7	1	4	3	19	1
7	1	5	1	23	2
7	1	5	2	20	3
7	1	5	3	20	0
7	1	6	1	27	0
7	1	6	2	28	1
7	1	6	3	27	2
7	1	7	1	24	4
7	1	7	2	28	1
7	1	7	3	28	0
7	1	8	1	27	0
7	1	8	2	28	2
7	1	8	3	28	2
7	1	9	1	28	0
7	1	9	2	29	0
7	1	9	3	28	0
7	1	10	1	27	1
7	1	10	2	32	0
7	1	10	3	29	0
8	3	1	1	12	2
8	3	1	2	10	2
8	3	1	3	16	1
8	3	2	1	21	2
8	3	2	2	20	4
8	3	2	3	22	1
9	3	1	1	2	6
9	3	1	2	10	4
9	3	1	3	9	4
9	3	2	1	12	5
9	3	2	2	14	9
9	3	2	3	13	7
10	3	1	1	20	4
10	3	1	2	30	0
10	3	1	3	31	0
10	3	2	1	30	1
10	3	2	2	27	4
10	3	2	3	29	3
11	3	1	1	26	1
11	3	1	2	23	1
11	3	1	3	29	0
11	3	2	1	21	3
11	3	2	2	20	4
11	3	2	3	22	2
12	3	1	1	24	1

12	3	1	2	25	0
12	3	1	3	28	0
12	3	2	1	24	2
12	3	2	2	27	1
12	3	2	3	27	2
13	3	1	1	19	3
13	3	1	2	23	0
13	3	1	3	21	0
13	3	2	1	22	2
13	3	2	2	20	4
13	3	2	3	23	1
14	3	1	1	24	0
14	3	1	2	28	1
14	3	1	3	18	1
14	3	2	1	23	5
14	3	2	2	22	3
14	3	2	3	19	6
15	3	1	1	24	3
15	3	1	2	22	4
15	3	1	3	22	3
15	3	2	1	22	4
15	3	2	2	25	3
15	3	2	3	18	5
16	3	1	1	21	4
16	3	1	2	22	4
16	3	1	3	33	2
16	3	2	1	21	5
16	3	2	2	25	3
16	3	2	3	24	6
17	3	1	1	22	4
17	3	1	2	20	6
17	3	1	3	25	3
17	3	2	1	27	1
17	3	2	2	30	1
17	3	2	3	27	0
17	3	3	1	25	0
17	3	3	2	30	0
17	3	3	3	25	0
17	3	4	1	28	5
17	3	4	2	27	5
17	3	4	3	25	5
17	3	5	1	32	3
17	3	5	2	30	2
17	3	5	3	31	4
17	3	6	1	35	3

17	3	6	2	36	4
17	3	6	3	30	10
17	3	7	1	35	0
17	3	7	2	33	2
17	3	7	3	33	2
17	3	8	1	33	1
17	3	8	2	38	5
17	3	8	3	38	4
17	3	9	1	22	10
17	3	9	2	38	6
17	3	9	3	36	7
17	3	10	1	35	10
17	3	10	2	35	11
17	3	10	3	38	6
18	3	1	1	29	3
18	3	1	2	26	4
18	3	1	3	26	2
18	3	2	1	31	3
18	3	2	2	28	1
18	3	2	3	25	1
18	3	3	1	27	0
18	3	3	2	27	0
18	3	3	3	31	0
18	3	4	1	28	2
18	3	4	2	30	4
18	3	4	3	33	0
18	3	5	1	30	0
18	3	5	2	30	0
18	3	5	3	33	0
18	3	6	1	32	3
18	3	6	2	28	6
18	3	6	3	30	5
18	3	7	1	34	3
18	3	7	2	36	3
18	3	7	3	32	5
18	3	8	1	20	0
18	3	8	2	29	1
18	3	8	3	27	3
18	3	9	1	27	3
18	3	9	2	32	3
18	3	9	3	32	2
18	3	10	1	26	4
18	3	10	2	28	5
18	3	10	3	25	3
19	3	1	1	15	4

19	3	1	2	13	5
19	3	1	3	15	3
19	3	2	1	15	1
19	3	2	2	11	2
19	3	2	3	17	0
19	3	3	1	14	2
19	3	3	2	13	2
19	3	3	3	14	4
19	3	4	1	20	3
19	3	4	2	19	3
19	3	4	3	18	6
19	3	5	1	14	0
19	3	5	2	12	8
19	3	5	3	16	8
19	3	6	1	10	4
19	3	6	2	15	5
19	3	6	3	8	5
19	3	7	1	7	8
19	3	7	2	7	7
19	3	7	3	10	15
19	3	8	1	16	7
19	3	8	2	13	4
19	3	8	3	15	3
19	3	9	1	12	8
19	3	9	2	14	8
19	3	9	3	17	10
19	3	10	1	15	3
19	3	10	2	17	3
19	3	10	3	20	2
20	3	1	1	11	3
20	3	1	2	11	3
20	3	1	3	10	2
20	3	2	1	12	3
20	3	2	2	12	2
20	3	2	3	12	2
20	3	3	1	7	0
20	3	3	2	9	6
20	3	3	3	8	12
20	3	4	1	10	6
20	3	4	2	10	8
20	3	4	3	10	5
20	3	5	1	14	0
20	3	5	2	12	8
20	3	5	3	11	9
20	3	6	1	2	18

20	3	6	2	5	10
20	3	6	3	6	12
20	3	7	1	7	8
20	3	7	2	11	4
20	3	7	3	8	7
20	3	8	1	13	2
20	3	8	2	17	0
20	3	8	3	11	7
20	3	9	1	19	6
20	3	9	2	16	4
20	3	9	3	20	2
20	3	10	1	10	11
20	3	10	2	12	11
20	3	10	3	13	5
21	3	1	1	18	7
21	3	1	2	17	7
21	3	1	3	15	10
21	3	2	1	17	3
21	3	2	2	15	5
21	3	2	3	19	5
21	3	3	1	26	5
21	3	3	2	17	10
21	3	3	3	22	12
21	3	4	1	25	5
21	3	4	2	18	2
21	3	4	3	21	4
21	3	5	1	26	4
21	3	5	2	22	3
21	3	5	3	26	7
21	3	6	1	18	2
21	3	6	2	16	4
21	3	6	3	27	1
21	3	7	1	24	6
21	3	7	2	26	4
21	3	7	3	23	7
21	3	8	1	18	2
21	3	8	2	31	4
21	3	8	3	27	3
21	3	9	1	29	6
21	3	9	2	21	4
21	3	9	3	25	3
22	3	1	1	17	11
22	3	1	2	13	11
22	3	1	3	14	3
22	3	2	1	20	1

22	3	2	2	15	0
22	3	2	3	15	5
22	3	3	1	17	3
22	3	3	2	14	0
22	3	3	3	16	4
22	3	4	1	18	2
22	3	4	2	14	4
22	3	4	3	18	6
22	3	5	1	22	3
22	3	5	2	18	7
22	3	5	3	11	4
22	3	6	1	20	10
22	3	6	2	25	5
22	3	6	3	23	8
22	3	7	1	23	2
22	3	7	2	30	3
22	3	7	3	33	1
22	3	8	1	23	2
22	3	8	2	32	1
22	3	8	3	31	4
22	3	9	1	20	4
22	3	9	2	27	6
22	3	9	3	28	3
22	3	10	1	31	2
22	3	10	2	35	5
22	3	10	3	30	3
23	3	1	1	18	1
23	3	1	2	15	0
23	3	1	3	15	0
23	3	2	1	15	3
23	3	2	2	8	6
23	3	2	3	15	3
23	3	3	1	13	1
23	3	3	2	12	2
23	3	3	3	15	0
23	3	4	1	14	0
23	3	4	2	15	0
23	3	4	3	18	2
23	3	5	1	14	0
23	3	5	2	20	0
23	3	5	3	13	1
23	3	6	1	13	2
23	3	6	2	14	1
23	3	6	3	13	2
23	3	7	1	15	0

23	3	7	2	15	0
23	3	7	3	14	1
23	3	8	1	15	0
23	3	8	2	15	0
23	3	8	3	16	0
23	3	9	1	15	1
23	3	9	2	11	4
23	3	9	3	18	0

APPENDIX U

Raw scores obtained for two observers who watched 10 different timed minutes of participants dribbling a soccer ball in and out of cones during Experiment 4. Observation number (Observation), number of cones passed correctly observed by Observer 1 (Ob1 C), number of cones passed incorrectly observed by Observer 1 (Ob1 I), number of cones passed correctly observed by Observer 2 (Ob2 C), and number of cones passed incorrectly observed by Observer 2 (Ob2 I).

Observation	Ob1 C	Ob1 I	Ob2 C	Ob2 I
1	31	3	33	2
2	25	1	25	1
3	22	4	22	4
4	31	3	30	4
5	22	2	23	1
6	30	4	30	4
7	16	0	16	0
8	30	5	32	3
9	12	2	13	2
10	17	0	17	0

APPENDIX V

Each participant's raw data for Experiment 5. The participant number (Participant), group (Group), the condition (Condition), the session number (Session), the timing number (Timing), the number of correct forward crosses completed in 1-min (CFC), the number of incorrect forward crosses completed in the same minute (IFC), the number of correct back scissors completed in a minute (CBS) and the number of incorrect back scissors completed in the same minute (IBS).

Participant	Group	Condition	Session	Timing	CFC	IFC
1	1	1	1	1	5	9
1	1	1	1	2	3	7
1	1	1	1	3	2	8
1	1	2	2	1	4	21
1	1	2	2	2	1	21
1	1	2	2	3	4	14
1	1	3	3	1	20	16
1	1	3	3	2	22	18
1	1	3	3	3	18	14
1	1	3	4	1	28	15
1	1	3	4	2	52	8
1	1	3	4	3	62	9
1	1	3	5	1	48	0
1	1	3	5	2	63	0
1	1	3	5	3	71	0
1	1	3	6	1	65	3
1	1	3	6	2	52	5
1	1	3	6	3	71	0
1	1	3	7	1	48	10
1	1	3	7	2	45	10
1	1	3	7	3	48	3
1	1	3	8	1	54	3
1	1	3	8	2	57	5
1	1	3	8	3	64	0
1	1	3	9	1	67	2
1	1	3	9	2	60	5
1	1	3	9	3	51	0
1	1	3	10	1	58	0
1	1	3	10	2	21	26
1	1	3	10	3	54	3
2	1	1	1	1	3	8
2	1	1	1	2	6	13
2	1	1	1	3	0	7
2	1	2	2	1	5	9
2	1	2	2	2	5	8
2	1	2	2	3	2	9

2	1	3	3	1	17	8
2	1	3	3	2	20	10
2	1	3	3	3	14	6
2	1	3	4	1	43	15
2	1	3	4	2	58	5
2	1	3	4	3	60	10
2	1	3	5	1	34	1
2	1	3	5	2	42	0
2	1	3	5	3	55	0
2	1	3	6	1	54	0
2	1	3	6	2	3	43
2	1	3	6	3	71	0
2	1	3	7	1	64	7
2	1	3	7	2	58	9
2	1	3	7	3	46	13
2	1	3	8	1	13	26
2	1	3	8	2	13	19
2	1	3	8	3	28	25
2	1	3	9	1	67	0
2	1	3	9	2	59	1
2	1	3	9	3	63	0
2	1	3	10	1	65	0
2	1	3	10	2	69	0
2	1	3	10	3	71	0
3	1	1	1	1	0	0
3	1	1	1	2	2	6
3	1	1	1	3	5	3
3	1	2	2	1	1	7
3	1	2	2	2	3	2
3	1	2	2	3	2	4
3	1	2	3	1	10	4
3	1	2	3	2	7	4
3	1	2	3	3	12	1
3	1	2	4	1	10	1
3	1	2	4	2	12	0
3	1	2	4	3	20	1
3	1	2	5	1	21	1
3	1	2	5	2	25	1
3	1	2	5	3	23	1
3	1	2	6	1	29	1
3	1	2	6	2	33	0
3	1	2	6	3	29	0
3	1	2	7	1	50	0
3	1	2	7	2	48	2
3	1	2	7	3	53	0

3	1	2	8	1	48	2
3	1	2	8	2	48	0
3	1	2	8	3	47	0
3	1	2	9	1	51	0
3	1	2	9	2	58	0
3	1	2	9	3	60	0
3	1	2	10	1	60	0
3	1	2	10	2	62	0
3	1	2	10	3	64	0
4	1	1	1	1	1	6
4	1	1	1	2	5	1
4	1	1	1	3	3	4
4	1	2	2	1	8	3
4	1	2	2	2	6	4
4	1	2	2	3	8	3
4	1	2	3	1	17	2
4	1	2	3	2	19	0
4	1	2	3	3	21	0
4	1	2	4	1	18	0
4	1	2	4	2	19	1
4	1	2	4	3	19	0
4	1	2	5	1	24	0
4	1	2	5	2	27	0
4	1	2	5	3	32	0
4	1	2	6	1	28	2
4	1	2	6	2	34	0
4	1	2	6	3	33	0
4	1	2	7	1	41	0
4	1	2	7	2	39	1
4	1	2	7	3	43	0
4	1	2	8	1	39	0
4	1	2	8	2	40	0
4	1	2	8	3	41	1
4	1	2	9	1	47	0
4	1	2	9	2	41	0
4	1	2	9	3	41	0
4	1	2	10	1	45	0
4	1	2	10	2	49	0
4	1	2	10	3	53	0
5	1	1	1	1	2	4
5	1	1	1	2	0	0
5	1	1	1	3	0	0
5	1	2	2	1	3	2
5	1	2	2	2	2	4
5	1	2	2	3	6	1

5	1	2	3	1	9	4
5	1	2	3	2	10	5
5	1	2	3	3	9	3
5	1	2	4	1	18	2
5	1	2	4	2	13	3
5	1	2	4	3	14	0
5	1	2	5	1	16	1
5	1	2	5	2	28	0
5	1	2	5	3	42	1
5	1	2	6	1	25	0
5	1	2	6	2	33	0
5	1	2	6	3	37	0
5	1	2	7	1	32	0
5	1	2	7	2	44	2
5	1	2	7	3	49	0
5	1	2	8	1	42	0
5	1	2	8	2	26	0
5	1	2	8	3	35	0
5	1	2	9	1	60	0
5	1	2	9	2	62	0
5	1	2	9	3	61	0
5	1	2	10	1	66	0
5	1	2	10	2	68	0
5	1	2	10	3	69	0
6	1	1	1	1	12	7
6	1	1	1	2	17	3
6	1	1	1	3	14	7
6	1	2	2	1	12	6
6	1	2	2	2	11	5
6	1	2	2	3	11	3
6	1	2	3	1	17	2
6	1	2	3	2	18	2
6	1	2	3	3	20	0
6	1	2	4	1	22	0
6	1	2	4	2	28	2
6	1	2	4	3	29	0
6	1	2	5	1	35	1
6	1	2	5	2	34	0
6	1	2	5	3	42	0
6	1	2	6	1	25	0
6	1	2	6	2	33	0
6	1	2	6	3	37	0
6	1	2	7	1	21	0
6	1	2	7	2	40	0
6	1	2	7	3	39	0

6	1	2	8	1	51	2
6	1	2	8	2	28	0
6	1	2	8	3	60	0
6	1	2	9	1	59	0
6	1	2	9	2	50	0
6	1	2	9	3	64	0
6	1	2	10	1	73	0
6	1	2	10	2	69	0
6	1	2	10	3	70	0
7	2	1	1	1	8	4
7	2	1	1	2	6	12
7	2	1	1	3	12	6
7	2	2	2	1	21	2
7	2	2	2	2	25	4
7	2	2	2	3	24	0
7	2	2	3	1	21	0
7	2	2	3	2	23	1
7	2	2	3	3	22	1
7	2	2	4	1	20	0
7	2	2	4	2	25	0
7	2	2	4	3	25	0
7	2	2	5	1	22	0
7	2	2	5	2	25	0
7	2	2	5	3	21	0
7	2	2	6	1	16	0
7	2	2	6	2	22	0
7	2	2	6	3	21	0
7	2	2	7	1	22	2
7	2	2	7	2	21	0
7	2	2	7	3	19	0
7	2	2	8	1	22	0
7	2	2	8	2	23	0
7	2	2	8	3	22	0
7	2	2	9	1	24	0
7	2	2	9	2	24	0
7	2	2	9	3	20	0
7	2	2	10	1	23	0
7	2	2	10	2	25	0
7	2	2	10	3	25	0
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8	2	1	1	2	21	9
8	2	1	1	3	20	10
8	2	2	2	1	21	10
8	2	2	2	2	13	14
8	2	2	2	3	13	6

8	2	2	3	1	26	0
8	2	2	3	2	32	0
8	2	2	3	3	29	0
8	2	2	4	1	24	0
8	2	2	4	2	27	0
8	2	2	4	3	27	0
8	2	2	5	1	28	0
8	2	2	5	2	42	0
8	2	2	5	3	26	0
8	2	2	6	1	34	0
8	2	2	6	2	31	0
8	2	2	6	3	43	0
8	2	2	7	1	30	0
8	2	2	7	2	26	1
8	2	2	7	3	24	0
8	2	2	8	1	48	0
8	2	2	8	2	35	0
8	2	2	8	3	41	0
8	2	2	9	1	31	0
8	2	2	9	2	31	0
8	2	2	9	3	19	0
8	2	2	10	1	40	0
8	2	2	10	2	37	0
8	2	2	10	3	42	0
9	2	1	1	1	0	4
9	2	1	1	2	0	5
9	2	1	1	3	0	5
9	2	2	2	1	4	4
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9	2	2	2	3	9	5
9	2	2	3	1	11	7
9	2	2	3	2	12	6
9	2	2	3	3	12	5
9	2	2	4	1	16	0
9	2	2	4	2	10	0
9	2	2	4	3	15	0
9	2	2	5	1	12	1
9	2	2	5	2	12	0
9	2	2	5	3	9	0
9	2	2	6	1	12	0
9	2	2	6	2	14	0
9	2	2	6	3	15	0
9	2	2	7	1	10	0
9	2	2	7	2	10	0
9	2	2	7	3	7	0

9	2	2	8	1	9	4
9	2	2	8	2	5	0
9	2	2	8	3	8	0
9	2	2	9	1	9	0
9	2	2	9	2	8	0
9	2	2	9	3	8	0
9	2	2	10	1	10	0
9	2	2	10	2	16	0
9	2	2	10	3	14	0
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10	2	2	3	2	16	2
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10	2	2	5	3	21	2
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10	2	2	6	2	17	1
10	2	2	6	3	21	1
10	2	2	7	1	19	1
10	2	2	7	2	18	0
10	2	2	7	3	24	0
10	2	2	8	1	19	2
10	2	2	8	2	21	1
10	2	2	8	3	23	1
10	2	2	9	1	21	2
10	2	2	9	2	34	3
10	2	2	9	3	31	0
10	2	2	10	1	26	2
10	2	2	10	2	29	0
10	2	2	10	3	30	0
11	2	1	1	1	0	5
11	2	1	1	2	4	4
11	2	1	1	3	3	4
11	2	2	2	1	1	6
11	2	2	2	2	4	6
11	2	2	2	3	6	2

11	2	2	3	1	8	2
11	2	2	3	2	9	2
11	2	2	3	3	14	3
11	2	2	4	1	9	2
11	2	2	4	2	11	2
11	2	2	4	3	12	2
11	2	2	5	1	17	0
11	2	2	5	2	13	0
11	2	2	5	3	19	2
11	2	2	6	1	20	0
11	2	2	6	2	19	0
11	2	2	6	3	20	0
11	2	2	7	1	19	0
11	2	2	7	2	23	2
11	2	2	7	3	22	0
11	2	2	8	1	21	0
11	2	2	8	2	23	0
11	2	2	8	3	22	1
11	2	2	9	1	25	2
11	2	2	9	2	22	1
11	2	2	9	3	26	1
11	2	2	10	1	31	0
11	2	2	10	2	24	0
11	2	2	10	3	33	0
12	2	1	1	1	12	14
12	2	1	1	2	15	13
12	2	1	1	3	9	17
12	2	2	2	1	5	21
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12	2	2	5	3	28	1
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12	2	2	6	2	27	2
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