Examining peer-controlled KR schedules during the learning of a movement-timing task as a function of task experience.

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Dedication

For my family and my Best Friend

Abstract

Learners can be provided with feedback in the form of knowledge of results (KR), under self-controlled and peer-controlled schedules. Recently, McRae, Hansen, and Patterson (2015), identified that inexperienced peers can provide KR that can facilitate motor skill acquisition. However, it is currently unknown whether previous task experience differentially impacts how peers present learners with KR and whether this KR impacts motor skill acquisition. In the present study, participants were randomly assigned to become inexperienced peer facilitators, learners with an inexperienced peer, learners with self-control who later became experienced peers, learners with an experienced peer, or learners in a control group. During acquisition learners completed a serial-timing task with a goal of 2500ms and returned approximately twenty four hours later for a delayed retention, time transfer, and pattern transfer test. We predicted that during the delayed tests, learners with self-control would outperform all other groups. Furthermore, we predicted that learners who received KR from experienced peers would outperform learners who received KR from inexperienced peers. However, our results indicated that participants who received peer-controlled and self-controlled KR schedules learned the task in an equivalent manner. Thus, our results are novel as they identify that inexperienced peers can provide KR that is as effective as KR provided by experienced peers and KR requested under self-controlled conditions.

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TABLE OF CONTENTS

CHAPTER 1: REVIEW OF LITERATURE

1.1 Motor Learning

Moving and interacting within an environment is a critical aspect of human life. Movement characteristics that are genetically predetermined and enduring can be classified as motor abilities (Haibach, Reid, & Collier, 2011). In this context, motor abilities are existing traits that learners acquire prior to learning a new task (Fleishman & Bartlett, 1969). In contrast, motor skills refer to the level of movement proficiency that a performer can demonstrate on a specific undertaking (Fleishman & Bartlett, 1969). Accordingly, motor skills are classified as movements that are not inherited but rather are "learned" (Schmidt & Lee, 2013). Thus, developing an understanding of how motor skills are learned is a continued area of investigation in the realm of motor learning.

Motor learning is an area of research that is interested in understanding the behavioural and cognitive processes associated with the acquisition, re-acquisition, enhancement or improvement of motor skills (Magill, 2011). In this regard, the term learning refers to the relatively permanent changes in motor performance that are sustained over time (Kantak & Winstein, 2011; Schmidt & Lee, 2013). However, as identified in a review of the knowledge of results (KR) literature by Salmoni, Schmidt and Walter (1984), early experiments in motor learning (e.g., Adams, 1971; for review see Bilodeau, 1969) failed to measure the degree to which the motor skill was learned. Instead, the development of motor skills was measured at the beginning and at the end of a defined practice period, on the same day. When analyzed in this manner the effects of the independent variable may still be present and changes that are witnessed may only reflect how well the learner preformed the task (Wulf, Shea, & Lewthwaite, 2010).

A clear representation of the differences between performance and learning can be observed when 100% KR frequency conditions are compared with reduced frequency of KR conditions (e.g., Nicholson & Schmidt, 1991; Winstein & Schmidt, 1990; for exceptions and review see Lai & Shea, 1999). In these studies, participants who are provided with high KR frequencies during acquisition perform better than or equal to participants who receive less frequent KR. However, when asked to complete the same task, without KR, 24-hours later (i.e., a delayed retention test), the trend is often reversed (for review see Salmoni et al., 1984; Winstein, 1991; Wulf & Shea, 2004). In this regard, the motor performance demonstrated by participants in acquisition (i.e., assessment of performance) may or may not persist during a delayed retention test (i.e., assessment of learning). Therefore, incorporating tests that assess the degree of resilience a motor skill maintains over time is of the utmost importance.

One way in which researchers can measure the degree to which a skill is learned is through the incorporation of immediate and delayed retention tests (for review see Christina & Shea, 1993). Immediate retention tests assess participants in a no-KR condition where participants practice the same task as what was completed during the acquisition phase of the experiment (Kantak & Winstein, 2011). In this case, a no-KR condition allows researchers to obtain an estimate of the participant's true performance capabilities when the independent variable (i.e., KR) is no longer available (for review see Russell & Newell, 2007). However, immediate retention tests in the self-controlled KR literature (i.e., a major topic that will be examined in detail in a future section) have been performed between 10 minutes (Patterson & Carter, 2011) and 15 minutes (Andrieux, Dana, & Thon, 2012; Bund & Weimeyer, 2004; Sanli & Patterson, 2013)

following the final trial of the acquisition period. As a result, the time delay (i.e., 10-15 minutes) may not ensure that the effects of the independent variable (i.e., KR) have dissipated (Salmoni et al., 1984). Thus, delayed retention tests are used to determine whether a participant's performance is persistent or temporarily boosted during the delayed retention interval that follows the immediate retention test (Christina & Shea, 1993). Therefore, an immediate retention test is said to provide researchers with an indication of how well a motor skill was learned prior to the consolidation phase of learning (Kantak & Winstein, 2011).

Consolidation processes encompass off-line procedures that begin 4-6 hours after practice, that mentally stabilize motor-memory (Robertson, 2009). Thus, in order to assess the learning achieved as a result of the consolidation process a delayed retention test can be used. Delayed retention tests in motor learning are typically preformed at least 24hours following the final practice trial in the acquisition phase (for review see Salmoni et al., 1984). In this context, requiring participants to return at least 24-hours after the acquisition phase is essential because it ensures that the temporary effects of KR that are witnessed during acquisition have dissipated (Salmoni et al., 1984) and that participants undergo consolidation of motor-memory (Kantak & Winstein, 2011). Supporting this view, delayed retention tests in the self-controlled KR literature have been conducted at 24 hours (e.g., Chiviacowsky, 2014), 72 hours (Chiviacowsky, Wulf, Wally, & Borges, 2009), or 4 days after the final practice trial of the acquisition phase (Janelle, Barba, Frehlich, Tennant, & Cauraugh 1997).

During a delayed retention test, participants are asked to perform the same task as what was completed during the acquisition phase. However, in the delayed retention test

all experimental groups are placed in a condition where they receive a common level of the independent variable (Salmoni et al., 1984). In this regard, all experimental conditions in the self-controlled KR literature traditionally receive no-KR during the performance of the delayed retention test (e.g., Chiviacowsky & Wulf 2002; 2005; Kaefer, Chiviacowski, Meira, & Tani 2014). Therefore, the permanence (i.e., consolidated memory) of the level of performance achieved in acquisition can be assessed when the effects of the experimenter-created practice conditions are no longer available (Kantak & Winstein, 2011).

One concern that often accompanies the utilization of both an immediate and a delayed retention test in motor learning is that the immediate retention test may influence the participant's performance during the delayed retention test (Schmidt & Lee 1999). To examine this issue, Magnusen, Shea, and Fairbrother (2004) assessed participants' performance during a novel key-pressing task in an immediate and delayed retention test. The results from this study identified that participation in a 10-minute immediate retention test did not affect the participant's performance in a subsequent 48-hour delayed retention test. Furthermore, experiments 1 and 3 in Fairbrother, Shea, and Marzilli, (2007) indicate that during the learning of a novel key-pressing task, repeated testing effects are not evident when 10-minute immediate retention and 24-hour delayed retention phases are used. Thus, researchers can be relatively confident (for an exception see Fairbrother, Augusto, & Barros, 2010) that an immediate no-KR retention test does not influence the results of a delayed retention test.

In the motor learning literature, it has been demonstrated that group differences may not be displayed in delayed retention tests but may be evident in transfer tests (e.g.,

Chiviacowsky & Wulf, 2002; Lai & Shea 1998; Wrisberg & Wulf 1997). Transfer tests assess the generalizability of what has been learned by requiring that participants perform in novel practice situations (Magnuson et al., 2004). As a result, participants either complete a variation of the previously performed task or perform in unique practice situations (Kantak & Winstein, 2011). For example, in Hansen, Pfieffer, and Patterson (2011) participants were asked to respond to a sequence of five numbers (1-3-4-2-3-1) in a goal time of 2500ms during an acquisition phase. Approximately 24-hours later (Salmoni et al., 1984) the participants completed pattern and time transfer tests. In the pattern transfer test the practice situation differed from acquisition as participants responded to a new sequence (2-3-4-1-3-1) in the same goal time as the acquisition phase (2500ms). In the time transfer test the practice situation differed from acquisition as the participants responded to the same sequence (1-3-4-2-3-1) as what had been completed in acquisition but in a new goal time (3300ms). In the self-controlled KR literature transfer tests are normally completed 10 minutes after the retention test (e.g., Post, Fairbrother, & Barros, 2011). In this context, transfer tests are preformed after retention tests to ensure that practicing in a unique practice situation does not affect the measure of learning that is obtained in retention.

In summary, motor learning research is generally interested in understanding how motor skills are learned. Using immediate retention tests, delayed retention tests and transfer tests motor skill learning is assessed. The following section of this literature review will describe the properties of KR and the impact that KR can have on motor learning.

1.2 Knowledge of Results

Knowledge of results (KR) is a form of augmented information that identifies a learner's response outcome relative to a task goal (Magill, 2004). In this context, KR can be used to supplement a learner's sensory experience by providing extrinsic information about the magnitude and direction of the learner's error (Newell, 1977). Consequently, KR is believed to provide learners with benefits that stem from informational factors (Wulf & Shea, 2004) such that KR can help the learner reduce uncertainty about their movement outcome (Guadagnoli & Lee, 2004). From an alternative viewpoint, early research claimed that KR might contain motivational properties (e.g., Locke, Cartledge, & Koeppel, 1968). Supporting this assertion, recent work by Badami, VaezMousavi, Wulf, and Namazizadeh (2011) indicates that intrinsic motivation can be positively impacted when KR is presented. Therefore, providing learners with KR can be seen as an advantageous process from both motivational and informational perspectives (for review see Wulf, et al., 2010).

In the past it was believed that the optimal learning of motor skills would be evidenced by the delivery of KR after every trial (Bilodeau & Bilodeau, 1958). In fact, two prominent motor learning theories (i.e., The Adams Theory & Schmidt's Schema Theory) are rooted in the notion that increased frequencies of KR are required to strengthen the cognitive processes associated with learning (Adams, 1971; Schmidt, 1975). However, this traditional viewpoint failed to recognize that when KR is provided too frequently the learner may become too dependent upon the KR they are provided (Winstein & Schmidt, 1990). In this context, frequent KR may help guide a learner to produce effective performance when KR is available (i.e., during acquisition) but the

learner's reliance on this KR may lead to ineffective learning when the KR is removed (i.e., during a delayed retention test). As a result, the guidance hypothesis that was originally proposed by Salmoni et al., (1984) suggests that learning may be facilitated in conditions where learners do not receive KR after every trial. Providing a stark contrast to the previous belief that any variable that made KR more frequent, more precise, or more immediate, would enhance learning (Wulf & Schmidt, 1989), the guidance hypothesis sparked an increased interest in KR scheduling within the motor learning literature.

In an attempt to examine the guidance hypothesis, research began to study the impact of methodologies that decreased the amount of KR the learner would receive during the acquisition period (e.g., Gable, Shea, & Wright, 1991; Schmidt, Lange, & Young, 1990). Using novel button pushing (e.g., Wulf & Schmidt, 1989), lever manipulation (e.g., Winstein & Schmidt, 1990; Nicholson & Schmidt 1990), and ballistic timing tasks (e.g., Schmidt, Young, Swinnen, & Sharpiro, 1989), early studies identified that learners who received reduced proportions of KR during acquisition demonstrated more effective learning in delayed retention tests than those who received KR after every trial. Yet, not all studies examining KR frequency produced results that supported the guidance hypothesis (for review see Lai & Shea, 1999). In fact, more recent research suggests that provided KR at higher frequencies may be beneficial during the learning of complex tasks (e.g., Wulf, Shea, & Matschiner, 1998; for review see Wulf & Shea, 2002) during periods where learners are asked to estimate their error prior to completing each trial (e.g., Guadgnoli, Kohl, & Robert, 2001), and in situations where participants have been diagnosed with Parkinson's disease (e.g., Guadgnoli, Leis, Gemmert, & Stelmach, 2002). Thus, research has begun to examine when learners request KR in situations where

they can control their own KR schedule (for review see Sanli, Bray, Patterson, & Lee, 2013). In these situations an examination of the preferred KR frequencies and preferred KR scheduling strategies of learners can be observed.

1.3 Self-Controlled KR

Providing participants with control over some aspect of their practice context can enhance motor skill acquisition (for review see Sanli, et al., 2013). In fact, learning advantages have been observed when participants are able to control the task difficulty (Andrieux, et al., 2012), the order of the trials they are asked to complete during multi-task learning (Keetch & Lee, 2007), the amount of total practice that is completed (Post, et al., 2011), the frequency of physical assistive device usage (Wulf & Toole, 1999), and the frequency of observing a model (Wulf, Rupauch, Pfieffer, 2005). However, the most extensively researched aspect of the practice context that learners are given self-control over is KR (for review see Wulf, 2007).

Traditionally, the potential benefits associated with self-controlled KR have been analyzed through a comparison of groups who are provided with control and those who are not. In this regard, those who are not provided with control are defined as a yoked condition and replicate the KR schedule of a paired learner with self-control (e.g., Bund & Weimeyer 2004; Chiviacowsky & Wulf 2002; 2005; Janelle, et al., 1997; Kaefer et al., 2014; Yoon, Yook, Suh, Lee, & Lee 2013; for review see Wulf, 2007; Sanli et al., 2013). Thus, when researchers utilize immediate retention (e.g., Janelle, Kim & Singer, 1995), delayed retention (e.g., Patterson & Carter, 2010) and transfer tests (e.g., Hansen, et al., 2011) to assess learning, differences in measures of movement performance can be attributed to one group's ability to self-control the KR schedule.

The differences between self-controlled KR and yoked KR groups have been assessed using a variety of tasks. For instance, novel key pressing tasks (e.g., Chiviacowsky & Wulf, 2002; 2005; Hansen, et al., 2011; Kaefer et al., 2014; Patterson & Carter, 2010; Patterson, Carter & Hansen, 2013; Patterson, Carter, Sanli, 2011; Sanli & Patterson, 2013) balance tasks (Lewthwaite & Wulf, 2010; Yoon et al., 2013), novel throwing tasks (Chiviacowsky, Wulf, Medeiros, Kaefer, & Tani, 2008; Chiviacowsky, et al., 2009; Janelle et al., 1995; Janelle et al., 1997) and sport skill tasks (Badami et al., 2011; Bund & Weimeyer 2004; Wulf et al., 2005) have been used. Focusing on the experiments that have utilized novel key pressing sequences (i.e., tasks that are similar to the one that was used in this study), the benefit of self-controlled KR has been observed. In particular, self-control groups have outperformed yoked groups in terms of absolute error (AE) and absolute constant error (ACE) in delayed retention (Patterson et al., 2011; Patterson & Carter, 2010) and transfer tests (Chiviacowsky & Wulf, 2002; 2005; Kaefer et al., 2014; Patterson & Carter, 2010; Patterson et al., 2011). Furthermore, less variable error (VE) has been observed in transfer tests (Patterson et al., 2011). Thus, the results from these studies demonstrate that providing learners with the ability to control their own KR schedule (i.e., self-control KR) during practice can enhance their retention of a motor skill as indexed by measures of accuracy and consistency.

The established benefits associated with self-controlled KR schedules have been suggested to stem from either motivational or informational processes. In this context, it has been proposed that during self-controlled learning situations, participants become more involved within the task and achieve a deeper processing of task relevant information (Mccombs 1989; Wulf, Clauss, Shea, & Whitacre, 2001). From a

motivational perspective, learners may become disinterested if not given KR when it is desired, or given KR when it is not desired (Chiviacowsky et al. 2009). Building on a motivational perspective, recent research asserts that self-controlling one's own KR schedule addresses an individual's basic psychological need of autonomy and improves self-efficacy (Badami et al., 2011; Chiviacowsky 2014; Sanli et al., 2013).

In self-controlled KR conditions, it has been shown that learners self-select KR on less than 100% of their acquisition trials. Specifically, participants who are able to request KR after every trial have selected KR on 71.3% (Patterson et al., 2011), 61.3%, 63%, 62.2% (Patterson & Carter, 2010), 35% (Chiviacowsky 2002), and 31.62% (Kaefer et al., 2014) of trials during novel key pressing tasks. Furthermore, participants have requested KR on 8% and 11% of trials during the learning of an anticipation-timing task (Ali, Fawver, Kim, Fairbrother, & Janelle, 2012) and on 11% (Janelle et al., 1995) and 7% (Janelle et al., 1997) of trials during the learning of novel throwing tasks. Consequently, learners appear to inherently support the tenet of the guidance hypothesis that identifies that KR that is provided too frequently is detrimental to learning.

Building on this research, recent studies have begun to constrain the total amount of self-control provided to learners. For instance, participants in Chiviacowsky (2014) were provided with opportunity to request KR after 2 trials in a six trial block. Similarly, participants in Chiviacowsky and Wulf (2005) were restricted to requesting KR on 3 trials during a 10 trial block. Extending these self-control limitations, the participants in Hansen et al., (2011) were placed in a condition where their self-controlled KR opportunities were yoked to the number of times a learner who had full control of their KR schedule requested KR (i.e., yoked with self-control). Despite the limited amount of

self-controlled KR opportunities learners received in these studies learning was facilitated. In particular, the yoked with self-control (YSC) group in Hansen et al., (2011) had less variable error (VE) than the 100% self-controlled KR group in transfer. Similar to this finding the learners with constrained self-control in Chiviacowsky (2014) outperformed a TY group in a delayed retention test as evidenced by AE. Therefore, research has demonstrated that participants prefer to request KR on less than 100% of trials and that participants can benefit from experimenter imposed restrictions of self-controlled KR frequency.

In addition to requesting KR on less than 100% of acquisition trials, learners with self-control also tend to request KR in a faded manner. To this point, participants in Janelle et al., (1997) decreased the total amount of extrinsic information they requested from an average of 20% in the first block to an average of 7% in the final block. Similarly, participants in Chiviacowsky, Wulf, Machado, and Ryberg (2012) requested KR on average 53.3% of the time in the first block and only on 6.7% of trials at the end of practice. Overall, these results and others (e.g., Chiviacowsky & Wulf, 2002; Wulf & Toole, 1999) demonstrate that learners with self-control seem to inherently follow the tenet of the guidance hypothesis that identifies that a decreased reliance on KR can be beneficial. Yet, not all studies have revealed this finding (e.g., Patterson & Carter 2010; Kaefer et al., 2014). Therefore, an examination of the trials after which learners request KR reveals an interesting trend.

Attempts at understanding the scheduling strategies of learners with self-control have analyzed AE on trials after which KR is selected (i.e., KR trials) versus when it is declined (i.e., no-KR trials). In this context, learners tend to request KR after perceived

good trials (e.g., Chiviacowky et al., 2009). Supporting this claim, Chiviacowsky and Wulf (2002) revealed that when participants requested KR, their AE was on average 145ms compared to 162ms when KR was declined. Another experiment by Chiviacowsky and Wulf (2005) revealed that when participants requested KR their relative timing AE was on average 19.85ms compared to 21.1ms when KR was declined. Similarly, participants in Chiviacowsky (2014) requested KR on trials where AE was 45.68ms compared to 50.32ms when KR was declined. Providing further support for the preference to request KR after good trials can be seen in many other motor learning studies (e.g., Chiviacowsky et al., 2012; Hansen et al., 2011; Kaefer et al., 2014; Patterson & Carter, 2010). Thus, if KR is provided in a manner that does not match the preference of the learner under self-controlled conditions a learning decrement may occur.

1.4 Dyad Learning

In the past, it was believed that individual testing periods were the most beneficial means of training participants. In fact, considerable amounts of money have been invested in individual skiing, golf, tennis, and rehabilitation sessions (Granados &Wulf, 2007). However, recent research challenges this idea and suggests that learning in pairs may be as effective if not more effective than practicing as an individual (e.g., Bjerrum, Eika, Charles & Hilberg 2014). Protocols where peers work in pairs have been investigated (e.g., Shea, Wulf, & Whitacre, 1999) and defined as dyadic learning. In this context, dyadic learning research has primarily stemmed from the human factors literature and the creation of the active interlocked modeling (AIM) dyad group (Shebliske, Regian, Arthur & Jordan, 1992).

In human factors research, dyad learning protocols almost exclusively (for an exception see Crook & Beier, 2010) utilize the Space Fortress video game task (SF). In SF, participants attempt to destroy a centrally located computer-controlled fortress by manipulating an in-game fighter ship (Arthur, Strong, Jordan, Williamson, Shebliske, & Regian, 1995). Controlling the in-game ship is an established complex task (for review see Mané & Donchin, 1989) and performance is measured through a calculation of total in-game score (Shebliske et al., 1992). Total in-game score is based upon the level of control the participants have over the ship (i.e., keeping the ship within certain boundaries), the points they accumulate by damaging the fortress, their ability to keep the ship under a critical velocity, and the speed by which they identify friends and foes (for a detailed review see Jordan, 1997).

In traditional dyad learning procedures the participants practice the SF task in pairs (i.e., AIM-dyad group) or as individuals (e.g., Arthur, Day, Bennett, McNelly, & Jordan, 1997; Arthur, Jefferey, Shebliske, & Young, 1996; Arthur et al., 1995; Sanchez & Arthur, 2000; Shebliske et al., 1992; Shebliske, Jordan, Goettl, & Day, 1999 experiment 1). In the AIM-dyad condition the learners practice simultaneously in the same room (for exceptions see Ioerger, Sims, Volz, Workman, Shebliske, 2003; Shebliske et al., 1999) and work together to destroy the fortress. Specifically, one learner uses a joystick to fire missiles and control the ships movements while a second learner uses a standard mouse to identify mines and bonus opportunities (for review see Arthur et al., 1995). The participants then alternate roles (i.e., joystick control or mouse control) after each practice trial. Thus, each learner is given experience with the joystick on half of the trials and experience with the mouse on the other half. In contrast, the participants in the individual

testing groups are given experience with both the mouse and the joystick on every practice trial.

A practice trial is a three-minute interval in which the game is played (Shebliske et al., 1992). When all of the practice trials have been completed the learner is said to have completed a practice session (for review see Jordan, 1997). Upon the completion of a practice session the participants (regardless of their experimental group) are asked to practice the SF task individually during two test trials (for review see Arthur et al., 1995). It is during these test trials that the effectiveness of the AIM-dyad group can be assessed. Specifically, a comparison between participants who practiced the task individually and those who practiced in AIM-dyad conditions can be made. The results from a series of these experiments (i.e., Arthur et al., 1995; Arthur et al., 1997; Sanchez & Arthur, 2000; Shebliske et al., 1992; Shebliske et al., 1999 experiment 1) have showed the total in-game score for participants who practiced the SF task in the AIM-dyad group was not significantly different than the score for participants who practiced individually. Additionally, no significant differences in regards to the either group's total in-game score have been measured in delayed retention tests (Shebliske et al., 1999 experiment 3) or reacquisition periods (Arthur et al., 1997).

The fact that there are no significant differences between the groups in these studies demonstrates that practicing with a peer can elicit a 100% gain in training efficiency (Shebliske et al., 1992). Specifically, if both of the learners in the AIM-dyad group can produce performances that are equivalent to the performance of a learner who practices individually than it can be suggested that the AIM-dyad group can effectively train two learners in the time it takes to train one learner individually.

Research in surgical skill training has examined the impact of dyadic learning using a different procedure than that of the AIM-dyad group. In surgical skill training two groups are formed involving one dyad learning group and one group who practices individually. In the dyad learning group one participant is asked to physically practice the task while the other observes the performer, alternating roles throughout the acquisition period (e.g., Rader, Henriksen, Butrymovich, Sander, Jorgensen, Lonn, & Rinsted 2014). During this time, the learners are encouraged to actively discuss strategies to benefit their acquisition of the skill. In contrast, participants in individual testing groups are asked to practice independently without the benefit of observation or discussion. The acquisition period for these groups has required participants to participate in lumbar puncture (Shanks, Brydges, Brok, Nair, Hatala 2013), bronchoscopy (Bjerrum, Eika, Charles & Hilberg 2014), and coronary angiography (Rader et al., 2014) tasks.

Following the acquisition period in these studies, all of the participants returned for a delayed retention test where they would practice the skill individually. In Bjerrum et al., (2014) participants were assessed using simulator scores that reflected such measures as procedure time, segments entered per minute, and wall collisions. In Shanks et al., (2013) participants were assessed based upon the ratings of 4 expert raters on the global rating scale (GRS) and the participants in Rader et al., (2014) were assessed by two expert raters on a scale similar to Shanks et al., (2013). The delayed retention tests in these three studies revealed no significant differences between the two groups in terms of rating scores (Rader et al., 2014; Shanks et al., 2013) or coronary angiography simulator scores (Bjerrum et al., 2014). As a result, it was suggested that learning alongside a peer when practicing a surgical skill was a beneficial method for skill acquisition. In particular

there is a benefit in training in pairs due to the fact that two participants can be trained in the time it takes to train one participant individually.

In motor learning, minimal research has examined the learning advantages of practicing in pairs. One study conducted by Shea, Wulf, and Whitacre (1999) asked participants to practice balancing on a stabilometer either individually, in a dyad-alternate or a dyad-control condition. In the dyad alternate condition participants observed one another physically practice the balance task and alternated roles after each trial. In the dyad-control condition the participants observed one another complete the entire practice session and then switched roles. In the individual practice group participants practiced the task without the presence of another learner. Overall, the participants in both dyad groups were given the opportunity to engage in discussion about the task and observe another learner. In comparison, the participants who practiced individually could not discuss nor observe another learner. Results from a 24-hour delayed retention test, where all learners were asked to practice individually showed that root mean square error (RMSE) was less for participants who practiced in the dyad-alternate group compared to both the individual practice and dyad-control groups.

Granados and Wulf (2007) examined whether the learning benefits in Shea et al., (1999) stemmed from discussion between participants or observation or a combination of both. Using four groups that practiced a cup stacking task in four different dyadic conditions (i.e., observation with discussion, no observation with discussion, no discussion with observation and no discussion with no observation) it was determined that observation was more critical to learning in dyads than dialogue. Specifically, a 24-

hour delayed retention test revealed movement time was decreased when observation was removed regardless of whether discussion was present in the condition.

In summary, the benefits of learning a task with a peer have been established across multiple domains. However, very few studies have examined paired practice in motor learning research. As a result, gaining more information regarding how learners practice with one another can be viewed as an important area for future research in the realm of motor learning.

1.5 Peer-Controlled Feedback Schedules

As depicted in the previous section, minimal research has examined the learning benefits associated with practicing with a peer. Yet, even less is known about how a peer would provide KR to another peer if given the opportunity to control the KR schedule. To our knowledge, only one study has examined the differences between a self-controlled and a peer-controlled KR schedule. In particular, in an experiment by McRae, Hansen, and Patterson (2015) peers were asked to provide a paired learner with KR throughout the acquisition of a novel motor task. In this context, no participant had prior experience physically practicing the key-pressing task before the acquisition phase of the experiment.

Examining the instances when peers provided KR it was determined through analyzing absolute error on KR and no-KR trials that peers provided learners with KR following good and bad trials equally. This finding differs from the self-control KR literature with learners showing a preference for KR following perceived good attempts (e.g., Patterson & Carter, 2010). Learners who received KR from their peer preformed equally as effectively in terms of AE and VE as learners in a self-controlled condition

during a 24- hour delayed retention test. As a result, the usefulness of a protocol that provides peers with control over another learner's KR schedule warrants further investigation. Specifically, the impact of providing a peer with physical experience with the task and its effect on the peer's KR scheduling strategies may be of interest.

In peer-teaching situations, it has been shown that feedback provided by a peer can be as effective as feedback that is presented by an expert. For example, Cho, Chung, King and Shunn (2008) showed that novice technology users indicated that feedback provided by another novice was equally as helpful as feedback that was provided by an expert. In this context, learners may be more receptive of feedback that is presented to them by a peer because the feedback can be easily comprehended (Bloxham & West, 2004). Building off of this proposal, Cho and MacArthur (2010) more thoroughly examined whether novice peers can more easily relate the needs of novice learners. In this study, participants were asked to write a first draft of a writing assignment. After handing in the material, learners received the document back with feedback from an expert, another novice peer, or multiple peers. Using an analysis of the type of revisions made by the original writer it was determined that those who were provided feedback by an expert made more simple corrections (i.e., corrections proven to be less advantageous) than participants provided feedback by a peer.

Overall, the importance of understanding the contribution of peer-controlled KR schedules for motor skill acquisition remains a gap in the motor learning research. What we do know, based on the present review of the literature is that peers without experience with an experimental task provide KR after good and bad trials (McRae et al., 2015), that practicing in pairs is advantageous to the retention of a skill in dyadic learning conditions

(e.g., Shea et al., 1999) and that peers can provide feedback that learners can easily relate with (Cho & MacArthur, 2010). However, further inquiry into peer-controlled KR schedules may warrant an investigation of the preferred KR schedule of peers, as a function of experience. In the study conducted by McRae et al., (2015) neither the learner nor the peer providing feedback was privy to any information about the experimental task prior to the acquisition period. Yet, in most situations learners look to peers with previous experience with the task for feedback concerning their movement (e.g., peer tutors or veteran team members). Therefore, identifying how peers with experience provide KR can be considered an interesting and novel research question in the realm of motor learning.

CHAPTER 2: INTRODUCTION

2.1 Introduction

Knowledge of results (KR) is a powerful performance and learning variable used to facilitate a learner's retention of a motor skill (Magill, 2004; Salmoni, et al., 1984). Consequently, experimenters have examined KR from many different perspectives (for reviews, see Adams, 1987; Newell, 1977; Schmidt, 1991; Swinnen, 1996; Wulf & Shea 2004). Early protocols examining KR, studied the timing of KR presentations (e.g., Lorge & Thorndike, 1935; Adams, 1971) as well as the learning advantages associated with reducing KR frequency (e.g., Winstein & Schmidt, 1990; Wulf & Schimdt, 1989). In this context, the KR provided to learners was delivered based on the predictions of the guidance hypothesis (Salmoni, et al., 1984). The guidance hypothesis states that KR that is provided too frequently can negatively impact a learner's retention of a motor skill. Contrasting the previous belief that optimal learning would be evidence by the delivery of KR after every trial (e.g., Adams, 1971; Bilodeau & Bilodeau, 1958; Schmidt, 1975; Wulf & Schmidt, 1989), the guidance hypothesis suggests that learners may develop a reliance on the information they are presented if they are provided with KR too often (Salmoni, et al., 1984). Specifically, learners who are frequently provided with KR preform effectively when KR is available but ineffectively when it is removed (Salmoni et al., 1984). Therefore, in order to facilitate relatively permanent changes in behaviour (i.e., learning), learners should be provided with KR on less than 100% of their acquisition trials (Winstein, Pohl, & Lewthwaite, 1994).

Withholding KR following a portion of a learner's attempts at a task has been proven to be an effective means by which to increase motor skill acquisition (e.g.,

Winstein & Schmidt 1990; Schmidt, Young, Swinnen, & Sharpiro, 1989; Wulf & Schmidt, 1989). However, the determination of when to provide or withhold KR is often based on an experimenter-determined schedule (Hemayattalab, 2014). Removing the learner from the decision making process, the KR that is provided may or may not be delivered when the learner would considered it most beneficial. In this context, KR may be provided when the learner does not wish to receive it or withheld when the learner would have typically requested it. In an attempt to address this issue, recent research has examined the learning advantages associated with providing learners with control over their own KR schedule (e.g., Janelle et al., 1995; Janelle et al., 1997; Sanli et al., 2013; Wulf, 2007).

When learners are provided with the opportunity to self-control their KR requests, learning advantages are apparent (e.g., Chiviacowsky, Wulf, Machado, Ryberg, 2012; Janelle, et al., 1995; Patterson & Carter, 2010). As a result, a considerable amount of research has examined the benefits of providing learners with the ability to control some aspect of their learning context (e.g., Andrieux, et al., 2012; Keetch & Lee, 2007; Post, et al., 2011). Yet, despite these established benefits, most real life situations do not provide learners with the opportunity to control a portion of their practice session. Instead, learners are often forced to receive information controlled by another individual (Hemayattalab, 2014; Sanli et al., 2013; see Salmoni, et al., 1984 for review).

At this time, little is known about how KR is provided when another individual is provided control of a physically practicing learner's KR schedule. In contrast, motor learning research has extensively examined the scheduling preferences of learners who are able to self-control their KR requests. In this regard, learners with self-control tend to

request KR in manner that supports the guidance hypothesis. For example, adults asked for feedback 11% of the time during a novel throwing task (Janelle et al., 1995); children requested KR on 25% of the acquisition trials during a beanbag-throwing task (Chiviacowsky, Wulf, Laroque de Medeiros, Kaefer, & Wally, 2008), and participants requested KR on 32% of the acquisition trials during a movement-timing task (Kaefer et al., 2014). Additionally, these learners have demonstrated a preference to request KR following what they perceive to be good trials (Chiviacowsky & Wulf, 2002; 2005; Chiviacowsky, & Wulf, 2007; Hansen, et al., 2011; Patterson & Carter, 2010). As a result, the trials after which (i.e., after good trials) and the quantity of KR (i.e., less than 50% of trials) that learners prefer to receive has been identified. However, in the motor learning literature, the preferred method by which KR is delivered by an individual given control of a physically practicing learner's KR schedule is currently unknown. Consequently, the benefits associated with self-controlled KR schedules may stem from a potential disparity between the preferred KR schedule of a learner (i.e., after good trials) and the preferred KR schedule of the individual in charge of providing KR (i.e., an alternative method). In this regard, if those in charge of the KR schedule provide KR to learners in manner that deviates from the preferred KR schedule of the learner, then the feedback that is provided could be considered less advantageous (Chiviacowsky, et al., 2009).

McRae, Hansen and Patterson (2015) addressed this gap in knowledge by examining how a peer provided KR to a performer who was asked to physically practice the motor task. Based on absolute error on KR and no-KR trials, McRae et al., (2015) determined that learners with self-control of their KR schedule demonstrated a preference

for requesting KR after perceived good trials whereas peers preferred to provide KR to performers after both good and bad trials equally. These findings support a discrepancy between the preferred KR schedule of learners with self-control (i.e., KR requests following good attempts) and the preferred KR schedule of a peer who is asked to provide KR to another learner (i.e., KR provisions following good and bad attempts). Interestingly, these identified differences in KR scheduling did not negatively impact the performer who was provided KR based upon the peer's KR schedule. As a result, this study suggests that a peer who does not have experience with a task can deliver KR that is beneficial for a physically practicing participant. Overall, the study conducted by McRae et al., (2015) can be considered similar to peer- teaching (Bloxham & West, 2004; Cho & MacArthur, 2010) and dyad training research (Granados, & Wulf, 2007; Shea, Wulf, & Whitacre, 1999; Shebilske, et al., 1992) that suggests that skill acquisition can be enhanced in a situation where paired learners provide information to one another.

Determining when the peers in McRae et al., (2015) provided KR is an important first step in understanding more about KR schedules controlled by individuals not required to learn or physically practice an experimental task. In this context, McRae et al., (2015) examined the scheduling preferences of peers who were not provided with an opportunity to physically practice the task prior to the acquisition phase of the study. However, it is often assumed that individuals who are given control of a performer's KR schedule have some degree of experience completing the task. As a result, an examination of whether previous experience affects the manner in which a peer provides KR warrants further investigation.

In the current study, the primary focus was to examine the potential differences

between a KR schedule controlled by an inexperienced peer (McRae et al. 2015) and a KR schedule controlled by a peer with experience. According to the Oxford Canadian Dictionary, (1998) 'experience' can be defined as, "The actual observation of or practical acquaintance with facts or events" (p. 489). As a result, the experienced peers in the present experiment were identified as participants who have physically practiced the motor task and were provided the opportunity to control their KR for the duration of their acquisition period before providing KR to another performer. In contrast, inexperienced peers did not have previous physical practice with the motor task or experience self-controlling KR, similar to the peers used in McRae et al., (2015).

A secondary aim of this experiment was to examine whether the act of providing another learner with KR facilitates the skill acquisition of the peer assuming the role of the peer facilitator. To complete this task, the inexperienced and experienced peers completed a delayed-retention test where their motor performance was analyzed and compared to the motor performance of the learners being provided their peer's respective KR schedule. This examination was conducted as a result of previous research that suggests that the determination of when to request KR under self-controlled conditions promotes a deeper understanding of task-relevant information (Wulf, Clauss, Shea & Whitacre, 2001). Similarly, we hypothesized that the opportunity to provide KR would beneficially impact the inexperienced and experienced peers' retention of the motor skill.

To our knowledge, this was the first study to examine the KR schedules of peers with differing levels of experience and their subsequent impact on a paired learners' motor skill acquisition. Furthermore, this was the first study to examine whether providing learners with KR can not only facilitate skill acquisition for the learner, but

also the peer providing the KR. Theoretically, the results of this study are expected to provide insight into the KR scheduling strategies of peers as a function of experience and the subsequent impact on skill acquisition.

2.2 Statement of the Research Problem

It has been established that participants in self-controlled learning conditions prefer to receive KR after good trials (e.g., Chiviacowsky & Wulf, 2002; 2005; Patterson & Carter, 2010) and request KR on less than 100% of the trials during acquisition (e.g.,Chiviacowsky et al., 2008; Janelle 1995; 1997). However, little is known about how peers, as a function of experience, provide learners with KR. In an attempt to address this gap in the literature, McRae et al., (2015) examined when peers with no prior experience with the motor task, provided KR to a paired learner. This process can be considered similar to two inexperienced "athletes" learning how to complete a sport skill for the first time. In this context, many real-life scenarios require that a coach disperse their attention amongst a large group. As a result, there are times when the coach is not available to provide athletes with feedback. During situations such as these, it is not uncommon for athletes to turn to one another to receive augmented information about the relative success of their movement. With little known about this type of practice, McRae et al., (2015) examined the preferred KR schedule of an inexperienced peer who assumed the role of a peer facilitator. The results of this study identified that inexperienced peers (i.e., participants with no experience with the motor task) preferred to provide KR to learners following both good and bad trials equally. Although this schedule did not match the preferred KR schedule of learners with self-control (i.e., KR after good trials), the participants who were provided KR by the inexperienced peer reported being satisfied

with the KR they were provided. Highlighting the influential role of the individual who assumes the role of the instructor, McRae et al., (2015) hypothesized that learners may trust the judgment of a peer, regardless of their level of experience.

In the study conducted by McRae et al., (2015) inexperienced peers were not provided with the opportunity to physically practice. However, in the current study a group of peers was given the chance to physically practice the experimental task prior to providing learners with KR. This situation is similar to an inexperienced athlete receiving KR from a more senior member of the team (i.e., a peer with more experience). Therefore, the current study set out to extend the work of McRae et al., (2015) by determining whether an individual with previous task experience could provide KR that is more or less effective than an unpracticed peer.

2.3 Experimental Predictions

Experimental Prediction #1: All groups would demonstrate similar AE, CE and VE during the acquisition period.

It was predicted that during the acquisition period of the study learners with self-control, learners with an inexperienced peer and learners with an experienced peer would demonstrate similar of movement accuracy (i.e., AE, CE) and movement consistency (i.e., VE). This prediction was based on research that has identified that when KR is made available to a learner, a learner can experience informational and motivational benefits (for review see Wulf, et al., 2010). Furthermore, it has been identified that when KR is available during acquisition, KR can equate the motor performance of experimental conditions (Kantak & Winstein, 2011; Salmoni et al., 1984; Wulf & Shea, 2004).

Experimental Prediction #2: Following their period of self-control the members of the SCP group would demonstrate lower AE, CE and VE in the delayed retention period compared to all other groups

During the delayed retention phase we predicted that learners with self-control would have significantly lower AE, CE and VE scores than learners who received KR from either inexperience or experienced peers. In this context, previous research has identified that learners with self-control tend to outperform learners who are not provided control of their own KR schedule (e.g., Patterson et al., 2011; Patterson & Carter, 2010).

Experimental Prediction #3: Learners who received KR from experienced peers would demonstrate lower AE, CE and VE scores compared to learners who received KR from inexperienced peers in the delayed retention period.

We predicted that during the delayed retention test learners who received KR from experienced peers would have lower AE, CE and VE scores than learners who received KR from inexperienced peers. To this point, peer-teaching research has suggested that inexperienced peers may not be able to correct the flaws of another learner's performance (Hovardas, Tsivitanidou & Zacharia, 2014). Thus, we predicted that the KR schedule provided by experienced peers would beneficially impact learners to a greater extent than the KR provided by inexperienced peers.

Experimental Prediction #4: Learners with self-control would request KR after good trials, inexperienced peers would provide KR after both good and bad trials and experienced peers would provide KR after bad trials during the acquisition period.

We also predicted that learners with self-control would request KR in accordance with the established preference to receive KR after perceived good trials (e.g.,

Chiviacowsky & Wulf, 2002; 2005). In contrast, we predicted that inexperienced peers would provide KR after good and bad trials equally (McRae et al., 2015) while experienced peers would show a preference for providing feedback after what they perceive to be poor attempts (Wulf & Shea, 2004).

Experimental Prediction #5: During the acquisition period learners with self-control and inexperienced peers would present similar proportions of KR throughout the practice period.

We predicted that learners who physically practiced the task during the acquisition phase would be presented with similar proportions of KR regardless of who was in control of the KR Schedule. This prediction was based on the work of McRae et al., (2015) who showed that learners with self-control and learners who received KR from an inexperienced peer were presented with similar proportions of KR during the learning of a movement-timing task.

Experimental Prediction # 6: Members of the IP group would demonstrate higher AE, CE and VE scores in the delayed retention test compared to members of the LI group.

Finally, this study examined whether the act of determining when to provide KR could beneficially impact the motor skill retention of the peer providing KR to their respective learner. In McRae et al., (2015) the inexperienced peer's motor performance was not assessed in the retention period. Thus, the present study extended McRae et al., (2015) by examining the motor performance of the peer self-controlling KR for their paired learner in a delayed retention test. In the observational learning literature it has been identified that in the absence of physical practice with feedback a learner cannot optimally learn a motor skill (Blandin, Lhuisset & Proteau, 1999). Therefore, we

predicted that inexperienced peer facilitators demonstrate higher AE, CE and VE scores in the delayed retention period compared to their paired learner who physically practiced during the acquisition phase.

CHAPTER 3: METHODOLOGY

3.1 Participants

Sixty (60) individuals were recruited from the university student body (20 men and 40 women; *M* age = 21.9 +/- 1.8 years). All participants were self-declared right hand dominant and had normal to corrected normal vision. Participants received course credit upon completion of the experiment. Written informed consent was acquired prior to the commencement of the testing protocol. This study received ethical approval from the University Research Ethics Board under the protocol number 14-004.

3.2 Apparatus

A custom-made E-Prime Software program (E-prime version 2.0.8.74 Psychology Software Tools, Inc., Pittsburgh, PA) controlled the timing of the experimental stimuli and recorded the timing and accuracy data. The software was run on a Dell OptiPlex computer with an Intel ® Core ™ i5-2500 CPU @3.30GHz processor. Experimental stimuli were presented on two 19" flat-screen Dell monitors with display settings set to 1290 by 1024 pixels. Manual responses were recorded using a Psychnet Tools five key serial response box (Psychological Software Tools, Inc., Pittsburgh, PA). All responses were made through the depression of four keys on the response box. Visual stimuli were presented in black, 12-point, Arial font with a white background. Liquid crystal goggles (Translucent Technologies Inc., Toronto, Canada) were used to occlude learners' vision during strategic time periods. To eliminate the opportunity for verbal interaction, one set of participants was asked to wear a pair of industrial headphones.

3.3 Conditions

Participants were pseudo-randomly assigned to the 'inexperienced peer facilitator'

group (IP, n = 12), the learner with an inexperience peer group (LI, n = 12), the self-control to peer facilitator group (SCP, n = 12), the learner with an experienced peer group (LE, n = 12), or the control group (CO, n = 12). A pseudo-random assignment process was used for this study as members of the SCP group were required to physically practice the task prior to being able to become an experienced peer. Therefore, pseudo randomized assignment in this study can be referred to as the collection of the SCP group prior to the collection of the LE group.

The participants in the IP group had no experience with the motor task and were required to provide KR to a learner who physically practiced during the acquisition phase (i.e., LI group). The participants in the SCP group first physically practiced the motor task while controlling their own KR schedule. During this period, the participants in the CO group observed the SCP group member's performance on a mirrored computer screen. When the SCP group completed a full acquisition and retention period of physical practice they were asked to return and provide KR to a learner who physically practiced the motor task (i.e., LE group).

For the duration of the acquisition period, the participants in the IP group were paired with the participants in the LI group (i.e., [IP + LI] pairing). Similarly, the participants in the SCP group formed two pairings. First, the SCP group physically practiced the task while being observed by a participant in the CO group (i.e., [SCP + CO] pairing). Following the completion of an acquisition and retention period the SCP group provided KR to a participant in the LE group (i.e., [SCP + LE] pairing). All three pairings consisted of learners of the same-sex (i.e., Male-Male; Female-Female) consistent with Wulf, Rupauch, Pfieffer (2005). In the [IP + LI] and [SCP + LE] pairings,

one participant was be asked to physically practice the task (i.e., LI & LE groups) while their paired peer (i.e., IP & SCP groups) was required to control the physically practicing participant's KR schedule. The physically practicing learners had no previous experience with the task. However, the peer providing the KR either had previous experience (i.e., SCP group) or no experience with the motor task (i.e., IP group).

To compare the KR schedule of an 'inexperienced peer facilitator' and the KR schedule of an 'experienced peer facilitator' the participants in the peer groups (i.e., IP & SCP groups) differed in their level of experience. In this context, the 'experienced peers' (i.e., SCP group) first physically practiced the motor task during an acquisition period, with the opportunity to control their KR. This process was similar to traditional self-controlled KR conditions that have been previously examined in the literature and have been shown to enhance motor skill acquisition (e.g., Chiviacowsky & Wulf, 2002; 2005). Traditional self-controlled KR conditions typically require participants to complete the acquisition phase by themselves. However, in this study a member of the CO group observed the SCP group's acquisition period. This was done in an effort to control for the social influence that a paired learner may have on acquisition. Specifically, the inclusion of the CO group ensured that each acquisition period was completed with two participants at one time (i.e., [IP + LI], [SCP + CO] & [SCP + LE] pairings). After completing the acquisition period in which they had self-control the SCP group completed a delayed retention phase. Only once these acquisition and retention periods were completed did the SCP group members have the opportunity to provide KR to another learner (i.e., assume the role of 'experienced peer facilitator').

As 'experienced peer facilitators' the participants in the SCP group observed the

motor performance and subsequent KR (correct/incorrect; too fast/slow in milliseconds) of a learner in the LE group, before deciding whether or not the learner should be provided KR. The 'experienced peers' had an undetermined amount of time to study the KR of the participant before deciding whether or not to provide KR. The SCP group and the LE group members did not consult with one another at any point during acquisition. Therefore, the learner in the LE group was not provided with any control over the receipt of their KR.

Learners in the LI group physically practiced the experimental task and were provided KR based upon a schedule determined by an 'inexperienced peer facilitator' (i.e., IP group). Similar to the protocol of the 'experienced peers' outlined above, the 'inexperienced peers' determined when to provide the LI group member with KR by observing their motor performance and viewing their KR on every acquisition trial (correct/incorrect; too fast/slow in milliseconds). The 'inexperienced peer facilitators' were allotted as much time as they need in order to decide whether or not KR was necessary.

3.4 Task

During periods of physical practice the participants were asked to complete a computerized timing task similar to Hansen, Pfeiffer, & Patterson (2011). The task required participants to respond to a series of numbers (3-1-2-4-3-1) appearing on a computer monitor by depressing the corresponding buttons on a five key serial response box (Psychological Software Tools, Inc., Pittsburgh, PA). The buttons on the serial response box were numbered from left (#1) to right (#5) and participants were asked to

depress the buttons with their index finger of their non-dominant hand. The goal of the motor task was to complete the sequence in 2500ms.

3.5 Procedure

3. 51 Pre-Test

To begin the experiment, all group members expect for those in the CO group were asked to complete a pre-test of ten trials without KR. For the members of the IP group the pre-test was the only time in which they physically practiced the task before the retention phase. As a result, the pre-test was essential as it enabled these participants to familiarize themselves with the motor task requirements.

3.5.2 Acquisition

During the experiment, the testing room was set up in a manner that supported the participation of two individuals at one time (i.e., [IP + LI], [SCP+ CO] & [SCP + LE] pairings). To do this, two standardized computer desks were positioned to face opposite directions. With the computer desks facing opposite directions the participants were seated back to back. Measured from chair to chair there was an approximate gap of 2 meters between the participants. This separation helped ensure that the peer groups (i.e., IP & SCP groups) provided KR in a manner that was not influenced by the physically practicing learners (i.e., LI & LE groups). Additionally, the ‘peers’ wore industrial headphones to eliminate the opportunity for verbal interaction between the participants.

During the acquisition period for all three pairings, the desk facing the left side of the lab was labeled “Desk 1” and the desk facing the right side of the lab was labeled “Desk 2” (for review see Appendix A). At the center of both desks identical computer monitors displayed the visual stimuli to the participants. The computer monitors always

presented the same information to both groups, as the monitors mirrored one another. For the peer controlled KR conditions (i.e., SCP- LE & IP-LI groups), “Desk 1” was occupied by the ‘peer facilitators’ (i.e., IP & SCP groups) who in an adjustable chair provided KR by pushing either the “y” or “n” button on a keyboard. At “Desk 2” the learners with a peer (i.e., LI & LE groups) were seated in an adjustable chair and used a serial response box (SR box) to respond to the visual stimuli presented on the screen. During experimenter defined time points liquid crystal goggles were used to occlude the vision of the physically practicing learners.

During the period of physical practice that the SCP group was required to complete, a member of the CO condition was asked to sit at “Desk 1” and observe the experimental protocol. The members of the CO group were not involved in the task in any manner and sat quietly while they observed the procedure. During this period, the members of the SCP group sat at “Desk 2” in an adjustable chair and depressed buttons on a SR box to complete the task (for review see Appendix B). To the immediate right of the SR box a wireless keyboard was made available to the SCP group members. Using the keyboard the SCP group members controlled their own KR schedule. Specifically, once each trial was completed the SCP group member determined whether or not they wanted KR by pushing the “y” or “n” button on the keyboard.

The acquisition period for all groups began by presenting a welcome screen to participants that was unique to their condition. Each welcome screen outlined the participant’s role in the experiment and only terminated when the participant wished to continue. Upon termination of the screen, each group was provided with the opportunity to practice one trial in their respective conditions. When the practice trial had been

completed each group was asked if they had any questions. If the participants did not have any questions their acquisition period would begin. However, if the participants were unsure of any component of the experiment a research assistant was available to clarify the procedure.

The first acquisition phase for the SCP group required participants to complete a movement-timing task. Each acquisition trial for the SCP group began with the word "Ready" presented in the middle of the computer screen for 3000ms. Next, a sequence of six numbers (3-1-2-4-3-1) was displayed. Each number appeared one at a time and terminated when a response was made. In this context, the sequence began with only the number '3' presented in the middle of the computer screen. When any response (including an incorrect button push) was made the next number in the sequence (i.e., '1') appeared. This pattern continued until the entire sequence had been completed. Movement-timing began when the first button push had been made and ended on the final button push. When participants depressed the final button in the sequence the words "Trial Complete" was presented for 500ms. At this time the participant in the SCP group was provided with the opportunity to request KR if they believed it is necessary, similar to Chiviacowsky and Wulf (2002). Specifically, the participants in the SCP group were presented with a screen: "Would you like feedback? Y/N?". If the member of the SCP group requested feedback, they depressed the Y button on the keyboard and were immediately displayed: 1) Goal: 2500ms, 2) Movement Time: ____ms, 3) Correct Sequence /Incorrect Sequence, 4) Too fast/Too slow, and 5) Constant error. The feedback was presented to the learner for 5000ms followed by a "done" screen that lasted for 1000 ms. If the SCP group member decided to decline feedback they depressed the "N" button

on the keyboard and a "done" screen was presented for 6000ms. During this entire process a member of the CO group sat at a separate desk and viewed the experimental procedure on the mirrored computer. The SCP group members were made aware that the participant in the CO group was simply in the room to view the procedure.

After completing their first acquisition period the participants in the SCP group were asked to complete both the no-KR post-test and the delayed retention test. Once these tests were completed the SCP group was required to participate in a second task. Specifically, the members of the SCP group were now required to determine the KR schedule of another physically practicing learner (i.e., LE group).

The acquisition period for the IP group and the second task for the SCP group did not differ. In this context, the two 'peer- facilitator' groups delivered KR to a participant who physically practiced the task (i.e., LI or LE groups). 'Peer facilitators' were told that they must help their paired learners acquire the motor skill through the delivery of KR. Due to the fact that the learners and their peers viewed the same information on mirrored computer screens, the LI and LE group members wore liquid crystal goggles to occlude their vision after each trial. During this time, their peers (i.e., IP or SCP group) viewed the learner's KR and determined whether to provide or withhold this feedback.

The 'peer facilitator' groups were made aware of the fact that they would also be asked to physically complete the task during a delayed retention period. This was the second retention test that the participants in the SCP group completed and the first for the participants in the IP group. Asking these groups to complete a retention phase helped identify whether the ability to provide KR to another learner is modified by experience and whether it differentially impacted the facilitator's subsequent motor performance.

For the LI and LE groups a typical acquisition trial began with the word “Ready” presented in the middle of the computer screen for 3000ms. Next, the number sequence (3-1-2-4-3-1) was displayed and a physically practicing learner was asked to respond as close to the goal time of 2500ms as possible. When the trial had been completed, the words “Trial Complete” were presented on the screen for 500ms. At this time liquid crystal goggles, controlled by E-Prime occluded the vision of the physically practicing learner. While the vision of the learner was occluded, a ‘peer facilitator’ (i.e., either an IP or SCP group member) was provided: 1) A reminder of the goal time (“Goal: 2500ms), 2) The movement time of the learner (“Movement Time: ___ms), 3) If the series was completed correctly (“Correct Sequence” or “Incorrect Sequence”), 4) If the learner was “too fast” or “too slow” and 5) The difference between the learners goal and actual performance (“Difference: +/- __ms”). On the same screen there was also the question “Would you like to provide feedback Y/N?” This decision screen was displayed to the learner’s peer for as long as it took for the peer to make a decision. Throughout this process the learner’s goggles remained closed. If the peer wished to provide feedback they depressed the “Y” button on a keyboard. Conversely, if the peer wished to withhold feedback they depressed the “N” button. Once the decision of the peer was recorded, the goggles became transparent. If the peer depressed the “Y” key the learner was able to view the computer screen with the KR just reviewed by their peer for 5000 ms followed by a done screen for 1000ms. If the peer depressed the “N” key, the goggles opened to the word “done” that was presented for 6000ms in order to equate the duration of each KR trial.

3.5.3 Immediate no-KR Post-Test

Once the acquisition period had been completed, and after a 10-minute break (filled with a word search task), all group members except for those in the control group (CO) were asked to complete 10 no-KR trials. In total, the learners with a peer (i.e., LI & LE groups) completed 100 physical practice trials (80 KR & 20 no-KR) before the delayed retention phase. Members of the IP group completed 20 physical practice trials without KR and 80 trials in which they determined a paired learner's KR schedule before the delayed retention phase. Participants in the SCP group completed 100 physical practice trials (80 KR & 20 no-KR) during their first acquisition period. After completing these trials the SCP group returned for their second day of testing and completed their first delayed retention phase. When the requirements of the delayed retention phase had been fulfilled the SCP group was asked to complete 80 trials in which they determined a paired learner's KR schedule and 10trials of physical practice in a second immediate no-KR post-test. The SCP group then returned for a third day of testing to complete a second delayed retention phase. The members of the CO group completed no physical practice trials (no-KR) and 80 trials in which they observed the performance of a member of the SCP group before the delayed retention phase (For a summary see Appendix C).

3.5.4 Delayed Retention Phase

Approximately twenty-four hours following each acquisition period the participants returned to complete the delayed retention phase. At this time, 30 no-KR trials were performed. These trials consisted of practice of the acquisition sequence and movement time goal (10 trials), a time transfer test (i.e., same sequence in 3300ms) (10 trials) and pattern transfer test (i.e., different key pressing sequence, with the acquisition

movement time) (10 trials). The retention test was performed before the transfer tests, and the transfer tests were counterbalanced across all participants. The total duration of the delayed retention test was approximately 15minutes.

3.5.6 Retention Test

During the retention test, a screen displaying the word "Ready" was presented for 3000ms. The acquisition sequence of (3-1-2-4-3-1) was displayed and participants were asked to respond as close as possible to the goal movement-time of 2500ms as possible. Finally, a screen with the word "Done" was displayed for 3000ms upon the completion of each retention trial. No-KR was provided during the retention and transfer phases. On trials where sequence errors were committed, the trial was not repeated. Instead the learner progressed through the protocol and the number of incorrect button pushes that were made was recorded.

3.5.7 Time transfer and pattern transfer tests

In the *time* transfer test, the pattern remained the same but the goal time was changed to 3300ms. In the *pattern* transfer test, the sequence of numbers changed from 3-1-2-4-3-1 to 2-1-3-1-4-3. However, the goal time remained 2500ms. The order and completion of the two transfer phases was counterbalanced across participants.

3.6 Questionnaires

Participants were asked to complete a brief survey at selected time periods during the experiment. The survey was conducted in an effort to provide greater insight into certain aspects of the learning process. Specifically, the survey included questionnaires that assessed the motivation of the participants, their ability to estimate performance, and

the rationale behind their feedback requests or provisions (For a review of temporal placement of questionairres see Appendix D).

3.6.1 Motivation Questionairre

Prior to the commencement of acquisition phase, at the end of the acquisition period, and before the retention phase all participants responded to a brief questionairre regarding their level of motivation during the testing protocol. Following the guidelines of Lewthwaite and Wulf (2010) the questionairre was used to help identify how motivated the participants were during the learning of the task. All conditions were asked to respond to the following question: 1) "How motivated are you to complete this task?" Participants responded by circling a number on a scale that best reflects how they felt at the time of the question. The motivation scale ranged from 1:10 with the written anchors of 1"Not at all", 5 "Somewhat", and 10 "Very".

3.6.2 Judgement of Learning Question

After the first block of the acquisition phase, at the end of the acquisition phase and before the retention period participants completed a short questionnaire regarding how well they believed they would complete the task in the delayed retention phase. Following a protocol similar to that of Simon & Bjork (2001) participants answered a judgment of learning question.

During the LI, and LE groups' acquisition period and during the SCP group's first testing session the judgement of learning question was completed after the first block of acquisition, at the end of the acquisition phase and before the retention period. For these three groups the question attempted to identify whether the physically practicing learners

could accurately estimate their own performance. At all three time points (after the first block, at the end of acquisition, and before retention) the physically practicing learners were asked: "How well do you believe *you* will perform during the delayed retention test?" Participants responded within a blank box followed by the word "milliseconds" (i.e., _____milliseconds). Estimated times were documented and analyzed in terms of absolute difference from their retention period score.

For participants in the IP group, CO group and during the second testing period for the SCP group, the judgment of learning question attempted to identify whether the 'peer facilitators' and observers were capable of estimating both their own performance as well as the performance of their paired learner. Specifically, after the first block and at the end of the acquisition period the groups were asked: "If practice was to end at this moment and *the learner* was asked to complete the delayed retention test how well would *the learner* preform?" Contrastingly, prior to the completion of the delayed retention period the 'peer facilitators' and the participants in the CO group were asked: "How well do you believe *you* will perform during the delayed retention test?" Participants will respond within a blank box followed by the word "milliseconds" (i.e., _____milliseconds). Estimated times were documented and analyzed in terms of absolute difference from their retention period score.

3.6.3 Feedback Questionnaire

Following the completion of the acquisition period, and before the retention phase all participants completed a short questionairre regarding their use of feedback during acquisition. Simliar to the questionnaires implemented by Chiviacowski & Wulf (2002)

and Patterson & Carter (2010), the questionairre was used to help identify the strategies underlying the request and the rationale behind the decision to provide feedback.

During the first testing session for the SCP group the members controlled their own KR schedule. As a result, the questions that the SCP group were asked to answer were as follows: 1) When/why did you ask for feedback? 2) When did you not ask for feedback? The options that were provided for both questions are: Perceived good trial, Perceived Bad Trial, Perceived Good & Bad Equally, Randomly, or Other.

For participants in the IP group and during the second testing period for the SCP group, the questions that were asked attempted to identify the strategy behind why they provided feedback. The questions were as follows: 1) When/Why did you provide feedback? 2) When did you not provide feedback to the learner? Options for both questions will include: Perceived good trial, Perceived Bad Trial, Perceived Good & Bad Equally, Randomly, or Other. Additionally, facilitators were asked to rank how well they believed they delivered feedback during the practice period. The question queried: "How well do you believe your feedback schedule was at improving the learning of your paired participant?" The scale that was used ranged from 1"Ineffective" to 10 "Extremely Effective".

The learners constituting the LI and LE groups were asked to identify whether the feedback they received was consistent with when the learner perceived it most beneficial. The questions posed to the learners in the LI and LE groups were as follows: 1) Do you think you received feedback after the right trials? (Yes/No) 2) If NO, when would you have liked to receive feedback? Options for question #2 will include: Perceived good trial, Perceived Bad Trial, Perceived Good & Bad Equally, Randomly, or Other.

Additionally, learners were asked to rank how well they believe their facilitator provided feedback. The question queried: “How well do you believe the feedback schedule provided to you was at improving your learning of the task?” The scale that was used ranged from 1“Ineffective” to 10 “Extremely Effective”.

Participants in the CO group were also asked to complete a feedback questionnaire. Specifically, CO group members were asked to identify whether they were able to identify a strategy that the members of the SCP group utilized. The questions asked: “When did you believe the learner requested KR?” and “When do you believe the learner did not request KR?” Options for these questions included: Unsure, Perceived good trial, Perceived Bad Trial, Perceived Good & Bad Equally, Randomly, or Other.

3.7 Dependent Measures and Analyses

The G*Power software analysis package (Faul, Erdfelder, Lang, & Buchner, 2007) was used to determine the sample size for this study. The calculation was carried out with an alpha level of 5% (e.g., Chiviacowsky, 2014), a power of 95%, and an effect size of 0.67 (e.g., Bund & Weimeyer, 2004; McRae et al., 2015). From the analysis, it was determined that a total of 50 participants should be dispersed among the five groups in our study (i.e., N = 10 per group). However, in an attempt to combat participant attrition, a total of 60 participants (i.e., N= 12 per group) were collected.

To examine whether differences existed between groups in the pre-test and the immediate no-KR post-test, the motor performance of participants physically practicing the motor task (i.e., LI, LE, IP & SCP groups) were indexed by measures of AE (absolute accuracy), CE (accuracy with direction) VE (consistency), and the number of errors committed. These measures were then analyzed in two separate 4-Group (LI, LE, SCP, IP) x 1 Block ANOVAS.

During the acquisition phase, the motor performance of participants physically practicing the motor task (i.e., LI, LE & SCP groups) were indexed by measures of AE, CE, VE, and the number of errors committed. These measures were analyzed in four separate 3-Group (LI, LE & SCP) by 8-Block (10 trials per block) mixed analyses of variance (ANOVAs) with repeated measures on blocks.

The trials after which the SCP group requested KR (i.e., KR trials) was compared to the trials after which peers provided KR to another learner (i.e., IP & SCP groups) (i.e., KR trials). This comparison allowed us to determine when a learner (i.e., SCP group), a peer without experience (i.e., IP group), and when a peer with experience (i.e., SCP

group) preferred KR. The AE from KR and No-KR trials during acquisition was analyzed in a Group (LI, LE & SCP groups) by Trial Type (KR & No-KR) ANOVA with repeated measures on trial type. The proportion of KR requests (i.e., self-controlled KR condition) and KR provisions during the acquisition period (i.e., IP & SCP groups) was analyzed in a 3-Group (LI, LE & SCP) by 8-Block ANOVA with repeated measures on blocks.

During the retention, time transfer and pattern transfer tests AE, CE, VE and the number of errors committed were analyzed in separate 5-group (IP, LI, SCP, LE & CO) by 1-Block ANOVA's. Tukey's HSD post-hoc tests were used during follow up analyses (e.g., Chiviacowsky & Wulf, 2002; Patterson et al., 2011; Patterson et al., 2013). The statistical significance level for this study was set at $p < 0.05$. Effect sizes were reported as Partial n^2 (e.g., Carter, Carlsen, & Ste-Marie 2014; Hansen et al., 2011) to measure the magnitude of the treatment effects.

Self-report motivation questionnaires were conducted for all experimental groups before the first trial (T1), at the end of the acquisition phase (T2), and before the retention and transfer tests (T3). To determine whether participants maintained their levels of motivation throughout the protocol a 6- Group (IP, LI, SCP [as a learner with self-control and as an experienced peer], LE & CO) x 3-Time Period (T1, T2, & T3) ANOVA with repeated measures on time was performed.

The judgment of learning questionnaire scores were used to compute absolute difference scores (absolute value of the difference between the predicted score and the actual performance observed in the retention test). Absolute difference scores were calculated for all experimental groups after the first block (T_1), at the end of the acquisition phase (T_2), and before the retention and transfer tests (T_3). To determine

whether any group differed in their ability to predict their own score or the score of their paired learner a 6- Group (IP, LI, SCP [as a learner with self-control and as an experienced peer], LE & CO) x 3-Time Period (T_1, T_2, & T_3) ANOVA with repeated measures on time was performed. Feedback preference questionnaire data was presented as descriptive statistics (i.e., Means & Standard Deviations).

CHAPTER 4: RESULTS

4.1 Pre-Test (No-KR test before the acquisition phase)

4.1.1 Absolute error (AE)

There was a main effect for group, F (3, 44) = 4.07, p = .01, η_p^2 = .22. A follow up Tukey's post-hoc test showed the IP group (M = 623.5, SD = 229.8) preformed the task with less AE compared to the SCP group (M = 1821.2, SD = 1488.5) (see Table 1; Figure 1).

4.1.2 Constant error (CE)

There was a main effect for group, F (3, 44) = 5.90, $p < .01$, η_p^2 = .29. The post-hoc test showed that the LI group (M = 251.3, SD = 575.9) preformed the task with less CE compared to the LE group (M = 1530.8, SD = 1461.4) and the SCP group (M = 1752.6, SD = 1559.9). Furthermore, the IP group (M = 313.5, SD = 427.8) preformed the task with less CE compared to the SCP group (M = 1752.6, SD = 1559.9) (see Table 1; Figure 2).

4.1.3 Variable error (VE)

There was a main effect for group, F (3, 44) = 3.67, p = .02, η_p^2 = .20. The post-hoc test showed that the LI group (M = 391.7, SD = 189.3) preformed the task with less VE compared to the LE group (M = 983.6, SD = 702.1). Furthermore, the IP group (M = 387.8, SD = 206.1) preformed the task with less VE than the LE group (M = 983.6, SD = 702.1) (see Table 1; Figure 3).

4.1.4 Number of errors committed

There were no statistically significant differences between groups for average number of errors committed during the pre-test, F (3, 44) = 1.14, p = .35 (see Table 1; Figure 4).

4.2 Acquisition

4.2.1 Absolute Error (AE)

Mauchly's Test of Sphericity showed the assumption of sphericity had been violated,

χ^2 (27) = 80.47, p < .01. As a result, the Greenhouse-Geisser correction was used during analyses. The Group x Block interaction was not statistically significant, F (6.98, 115.24) = 1.44, p = .19 nor was the group main effect, F (2, 33) = .49, p = .62. However, there was a main effect for block, F (3.49, 115.24) = 13.65, p < .01, η_p^2 = .29. Results of the post-hoc test showed that block 1 (M = 318.1, SD = 185.7) was performed with greater AE compared to block 2 (M = 215.0, SD = 101.6), block 3 (M = 203.2, SD = 103.6), block 4 (M = 159.5, SD = 84.7), block 5 (M = 150.9, SD = 77.9), block 6 (M = 171.4, SD = 100.5), block 7 (M = 187.0, SD = 127.2) and block 8 (M = 161.1, SD = 82.2). Furthermore, block 2 (M = 215.0, SD = 101.6) and block 3 (M = 203.2, SD = 103.6) demonstrated higher AE than block 5 (M = 150.9, SD = 77.9) (see Table 2; Figure 5).

4.2.2 Constant error (CE)

Mauchly's Test of Sphericity showed the assumption of sphericity had been violated, χ^2 (27) = 133.01, p < .01. As a result, the Greenhouse-Geisser correction was used during analyses. The Group x Block interaction was not statistically significant, F (4.99, 82.44) = .88, p = .50 nor was the main effect for group, F (2, 33) = 1.88, p = .17, or the main effect for block, F (2.49, 82.44) = .53, p = .81 (see Table 2; Figure 6).

4.2.3 Variable error (VE)

Mauchly's Test of Sphericity showed the assumption of sphericity had been violated, χ^2 (27) = 169.40, $p < .01$. As a result, the Greenhouse-Geisser correction was used during analyses. The Group x Block interaction was not statistically significant, F (4.44, 73.29) = 1.36, $p = .26$ nor was the main effect for group, F (2, 33) = 2.91, $p = .07$. However, there was a main effect for block, F (2.22, 73.29) = 2.96, $p = .045$, $\eta_p^2 = .08$. The post-hoc test showed that block 1 (M = 200.2, SD = 87.9) had higher VE compared to block 2 (M = 132.9, SD = 51.5), block 4 (M = 136.2, SD = 113.7), block 5 (M = 102.1, SD = 58.9), block 6 (M = 122.5, SD = 70.4) and block 8 (M = 113.2, SD = 77.7). Furthermore, block 3 (M = 174.9, SD = 138.1) had higher VE compared to block 5 (M = 102.2, SD = 58.9) (see Table 2; Figure 7).

4.2.4 Number of errors committed

Mauchly's Test of Sphericity showed the assumption of sphericity had been violated,

χ^2 (27) = 57.02, $p < .01$. As a result, the Greenhouse-Geisser correction was used during analyses. The Group x Block interaction was not statistically significant, F (9.81, 161.80) = 1.09 $p = .37$ nor was the group main effect, F (2, 33) = .02, $p = .98$, or the block main effect, F (4.90, 161.80) = 1.019, $p = .418$ (see Table 6; Figure 8).

4.2.5 Proportion of KR trials

Mauchly's Test of Sphericity showed the assumption of sphericity had been violated, χ^2 (27) = 40.80, $p = .04$. As a result, the Greenhouse-Geisser correction was used during analyses.

The Group x Block interaction was not statistically significant, F (10.29, 169.86) = 1.68 p = .09 nor was the main effect for group, F (2, 33) = 2.96, p = .07. However, there was a main effect for block, F (5.14, 169.86) = 5.80, $p < .01$, $\eta_p^2 = .15$. The post-hoc test showed more frequent requests for KR in block 1 (M = .61, SD = .25) compared to block 4 (M = .44, SD = .26), block 5 (M = .44, SD = .26), block 6 (M = .46, SD = .28) and block 7 (M = .49, SD = .24). Additionally, KR was requested more frequently in block 3 (M = .56, SD = .27) compared to block 4 (M = .44, SD = .26), and block 5 (M = .44, SD = .26) (see Table 5; Figure 13).

4.3 Post-Test (No-KR test 10 minute after acquisition)

4.3.1 Absolute error (AE)

There was a main effect for group, F (3, 44) = 6.32, $p < .01$, $\eta_p^2 = .30$. A post-hoc test showed the IP group (M = 433.6, SD = 222.1) preformed the task with higher AE compared to the LI Group (M = 181.5, SD = 85.1), the SCP group (M = 253.9, SD = 189.3), and the LE group (M = 187.9, SD = 112.9) (see Table 3; Figure 5).

4.3.2 Constant error (CE)

There were no statistically significant differences between groups during the post-test,

F (3, 44) = .40, p = .75 (see Table 3; Figure 6).

4.3.3 Variable error (VE)

There was a main effect for group, F (3, 44) = 3.65, p = .02, $\eta_p^2 = .20$. The post-hoc test showed that the IP group (M = 239.4, SD = 109.7) preformed the task with higher VE than the LE group (M = 114.2, SD = 47.1) (see Table 3; Figure 7).

4.3.4 Number of errors committed

There were no statistically significant differences between groups for the average number of errors committed during the post-test, F (3, 44) = .79, p = .51 (see Table 3; Figure 8).

4.4 Delayed Retention Test (No-KR test 24 hours after acquisition)

4.4.1 Absolute error (AE)

There was a main effect for group, F (4, 55) = 6.55, $p < .01$, $\eta_p^2 = .32$. The post-hoc test showed the CO group (M = 745.6, SD = 569.8) preformed the task with higher AE compared to the LE group (M = 187.3, SD = 119.1), the SCP group (M = 237.6, SD = 61.1), the IP group (M =373.8, SD = 303.0), and the LI group (M =294.9, SD = 135.4) (see Table 4; Figure 5).

4.4.2 Constant error (CE)

There was a main effect for group, F (4, 55) = 7.19, $p < .01$, $\eta_p^2 = .34$. The post-hoc test showed the CO group (M = 676.6, SD = 626.8) preformed the task with greater CE compared to the LE group (M = -64.3 SD = 198.6), the SCP group (M = -6.7, SD = 204.8), the IP group (M = 6.4, SD = 481.0), and the LI group (M = -8.4, SD = 325.3) (see Table 4; Figure 6).

4.4.3 Variable error (VE)

There was a main effect for group, F (4, 55) = 5.25, $p < .01$, $\eta_p^2 = .28$. A follow up post-hoc test showed that the CO group (M = 297.9, SD = 124.4) preformed the task with greater VE compared to the LE group (M = 110.5, SD = 36.9), the SCP group (M = 155.4, SD = 79.9), and the IP group (M = 170.8, SD = 92.6) (see Table 4; Figure 7).

4.4.4 Number of errors committed

There were no statistically significant differences between groups for the average number of errors committed during the retention test, F (4, 55) = 1.06, p = .38 (see Table 6; Figure 8).

4.5 Delayed Time Transfer Test (No-KR transfer test 24 hours after acquisition)

4.5.1 Absolute error (AE)

There were no statistically significant differences between groups during the time transfer test, F (4, 55) = 1.32, p = .27 (see Table 4; Figure 5).

4.5.2 Constant error (CE)

There were no statistically significant differences between groups during the time transfer test, F (4, 55) = 1.15, p = .34 (see Table 4; Figure 6).

4.5.3 Variable error (VE)

There was a main effect for group, F (4, 55) = 2.69, p = .04, η_p^2 = .16. A follow up post-hoc test showed the CO group (M = 327.7, SD = 130.5) preformed the task with higher VE compared to the LE group (M = 200.8, SD = 85.2) (see Table 4; Figure 7).

4.5.4 Number of errors committed

There were no statistically significant differences between groups for the average number of errors committed for the time transfer test, F (4, 55) = .85, p = .50 (see Table 7; Figure 8).

4.6 Delayed Pattern Transfer Test (No-KR transfer test 24 hours after acquisition)

4.6.1 Absolute error (AE)

There were no differences between groups for the pattern transfer test, F (4, 55) = 2.50, p = .05 (see Table 4; Figure 5).

4.6.2 Constant error (CE)

There was a main effect for group, F (4, 55) = 3.15, p = .02, ηp^2 = .18. A follow up post-hoc test showed the IP group (M = -409.9, SD = 711.2) preformed the task with higher CE compared to the CO group (M = 239.7, SD = 795.1) (see Table 4; Figure 7) (see Table 4; Figure 6).

4.6.3 Variable error (VE)

There were no statistically significant differences between groups for the pattern transfer test, F (4, 55) = 1.86, p = .13 (see Table 4; Figure 7).

4.6.4 Number of errors committed

There were no statistically significant differences between groups for the average number of errors committed for the pattern transfer test, F (4, 55) = 1.71, p = .16 (see Table 7; Figure 8).

4.7 Self-Control to Peer-Facilitator Comparisons

4.7.1 Retention Test–Retention Test: *Performance differences between the SCP group's first delayed retention test (after self-controlling KR) compared to their second delayed retention test (after providing KR).*

Despite approaching statistical significance, the performance differences between the SCP group's first delayed retention test (after self-controlling KR) and second delayed retention test (after providing KR) were not statistically significant, F (1, 11) = 4.73, p = .05 (see table 4; Figure 9). There were also no differences for CE, F (1, 11) = 2.99, p = .11 (see table 4; Figure 10); VE, F (1, 11) = 1.29, p = .28 (see table 4; Figure

11); or the average number of errors committed, F (1, 11) = 1.00, p = .34 (see table 7; Figure 12).

4.7.2 Time Transfer-Time Transfer: *Performance differences between the SCP group's first delayed time transfer test (after self-controlling KR) compared to their second delayed time transfer test (after providing KR).*

There were no statistically significant differences between the SCP group's first delayed time transfer test (after self-controlling KR) and second delayed time transfer test (after providing KR) for AE, F (1, 11) = .60, p = .46 (see table 4; Figure 9); CE, F(1,11) = 2.61, p = .13 (see table 4; Figure 10); VE, F (1, 11) = .07, p = .80 (see table 4; Figure 11); or the average number of errors committed , F (1, 11) = .48, p = .50 (see table 7; Figure 12).

4.7.3 Pattern Transfer-Pattern Transfer: *Performance differences between the SCP group's first delayed pattern transfer test (after self-controlling KR) compared to their second delayed pattern transfer test (after providing KR).*

There were no statistically significant differences between the SCP group's first delayed pattern transfer test (after self-controlling KR) and second delayed pattern transfer test (after providing KR) for AE, F (1, 11) = 1.56, p = .24 (see table 4; Figure 9); for CE, F (1, 11) = .18, p = .68 (see table 4; Figure 10); CE, F (1, 11) = 4.19, p = .07 (see table 4; Figure 11); VE, F (1, 11) = .18, p = .68 (see table 4; Figure 11); or the average number of errors committed, F (1, 11) = 1.00, p = .34 (see table 7; Figure 12).

4.8 Inexperienced Peer Comparisons

4.8.1 Post Test-Delayed Retention Test: *Performance differences between the IP group's no-KR post-test (10 minutes after acquisition) compared to their delayed no-KR retention test (24 hours after acquisition).*

There were no statistically significant differences between the immediate no-KR post-test (10 minutes after acquisition) compared to the delayed no-KR retention test (24

hours after acquisition) for AE, F (1, 11) = .59, p = .46 (see table 4; Figure 5); CE, F (1, 11) = 2.00 p = .19 (see table 4; Figure 6); VE, F (1, 11) = 4.58, p = .06 (see table 4; Figure 7); or for the average number of errors committed, F (1, 11) = .29, p = .60 (see table 7; Figure 12).

4.9 Feedback Decisions

The Group x feedback choice interaction was statistically significant F (2, 32) = 6.17, $p < .01$, $\eta_p^2 = .28$. A follow up post-hoc test revealed that after self-controlling their KR schedule the SCP group had higher AE (M = 243.7, SD = 83.9) compared to the IP group (M = 142.9, SD = 76.2) on no-KR trials. Furthermore, the IP group had higher AE on KR trials (M = 223.8, SD = 98.2) compared to no-KR trials (M = 142.9, SD = 76.1). There were no statistically significant differences among the groups for KR trials. Similarly, the main effect of feedback choice F (1, 32) = 3.79, p = .06 and the main effect for group F (2, 32) = 1.09, p = .35 (see table 9; figure 16) did not reach statistical significance.

4.9.1 Decision time on KR and No-KR trials

The Group x feedback choice interaction F (2, 32) = .15, p = .86, the main effect of feedback choice F (2, 32) = .65, p = .41 and the main effect of group F (2, 32) = .37, p = .69 were not statistically significant (see table 10; figure 17).

4.9.2 Total Time

There were no differences amongst the experimental conditions for the total time required to complete the acquisition period, F (1, 21) = .59, p = .56 (see table 8; figure 18).

4.10 Questionnaire Data

4.10.1 Motivation

Mauchly's Test of Sphericity showed the assumption of sphericity had been met, χ^2 (2) = 1.76, p = .41. The Group x Motivation Time Point interaction was not statistically significant, F (10, 132) = 1.13, p = .34 nor was the main effect for group F (5, 66) = .89, p = .49. However, the main effect of Motivation Time Point (i.e., before acquisition, at the end of acquisition and before retention) was statistically significant F (2, 132) = 5.17, $p < .01$, $\eta_p^2 = .07$. The post-hoc test showed participants reported that they were more motivated to learn the task before the retention period (M = 7.03, SD = 1.68) compared to before the commencement of the acquisition period (M = 6.49, SD = 1.74).

4.10.2 Feedback Questions

Self-report data showed that eight out of the twelve learners (67%) with an inexperienced peer believed they received feedback after the appropriate trials during acquisition. In comparison, eleven of the twelve of the learners (92%) with experienced peers reported they received feedback after the appropriate trials.

When the participants who received feedback from the inexperienced peer group were asked to rate the effectiveness of the feedback schedule provided to them (from 1 to 10 with one representing "ineffective feedback" and ten representing "extremely effective feedback") they reported an average score of 7.3/10. Participants who received feedback from the experienced peer group reported that the effectiveness of the feedback schedule provided to them was on average 7.7/10 (see table 13).

When the inexperienced peer group was asked to rate the effectiveness of the feedback schedule they provided to their paired learner (from 1 to 10 with one

representing "ineffective feedback" and ten representing "extremely effective feedback") they reported an average of 6.8/10. The experienced peer facilitator group rated the effectiveness of their feedback schedule an average of 6.9/10 (see table 14).

When given the opportunity to self-control their own feedback schedule (SCP), participants reported to request feedback most often after good trials (33%) (see table 10). However, when asked when they provided feedback as experienced peers (SCP) participants reported they provided feedback most often after poor trials (33%). Similarly, inexperienced peers (IP) reported to have provided feedback most often after poor trials (50%) (see table 14). When asked to identify when the members of the SCP group requested feedback, the control group (CO) was able to correctly recognize when the learners with self-control requested KR 42% of the time.

4.10.3 Absolute difference (AD)

The Group x AD time point interaction was statistically significant F (10, 132) = 1.99, p = .04, η_p^2 = .13. The follow up post-hoc test revealed that across each time point queried (i.e., after the first block of acquisition, at the end of acquisition and before retention) the CO group had higher AD scores than all other groups. However, there were no statistically significant differences between groups at any time point. The main effect of group was also significant F (5, 66) = 5.68, p < .01, η_p^2 = .30. The post-hoc test showed that the CO group (M = 582.6, SD = 563.9) had a higher AD scores compared to the LI group (M = 140.2, SD = 69.3), the LE group (M = 178.7, SD = 160.1), the IP group (M = 256.6, SD = 273.1), the SCP group when asked to self-control their KR (M =114.6, SD = 69.8), and the SCP group when asked to provide KR (M = 83.9, SD = 55.9). All other group comparisons were not statistically significant. The main effect of AD time

point (i.e., after the first block of acquisition, at the end of acquisition and before retention) for AD was not statistically significant F (2, 132) = .61 p = .55 (see table 15; figure 19).

CHAPTER 5: DISCUSSION

5.1 Discussion

The purpose of the present experiment was to determine whether previous task experience would differentially impact how peers would present KR to learners, and whether the KR presented would subsequently impact motor skill acquisition. It was predicted that during the acquisition phase of the experiment, learners with self-control, learners with an inexperienced peer and learners with an experienced peer would demonstrate similar improvements in movement accuracy (i.e., AE, CE) and movement consistency (i.e., VE). This hypothesis was based on the fact that when made available to the learner, KR can enhance performance during acquisition, resulting in the similar motor performance of experimental conditions (Kantak & Winstein, 2011; Salmoni et al., 1984; Wulf & Shea, 2004). The results of the acquisition period revealed no statistically significant differences between learners with self-control, learners with an inexperienced peer and learners with an experienced peer based on measures AE, CE and VE, thus providing support for the acquisition period prediction. The performance results from the self-control condition is consistent with previous research examining self-controlled KR schedules (e.g., Chiviacowsky & Wulf, 2002; 2005; Hansen et al., 2011; Kaefer et al., 2014), and the motor performance results from the learners with an inexperienced peer are consistent with (McRae et al., 2015). The motor performance results of the learner with an experienced-peer suggest that those who receive KR from inexperienced or experienced peers can demonstrate similar motor performance during skill acquisition.

The results of the acquisition period also help to explain the differences that were observed in the pre-test. In this regard, the group differences that were observed in the

pre-test were no longer evident by the first block of acquisition. Specifically, all groups preformed the task similarly based upon measures AE, CE or VE in the first block. Furthermore, all experimental conditions experienced a block main effect for measures of AE and VE such that the groups had higher AE in the first block compared to the final block of acquisition. As a result, the differences between groups that were observed in the pre-test effectively dissipated over the course of the acquisition period. Therefore, it can be suggested that the results of our experiment are not differentially impacted by our pre-test scores.

Also of interest, there were no statistically significant differences in regards to the proportion of KR trials that were presented to learners with self-control (M = .60) and learners receiving KR from our peer groups (i.e., experienced (M = .40) and inexperienced (M = .52) during the acquisition period. Thus, based on previous KR research examining reduced frequency KR schedules (e.g., Nicholson & Schmidt, 1991; Wulf & Schmidt, 1989; Wulf, Shea & Rice, 1996) similar improvements in motor-performance were expected during the acquisition period (Magill, 2004; Winstein & Schmidt, 1990). In this context, the experimental conditions demonstrated higher AE and VE in the first block compared to the final block of our acquisition phase as evidenced by a block main effect. Furthermore, based on the fact that there was not a main effect of group, or group x block interaction, the present results suggest that the groups performed the task similarly throughout the acquisition phase. Consequently, the present findings are novel as they suggest that performance measures (i.e., AE, CE and VE) are not differentially impacted by self-controlled or peer-controlled KR schedules during motor skill acquisition when the proportion of KR trials are similar.

For the delayed retention period, it was predicted that learners with self-control would demonstrate greater AE, CE and VE scores compared to learners receiving KR from inexperienced or experienced peers. This prediction was based on previous research suggesting that learners with self-control outperform learners who are not provided with control over their own KR schedule (e.g., Patterson et al., 2011; Patterson & Carter, 2010). In this context, the underlying benefits associated with self-controlled KR have been attributed to a learner's ability to individualize the practice context to match their preferences (Chiviacowsky & Wulf, 2002), such that, requesting KR when it is deemed necessary by the learner results in a deeper processing of task information (Mccombs 1989; Wulf, Clauss, Shea, & Whitacre, 2001).Yet, the results from the delayed retention period failed to support this prediction. No statistical differences between learners with self-control, learners with an inexperienced peer and learners with an experienced peer were evident based on measures AE, CE and VE. The observed similarity in retention scores (i.e., AE, CE and VE) between our learners with an inexperienced peer and our learners with self-control are consistent with the findings of McRae et al., (2015). Furthermore, this result supports Karlinsky and Hodges (2014), who identified that learners whose practice context was controlled by an inexperienced peer had similar measures of percentage error (%ACE) compared to learners with self-control in a delayed retention test. However, the observed similarity in AE, CE, and VE between learners with experienced peers and learners with self-control in the delayed retention period is a novel contribution to the motor learning literature.

A potential explanation for the similar motor performance observed in the delayed retention period between learners who received KR from one of the peer groups (i.e.,

inexperienced or experienced peers) and learners with self-control may have been associated with the findings from the self-report motivation questionnaire. Motivation is a powerful learning variable that can influence a learner's ability to retain a motor skill (for review see Kantak & Winstein, 2011; Lewthwaite & Wulf, 2012). In this context, increased levels of self-reported motivation have been suggested to enhance motor proficiency (e.g., Lewthwaite & Wulf, 2010) while similar levels of self-reported motivation contribute to similarities in motor performance (Jourden, Bandura, & Banfield, 1991). During the present experiment, participants self-reported how motivated they were to complete the task before the acquisition period, after the acquisition period and before the retention period. The results from the motivation questionnaire showed that all the experimental groups were equally motivated to learn the task during all portions of the experiment. This finding provides a novel contribution to the motor learning literature as no other study has examined self-reported motivation from peer-controlled KR schedules. Additionally, the present findings extend motor learning and motivation research (e.g., Chiviacowsky, 2014; Chiviacowsky, Wulf, Lewthwaite, 2012) suggesting that irrespective of how KR is controlled (i.e., self-controlled or peer-controlled) during the acquisition period, motivation was not differentially effected and learning was not undermined.

For the delayed retention period, we also predicted that learners who received KR from experienced peers would demonstrate greater AE, CE and VE scores compared to learners receiving KR from inexperienced peers. This prediction was based on peer-teaching research that has suggested that inexperienced peers may not have the ability to appropriately identify or correct flaws in a learner's performance (Hovardas, Tsivitanidou

& Zacharia, 2014). The results from the delayed retention period failed to support this prediction showing that learners with an inexperienced peer and learners with an experienced peer learned the task similarly based on measures of AE, CE and VE. Extending the work of McRae et al., (2015) and Karlinsky and Hodges (2014) that examined inexperienced peers only, the motor performance results from the present experiment suggest that the learning of the movement-timing task was not differentially impacted by the experience level of a peer providing KR. A possible explanation for this finding comes from Cho et al., (2008) who suggested that KR provided by an inexperienced peer can be as helpful as KR that is provided by an expert. In this context, Cho and MacArthur (2010) proposed that inexperienced peer facilitators may more easily relate with inexperienced learners and subsequently provide feedback that closely resembles the learner's preference. To examine whether the inexperienced peers in our study provided KR on a schedule that resembled the preference of the learner with self-control, an analysis of AE on KR and no-KR trials for our learners with self-control, learners with inexperienced peers and learners with experienced peers.

It was predicted that learners with self-control would demonstrate a preference to request KR after perceived good trials (e.g., Chiviacowsky & Wulf, 2002; 2005). This prediction was based on previous research that has shown that learners with self-control tend to have significantly lower AE on KR-trials compared to no-KR trials (e.g., McRae et al., 2015). However, our prediction was not supported with statistically significant differences. Instead, our learners with self-control displayed only a tendency to have lower AE on KR compared to no-KR trials (i.e., request KR on good trials) (see table 9; figure 16). Although not statistically significant, it is important to note that this finding is

commensurate with previous research that has shown only a trend for learners with self-control to request KR most frequently after perceived good attempts (e.g.,Chiviacowsky, 2014; Hansen et al., 2011; Kaefer et al., 2014; Patterson & Carter, 2010; Patterson, 2013). Furthermore, our results support Aiken, Fairbrother and Post (2012) who showed no clear preference for learners with self-control to request KR after perceived good or perceived poor trials. In this context, the present findings highlight the complexities associated with a learner's decision to request or decline KR. Similar to the suggestion of Aiken et al., (2012) we hypothesize that requesting KR after both good and poor trials may identify that learners request KR for different reasons on different trials. For example, a learner may request KR after a perceived good trial to confirm that they are on the "right track" (Chiviacowsky, 2005). Alternatively, a learner may request KR after a perceived poor trial in an attempt to determine how far from the target their response actually was. Previous research attempting to understand why KR is requested in self-controlled conditions has used self-report surveys (e.g.,Chiviacowsky & Wulf, 2002; Patterson et al., 2011). Yet, the results from these studies have been rather inconclusive, where some researchers have identified that learners with self-control request KR after perceived good trials (e.g., Chiviacowsky & Wulf, 2002; Patterson & Carter, 2010; McRae et al., 2015) while others have reported mixed results (e.g., Patterson et al., 2011; Patterson et al., 2013). Thus, further research is needed to provide further insight into the mechanisms underlying the decision of when learners should receive KR if given control of their own KR schedule. One potential way in which this may be analyzed is through the creation of an experimental protocol where learners are queried on when they requested KR with open-ended questions. Without the potential bias associated with written anchors on a

self-report survey, a learner's response would be more indicative of their true preference for requesting KR.

For the inexperienced peer group it was predicted that inexperienced peers would demonstrate a preference to have similar AE on KR and no-KR trials (i.e., request KR after good and poor trials equally). This prediction was based on the work of McRae et al., (2015) who identified that inexperienced peers provided KR to inexperienced learners after both good and poor trials equally. However, our inexperienced peers demonstrated statistically significant higher AE on KR trials compared to no-KR trials (i.e., provided KR on poor trials) (see table 9; figure 16). In this context, our results failed to support McRae et al., (2015) and our prediction that inexperienced peers would provide KR on good and bad trials equally (i.e., similar AE on KR and no-KR trials). To this point, the inexperienced peers in the present study may have provided KR after perceived poor trials in an effort to guide the learner to the correct motor response (for review see Salmoni et al., 1984; Wulf & Shea, 2004). Alternatively, the difference between the present findings and those of McRae et al., (2015) may be due to the fact that the methodologies that were used differed. Specifically, the inexperienced peers in the present study were able to participate in a no-KR pre-test before providing KR to another learner while the inexperienced peers in McRae et al. (2015) were not afforded this opportunity. Consequently, the physical practice the inexperienced peers completed in their pre-test may have provided the inexperienced peer with the ability to develop an initial understanding of the task-related sensory information (i.e., connection between visual stimuli and button pushing requirements). In contrast, the inexperienced peers in

McRae et al., (2015) may have demonstrated similar AE on KR and no-KR trials because they were uncertain of the task demands prior to providing KR to the learner.

Finally, it was predicted that experienced peers would demonstrate higher AE on KR trials compared to no-KR trials (i.e., provide KR after poor trials). This prediction was based on previous research that has shown that experienced learners prefer to request augmented information most frequently after inaccurate trials (Hodges, Edwards, Luttin, & Bowcock, 2013). Furthermore, Wulf and Shea (2004) suggested that instructors provide information to learners that is guiding in nature (i.e., feedback after poor attempts). However, our prediction was not supported as there were no statistical differences between AE on KR and no-KR trials (i.e., experienced peers provided KR after good and poor trials equally) (see table 9; figure 16). These results suggest that previous task experience differentially impacted how peers provided KR to their respective learner. Specifically, our inexperienced peers provided KR most frequently after poor trials (i.e., KR on trials with low AE) while our experienced peers provided KR to learners after good and bad trials equally (i.e., similar AE on KR and no-KR trials). In this regard, the results from the analysis of AE on KR and no-KR trials are the first to identify that experienced peers provided KR to learners on the trials they themselves would request KR in self-controlled conditions. Furthermore, learners who received KR from inexperienced and experienced peers did not statistically differ in the delayed retention period, as evidenced by the measures of motor performance. Thus, the present findings suggest that prior task experience influences when peers provide KR, but the provision of KR does not appear to impact a paired participant's learning of the motor task.

To further examine the KR schedules of our learners with self-control and learners who received KR from one of the peer groups (i.e., learners with an inexperienced or experienced peer) we analyzed the frequency of KR during the acquisition period. We predicted that learners with self-control and learners with our peer groups would be presented with similar proportions of KR. This prediction was based on the work of McRae et al., (2015) who showed that learners with self-control and learners who received KR from an inexperienced peer were presented with similar proportions of KR during the learning of a movement-timing task. Specifically, McRae et al., (2015) showed that participants with self-control requested KR on 39.5 of 51, or 77.4% of their acquisition trials while the inexperienced peers on average provided KR on 51 of 80, or 63.8% of the acquisition trials. Supporting our prediction, the present study also showed no statistically significant differences between learners with self-control, inexperienced or experienced peers in regards to the proportion of KR trials during acquisition. Inexperienced peers provided KR on 48 of 80, or 60.0% of the acquisition trials, experienced peers provided KR on 32 of 80, or 40.0% of the acquisition trials and learners with self-control requested KR on 42 of 80, or 52.5% of the acquisition trials. In McRae et al., (2015) these similarities in KR frequency were proposed to be a potential explanation as to why learners with an inexperienced peer performed as effectively (i.e., similar AE, CE & VE) as learners with self-control in the delayed retention period. To this point, McRae et al., (2015) found, based on self-report measures, that seven out of eight learners (88%) with an inexperienced peer learners believed they received KR on the appropriate trials. Similarly, in the present study, eight out of the twelve learners (67%) with an inexperienced peer and eleven of the twelve learners (92%) with an

experienced peer self-reported they received KR on trials that matched their own KR preference. Thus, the results of the present study extends McRae et al., (2015) suggesting that learners were satisfied with when KR they were presented during the acquisition period, independent of whether an inexperienced or experienced peer provided KR.

To our knowledge, the present study was also the first study to examine whether inexperienced peers without previous practice with the motor task, would experience motor learning benefits from controlling the KR schedule of a paired learner. We predicted that inexperienced peers would perform with higher AE, CE and VE compared to their paired learner in the delayed retention period. This prediction was based on research in the observational learning literature that has identified that in the absence of physical practice without feedback a learner cannot optimally learn a motor skill (Blandin, Lhuisset & Proteau, 1999). In this context, feedback can be considered an essential component of the learning process and is necessary to calibrate the motor planning of the task (Wulf and Shea, 2004).Yet, contrary to our prediction and the results of Karlinsky and Hodges (2014), our inexperienced peers did not significantly differ from their paired learner in the delayed retention period in regards to AE, CE and VE measures. This result is noteworthy as it illustrates that skill acquisition can be facilitated when a peer is provided with the opportunity to control another learner's KR schedule. Remember, our inexperienced peers did not physically practice the task during the acquisition phase of the experiment but rather only controlled the KR schedule of another learner. Thus, training efficiency was enhanced as two participants (i.e., the inexperienced peer providing KR and the learner who physically practiced) learned the task similarly despite the fact that only one participant physically practiced the task.

Further, the inexperienced peers outperformed the control group in the delayed retention period based on measures of AE, CE and VE. The inexperienced peers and the control group both observed the visual stimuli of the motor task (i.e., stimuli on a mirrored computer without the opportunity to observe physical practice). However, the inexperienced peers were provided with the opportunity to determine when KR should be provided to another learner while the control group was not afforded this opportunity. Consequently, the results of the present experiment suggest that the ability to control another learner's KR schedule can provide the peer with learning benefits. In the self-controlled KR literature, it has been proposed that being actively engaged in the determination of when to request KR promotes a deeper understanding of task relevant information (Wulf, Clauss, Shea & Whitacre, 2001).Additionally, work in the dyad learning literature identifies that teaching another learner can promote a deeper understanding of the to be learned content for both the teacher and the learner (Shanks, et al., 2013). Likewise, the results of the present experiment suggest peers who provide KR experience deeper processing of task relevant information when they are given the opportunity to control another learner's KR schedule.

To further examine whether the ability to control another learner's KR schedule facilitates an active engagement in the task, analyses of absolute difference scores (AD) after the first block of acquisition phase, after the completion of the acquisition phase and immediately before the delayed retention period were conducted. Analyses of AD scores provide researchers with information pertaining to a learner's capacity for accurate subjective performance appraisal (Newell, 1974, Carter & Patterson, 2012) such that lower AD scores reflect greater error detection capabilities (e.g., Andrieux & Proteau,

2014; Guadagnoli & Kohl, 2001).The present results showed the control group had statistically higher AD compared to all other conditions. This result suggests that inexperienced peers were capable of predicting their own performance in the delayed retention period as well as participants who physically practiced the task (i.e., learners with self-control, learners with an inexperienced and experienced peer). This finding is similar to those observed in the observational learning literature that have identified that observation of a model engages a one in cognitive processes similar to those occurring during physical practice (Blandin & Proteau, 2000). Our results extend this literature identifying that the determination of when to provide another learner with KR strengthens the error detection and error correction processes to an extent similar to those obtained in self-controlled KR conditions.

5.2 Limitations

There are some discernable limitations in the present study that offer avenues for future research. For example, our experiment did not include a traditional yoked group. The addition of a traditional yoked group in future research would allow for a comparison of absolute and relative feedback schedules. Yet, for this study it was believed that the addition of a traditional yoked group was unwarranted, as previous research (has already established the differences between learners with self-control and those without (e.g., Chiviacowsky et al., 2009; Hansen et al., 2011). Future studies may incorporate a traditional yoked group to examine the relationship between peer-controlled and yoked feedback schedules. In this regard, both peer-controlled and yoked feedback schedules would present learners with KR on the same trials during acquisition. However, peers would evaluate a learner's performance and determine when KR was necessary compared

to the yoked feedback condition where learners would receive KR based on the KR schedule designed by the peer, and for another learner. A comparison such as this may help future researcher determine whether a strategy exists in peer-controlled (i.e., inexperienced and experienced peer-controlled) KR schedules.

Another limitation of the present study that must be acknowledged stems from the fact that our experiment utilized a fundamental movement-timing task. In this context, the movement-timing task chosen for this experiment was derived from previous research (e.g., Hansen et al., 2011; McRae et al., 2015) examining self-controlled and peer-controlled KR schedules. However, future research may be interested in identifying whether the results from the present study are generalizable to other motor tasks. One task that may be used in the future to test the reproducibility of the results of the present experiment would be spatiotemporal task. A spatiotemporal task would seem to be an ideal extension of the present study as it could also be controlled in a laboratory setting. Alternatively, it may be of interest to determine whether the results of the present experiment extend to more practical situations. For example, it would be interesting to determine whether KR provided by inexperienced and experienced peers can facilitate the learning of a sport skill, such as a basketball free-throw, in a similar manner.

5.3 Future Directions

The results of the present study, examining peer-controlled KR schedules, are important as they provide a foundation from which other studies can build. For example, a future study should examine the impact of KR schedules controlled by peers with differing amounts of experience providing KR. In the present study, an experienced peer was defined as a peer with previous experience physically practicing the motor task after

only one session of practice. In addition to physical practice, an experienced peer may also be defined as a peer with previous experience *controlling* the KR schedule of another learner. In this context, a future study would be able to identify whether previous experience providing KR to a learner would differentially impact how peers provide KR to subsequent learners. Furthermore, this comparison would provide insight into whether it is better to receive feedback from a peer who has physically practiced the task or a peer who has previously controlled another learner's KR schedule.

An examination of how peers provide feedback to learners with differing ranges of experience is also worthy of future inquiry. In the present study, inexperienced and experienced peers provided KR to inexperienced learners only. Yet, in many practical situations learners have varying degrees of experience completing motor tasks. In this context, a future study that examines this comparison would determine whether peers provide KR similarly, independent or dependent on the learner's experience with the motor task. Additionally, this comparison would provide coaches and facilitators with information about how to appropriately schedule KR in a practice context with learners of differing levels of experience with the task.

CHAPTER 6: CONCLUSION

6.1 Conclusion

The findings from the present experiment provide further insight into our understanding of peer-controlled KR schedules. Previous research has examined KR schedules that were determined solely by inexperienced peers (McRae et al., 2015). However, the present study provides a novel contribution to the motor-learning literature as it examined a KR schedule controlled by a peer with previous task experience. In this context, learners with self-control requested KR after good and poor trials equally, inexperienced peers provided learners with KR most frequently after poor trials and experienced peers provided KR on good and poor trials equally. These findings suggest that experienced peers provided KR to learners on a schedule similar to the KR schedule they requested KR while under self-controlled conditions. In contrast, inexperienced peers provided KR after perceived poor trials and may have done so in an effort to guide the learner to the correct motor response (for review see Salmoni et al., 1984; Wulf & Shea, 2004). However, despite this finding, the learning of our movement-timing task was not differentially impacted when KR was presented under self-controlled or peer-controlled (i.e., inexperienced or experienced) conditions. Furthermore, the inexperienced peers in our study, in the absence of physical practice during the acquisition period, learned the task similarly to the peer they were controlling KR for based on the motor performance results from the retention period.

From a practical standpoint, the present experiment has applied implications for instruction in the absence of an expert facilitator. As mentioned in McRae et al., (2015), there are many contexts, such as team practices, where learners rely on one another to

perpetuate skill acquisition. The results from the present experiment are important in understanding this relationship as they suggest that peers with limited experience with a motor task can experience learning benefits from the opportunity to provide KR, and the KR they provide can facilitate the motor skill acquisition of a peer. For example, in a timing task such as a timed assessment of an individual's proficiency with a keyboard, a learner may look to a peer who has observed their performance for feedback about their typing accuracy. In this context, our results would suggest that the peer providing feedback about the typing session as well as the learner physically practicing the motor task would be able to acquire the motor skill. This finding can be considered an important contribution as it highlights a gain in training efficiency where two learners can acquire a motor skill with only one learner physically practicing the task. Furthermore, our results are novel as they suggest that irrespective of the experience level of the peer providing feedback, learning of the motor-task is not differentially impacted. In the aforementioned practical example, this finding would depict a situation where a learner would be able to perform the typing task with a similar level of success independent of whether they received feedback from an inexperienced or experienced peer. In conclusion, the results of the present experiment identify that KR schedules that are controlled by inexperienced peers can be beneficial during the acquisition and retention of a motor task.

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LIST OF TABLES

Table 1: Pre-Test Mean Scores

Pre-test (no-KR test before acquisition) mean scores (standard deviations) for absolute error (AE), constant error (CE), variable error (VE) and the number of incorrect response. Pre-test scores are provided for the LI, IP, SC and LE Groups.

Dependent Variable	LI	IP	SC	LE
AE(ms)	697(259)	624(230)	1821(1489)	1576(1424)
CE (ms)	251 (576)	313(427)	1753(1560)	1531(1461)
VE (ms)	392(189)	387(207)	900(879)	984(702)
Incorrect Responses	0.42(0.79)	0.83(1.3)	0.17(0.39)	0.5(0.91)

Table 2: Acquisition Mean Scores

Acquisition mean scores (standard deviations) for absolute error (AE), constant error (CE), and variable error (CE). Acquisition scores are provided for the LI, SC and LE Groups.

Group	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7	Block 8
AE (ms)								
LI	261(105)	189(98)	201(88)	164(93)	156(74)	172(87)	179(118)	156(88)
SC	364(168)	211(55)	239(129)	164(95)	169(98)	152(81)	243(169)	164(81)
LE	329(254)	244(136)	169(83)	150(70)	127(56)	189(130)	138(52)	162(84)
CE (ms)								
LI	-148(178)	-87(67)	-59(150)	-9(83)	-39(101)	-26(139)	-51(137)	-31(105)
SC	28(372)	59(125)	22(201)	11(141)	-5(131)	-10(100)	83(239)	16(108)
LE	42(363)	-52(242)	-83(59)	-16(116)	-25(80)	-25(219)	-51(81)	-64(152)

VE (ms)								
LI	194(76)	140(74)	156(83)	120(73)	103(48)	135(85)	137(121)	117(101)
SC	228(103)	141(34)	255(201)	145(103)	120(86)	108(47)	284(440)	118(71)
LE	177(81)	117(38)	114(39)	143(157)	83(25)	125(77)	84(22)	105(63)

Table 3: Post-Test Mean Scores

Post-test (no-KR test 10 minutes after acquisition) mean scores (standard deviations) for absolute error (AE), constant error (CE), variable error (VE) and the number of incorrect responses. Post-test scores are provided for the learner with an inexperienced peer group (LI), the inexperienced peer group (IP), the learners with self-control (SC), the learner with an experienced peer group (LE), and the experienced peer group (SCP).

Dependent Variable	LI	IP	SC	LE	SCP
AE (ms)	182(85)	434(222)	254(189)	188(112)	335(179)
CE (ms)	71(98)	127(474)	103(293)	-1(202)	115(351)
VE (ms)	142(114)	239(110)	170(103)	114(47)	164(84)
Incorrect Responses	0.08(0.29)	0.58(1.7)	0.08(0.29)	0.17(0.58)	0.33(0.66)

Table 4: Delayed Retention Phase Mean Scores

Twenty-four hour no-KR delayed retention (Ret), time transfer (Tme) and pattern transfer (Pat) test mean scores (standard deviations) for absolute error (AE), constant error (CE) and variable error (VE). Delayed test scores are provided for all Groups.

Test	LI	IP	SC	CO	LE	SCP
AE (ms)						
Ret	295(135)	374(303)	237(61)	187(119)	746(570)	184(72)
Tme	568(427)	636(506)	456.5(161)	373(134)	673(469)	396(279)
Pat	607(452)	494(268)	455(235)	360(217)	745(380)	376(76)

CE (ms)						
Ret	-9(325)	6.6(481)	-7(204)	-64(199)	676(626)	72(156)
Tme	489(566)	388(368)	-338(295)	-157(326)	239(795)	296(208)
Pat	229(662)	-409(711)	349(304)	274(301)	614(508)	-130(456)
VE (ms)						
Ret	185(153)	171(93)	156(80)	111(37)	297(124)	128(57)
Tme	244(106)	244(74)	190(53)	208(42)	327(131)	145(60)
Pat	231(87)	160(58)	232(88)	201 (71)	236(115)	245(126)

Table 5: Proportion of KR Trials

Acquisition mean scores (standard deviations) for the proportion of feedback trials provided by the inexperienced peer group (IP) and the experienced peer group (SCP). Additionally, the proportion of feedback trials requested by learners with self-control (SC) is presented.

Groups	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7	Block 8
IP	.68(.23)	.61(.21)	.65(.26)	.58(.25)	.51(.25)	.58(.29)	.63(.23)	.60(.31)
SC	.58 (.29)	.50(.34)	.55(.33)	.41(.28)	.48(.32)	.51(.31)	.49(.21)	.68(.22)
SCP	.58(.25)	.45(.24)	.47(.22)	.33(.20)	.33(.18)	.30(.13)	.34(.17)	.36(.22)

Table 6: Incorrect Responses during Acquisition

Acquisition mean scores (standard deviations) for the number of incorrect responses committed by the learner with an inexperienced peer group (LI), the learners with self-control (SC) and the learner with an experienced peer group (LE).

Groups	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7	Block 8
LI	0.33(0.49)	0.08(0.29)	0.17(0.39)	0.33(0.49)	0.25(0.62)	0.25(0.45)	0.5(1.0)	0.25(0.45)
SC	0.5(0.9)	0.25(0.45)	0.25(0.45)	0.08(0.29)	0.25(0.87)	0.08(0.29)	0.08(0.29)	0.42(0.9)
LE	0.5(0.9)	0.42(1.4)	0.58(1.2)	0.25(0.45)	0.08(0.29)	0.08(0.29)	0.17(0.58)	0.08(0.29)

Table 7: Incorrect Responses during the Delayed Retention Phase

Twenty-four hour no-KR delayed retention (Ret), time transfer (Tme) and pattern transfer (Pat) test mean scores (standard deviations) for the number of incorrect responses. The number of incorrect responses are provided for the learner with an inexperienced peer group (LI), the inexperienced peer group (IP), the learners with self-control (SC), the control group (CO), the learner with an experienced peer group (LE) and the experienced peer group (SCP).

Test	LI	IP	SC	CO	LE	SCP
Ret	0(0)	0.33(0.49)	0.25(0.45)	0.5(1.2)	0.17(0.39)	0.08(0.29)
Tme	0.33(0.49)	0.92(1.6)	0.5(0.67)	0.5(0.8)	0.33(0.49)	0.33(0.49)
Pat	0.08(0.29)	0.17(0.39)	0.33(0.49)	0.08(0.29)	0(0)	0.17(0.39)

Table 8: Total Time

Mean scores (standard deviations) for the total time (Time) needed for the inexperienced peer group (IP), the learners with self-control (SC) and the experienced peer group (SCP) to complete the acquisition phase of the experiment.

	IP	SC	SCP
Time (min)	20.2(1.6)	19.8(1.1)	19.6(1.7)

Table 9: AEKR and AENKR

Mean scores (standard deviations) for the absolute error (AE) on feedback (KR) and no feedback trials (No-KR). Absolute error data is presented for the inexperienced peer group (IP), the learners with self-control (SC) and the experienced peer group (SCP)

Group	AEKR	AENo-KR
IP	224(98)	143(76)
SC	199(79)	244(84)
SCP	202(85)	167(95)

Table 10: Decision Time

Mean scores (standard deviations) for the decision time (DT) on feedback (KR) and no feedback trials (No-KR). Decision time data is presented for the inexperienced peer group (IP), the learners with self-control (SC) and the experienced peer group (SCP)

Group	DTKR	DTNo-KR
IP	1772(467)	1661(522)
SC	1678(840)	1722(328)
SCP	1921(471)	1804(454)

Table 11: Motivation Questionnaire

Motivation questionnaire results: The motivation scale that was used ranged from 1:10 with written anchors of 1(Not Motivated), 5(Somewhat Motivated) and 10(Very Motivated).

	Average of Group Responses
Learner with an Inexperienced Peer Group (LI)	
1. *How motivated are you to learn this task?*	
a) Before Acquisition	6.8
b) End of Acquisition	6.6
c) Before Retention	6.5
Inexperienced Peer Group (IP)	
1. *How motivated are you to learn this task?*	
a) Before Acquisition	7.0
b) After Acquisition	7.3
c) Before Retention	7.3
Self-Control to Peer Facilitator Group (SCP)	
1. *How motivated are you to learn this task?*	
As Learner with Self-Control	
a) Before Acquisition	5.9
b) End of Acquisition	6.3
c) Before Retention	6.8
As Experienced Peer Facilitator	
d) Before Acquisition	6.4
e) End of Acquisition	6.3
f) Before Retention	7.0

	Average of Group Responses
Learner with an Experienced Peer Group (LE)	
1. *How motivated are you to learn this task?*	
a) Before Acquisition	7.2
b) End of Acquisition	7.3
c) Before Retention	7.6
Control Group (CO)	
1. *How motivated are you to learn this task?*	
a) Before Acquisition	5.7
b) End of Acquisition	6.8
c) Before Retention	6.8

Table 12: Judgment of Learning

Judgment of Learning Questionnaire Results

Average of Group Responses (ms)

Learner with an Inexperienced Peer Group (LI)

1. *How well will you perform in the delayed retention test?*

a) After First Block 290.3
b) End of Acquisition 219.8
c) Before Retention 287.0

Inexperienced Peer Group (IP)

1. *How well will your partner perform in the delayed retention test?*

a) After First Block 158.8
b) End of Acquisition 215.3

2. How well will you perform in the delayed retention test?

c) Before Retention 250.0

Self-Control to Peer Facilitator Group (SCP)

1. *How well will you perform in the delayed retention test?*

As Learner with Self-Control

a) After First Block 257.1
b) End of Acquisition 206.3
c) Before Retention 202.3
d) Before 2nd Retention Test 199.0

2. *How well will the learner perform in the delayed retention test?*

As Experienced Peer Facilitator

e) Before Acquisition 256.7
f) End of Acquisition 154.6

Average of Group Responses (ms)

Learner with an Experienced Peer Group (LE)

1. *How well will you perform in the delayed retention test?*

a) After First Block 210.0
b) End of Acquisition 226.3
c) Before Retention 311.3

Control Group (CO)

1. *How well will your partner perform in the delayed retention test?*

a) After First Block 182.1
b) End of Acquisition 132.1

2. *How well will you perform in the delayed retention test?*

c) Before Retention 251.8

Table 13: Feedback Questions for Learners

	Number of Responses
Learner with an Inexperienced Peer Group (LI)	
1. *Do you think you received feedback after the right trials?*	
a) Yes	8
b) No	4
2. *If NO, when would you have liked to receive feedback?*	
a) Perceived Good Trials	0
b) Perceived Bad Trials	2
c) Perceived Good & Bad Equally	0
d) Randomly	0
e) Other	2
3. *How well did the feedback schedule provided to you facilitate your learning of this task?*	7.3/10
Self-Control to Peer Facilitator Group (SCP)	
As Learner with Self-Control	
1. *When/Why did you request feedback?*	
a) Perceived Good Trials	4
b) Perceived Bad Trials	1
c) Perceived Good & Bad Equally	3
d) Randomly	1
e) Other	3
2. *When/Why did you not request feedback?*	
a) Perceived Good Trials	1
b) Perceived Bad Trials	5
c) Perceived Good & Bad Equally	1
d) Randomly	3
e) Other	2

	Number of Responses
Learner with an Experienced Peer Group (LI)	
1. *Do you think you received feedback after the right trials?*	
a) Yes	11
b) No	1
2. *If NO, when would you have liked to receive feedback?*	
a) Perceived Good Trials	1
b) Perceived Bad Trials	0
c) Perceived Good & Bad Equally	0
d) Randomly	0
e) Other	0
3. *How well did the feedback schedule provided to you facilitate your learning of this task?*	7.7/10
Control Group (CO)	
1. *Ability to correctly identify when the SCP group requested KR:*	
a) Correct	5
b) Incorrect	7

Table 14: Feedback Questions for Facilitators

	Number of Responses
Inexperienced Peer Group (IP)	
1. *When/why did you provide the learner with feedback?*	
a) Perceived Good Trials	1
b) Perceived Bad Trials	6
c) Perceived Good & Bad Equally	5
d) Randomly	0
e) Other	0
2. *When/why did you not provide the learner with feedback?*	
a) Perceived Good Trials	6
b) Perceived Bad Trials	2
c) Perceived Good & Bad Equally	2
d) Randomly	1
e) Other	1
3. *How well did the feedback schedule you provided facilitate the learner's learning of this task?*	6.8/10
Control Group (CO)	
1. *When/why did the learner request feedback?*	
a) Perceived Good Trials	5
b) Perceived Bad Trials	0
c) Perceived Good & Bad Equally	2
d) Randomly	4
e) Other	1
2. When/why did the learner not request feedback?	Number of Responses
a) Perceived Good Trials	0
b) Perceived Bad Trials	3
c) Perceived Good & Bad Equally	3
d) Randomly	4
e) Other	2
Self-Control to Peer Facilitator Group (SCP)	
As Experienced Peer Facilitator	
1. *When/Why did you provide feedback?*	
a) Perceived Good Trials	3
b) Perceived Bad Trials	4
c) Perceived Good & Bad Equally	2
d) Randomly	0
e) Other	3
2. *When/Why did you provide feedback?*	
a) Perceived Good Trials	3
b) Perceived Bad Trials	3
c) Perceived Good & Bad Equally	0
d) Randomly	2
e) Other	4
3. *How well did the feedback schedule you provided facilitate the learner's learning of this task?*	6.9/10

Table 15: Absolute Difference Scores

Absolute Difference Results Average of Group Responses (ms)

Learner with an Inexperienced Peer Group (LI)

1. *How well will you perform in the delayed retention test?*
   a) After First Block 161.2
   b) End of Acquisition 140.6
   c) Before Retention 118.7

Inexperienced Peer Group (IP)

1. *How well will your partner perform in the delayed retention test?*
   a) After First Block 239.1
   b) End of Acquisition 280.9

2. How well will you perform in the delayed retention test?
   c) Before Retention 249.8

Self-Control to Peer Facilitator Group (SCP)

1. *How well will you perform in the delayed retention test?*
   As Learner with Self-Control
   a) After First Block 156.3
   b) End of Acquisition 87.1
   c) Before Retention 100.4
   d) Before 2nd Retention Test 86.4

2. *How well will the learner perform in the delayed retention test?*
   As Experienced Peer Facilitator
   a) Before Acquisition 102.5
   b) End of Acquisition 62.9

Average of Group Responses (ms)

Learner with an Experienced Peer Group (LE)

1. *How well will you perform in the delayed retention test?*
   a) After First Block 144.0
   b) End of Acquisition 163.6
   c) Before Retention 228.6

Control Group (CO)

1. *How well will your partner perform in the delayed retention test?*
   a) After First Block 605.4
   b) End of Acquisition 613.6

2. *How well will you perform in the delayed retention test?*
   c) Before Retention 528.7

LIST OF FIGURES

Figure 1: Pre-Test and Post Test Absolute Error Scores

Absolute error data (ms) before the commencement of the acquisition period (Pre) and 10 minutes following the acquisition period in a no-KR post-test (PT). Absolute error data is presented for the learner with an inexperienced peer (LI), inexperienced peer (IP), self-control (SCP), and learner with an experienced peer (LE) groups.

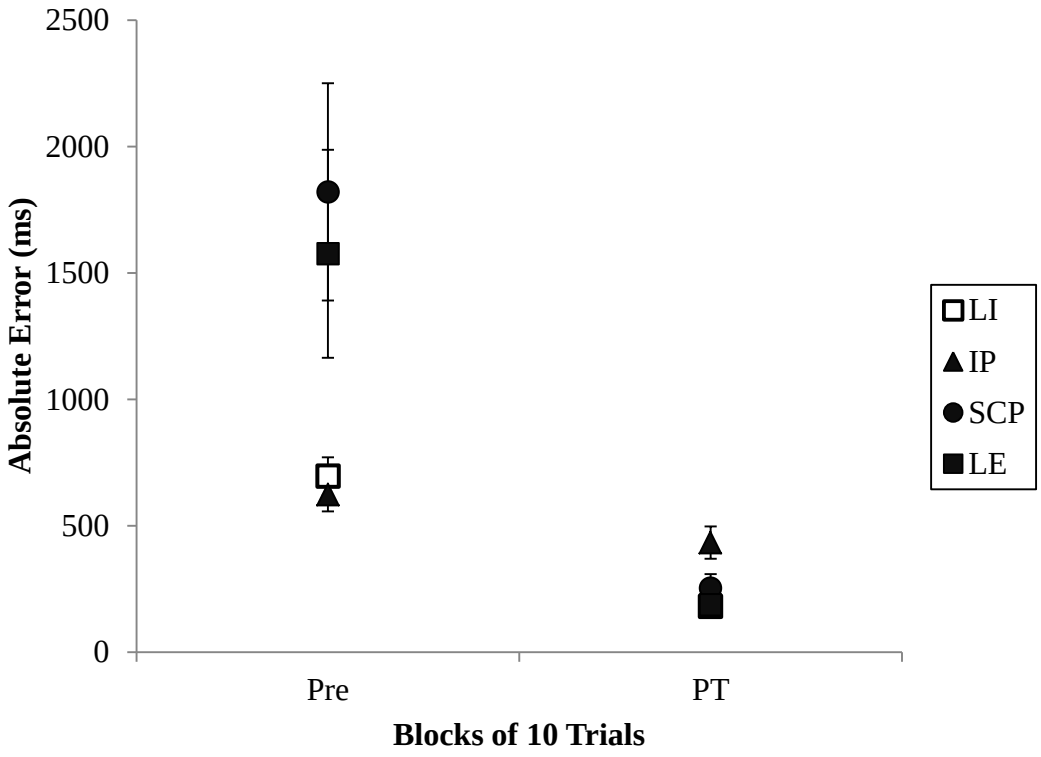


Figure 2: Pre-Test and Post Test Constant Error Scores

Constant error data (ms) before the commencement of the acquisition period (Pre) and 10 minutes following the acquisition period in a no-KR post-test (PT). Constant error data is presented for the learner with an inexperienced peer (LI), inexperienced peer (IP), self-control (SCP), and learner with an experienced peer (LE) groups.

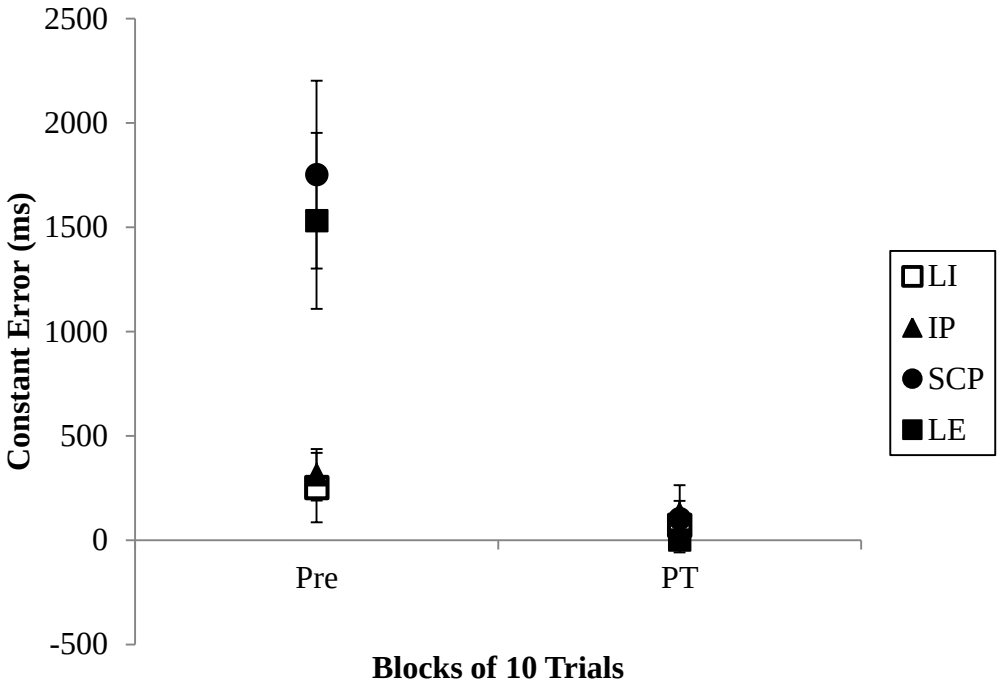


Figure 3: Pre-Test and Post Test Variable Error Scores

Variable error data (ms) before the commencement of the acquisition period (Pre) and 10 minutes following the acquisition period in a no-KR post-test (PT). Variable error data is presented for the learner with an inexperienced peer (LI), inexperienced peer (IP), self-control (SCP), and learner with an experienced peer (LE) groups.

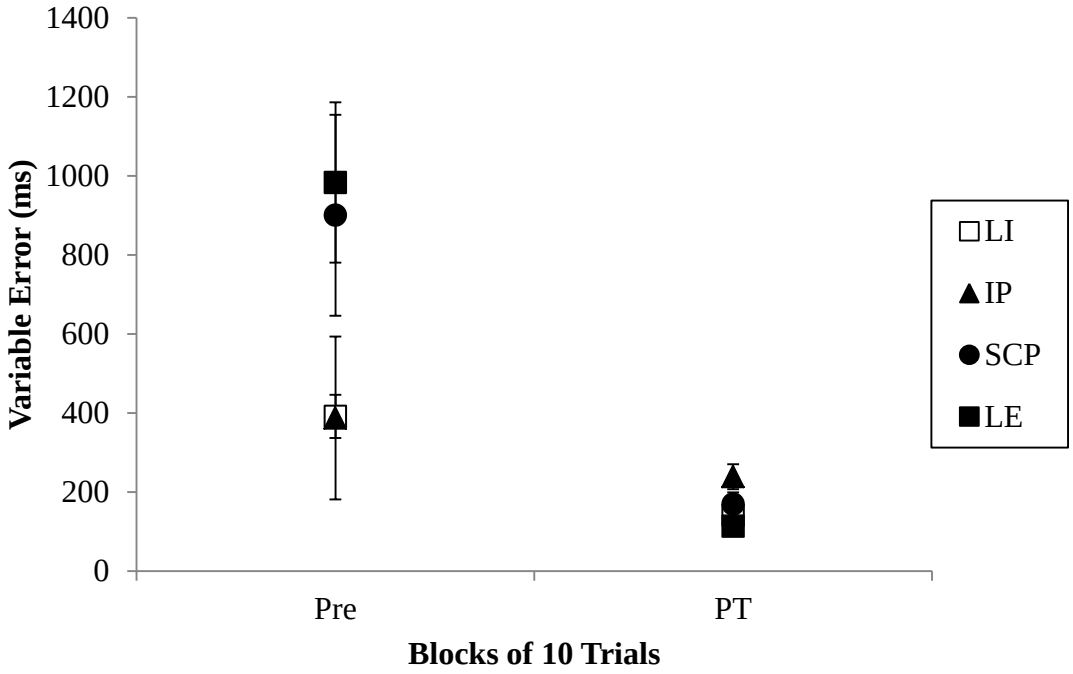


Figure 4: Pre-Test and Post Test Number of Errors Committed

The average number of errors committed (#) before the commencement of the acquisition period (Pre) and 10 minutes following the acquisition period in a no-KR post-test (PT). The average number of errors committed is provided for the learner with an inexperienced peer (LI), inexperienced peer (IP), self-control (SCP), and learner with an experienced peer (LE) groups.

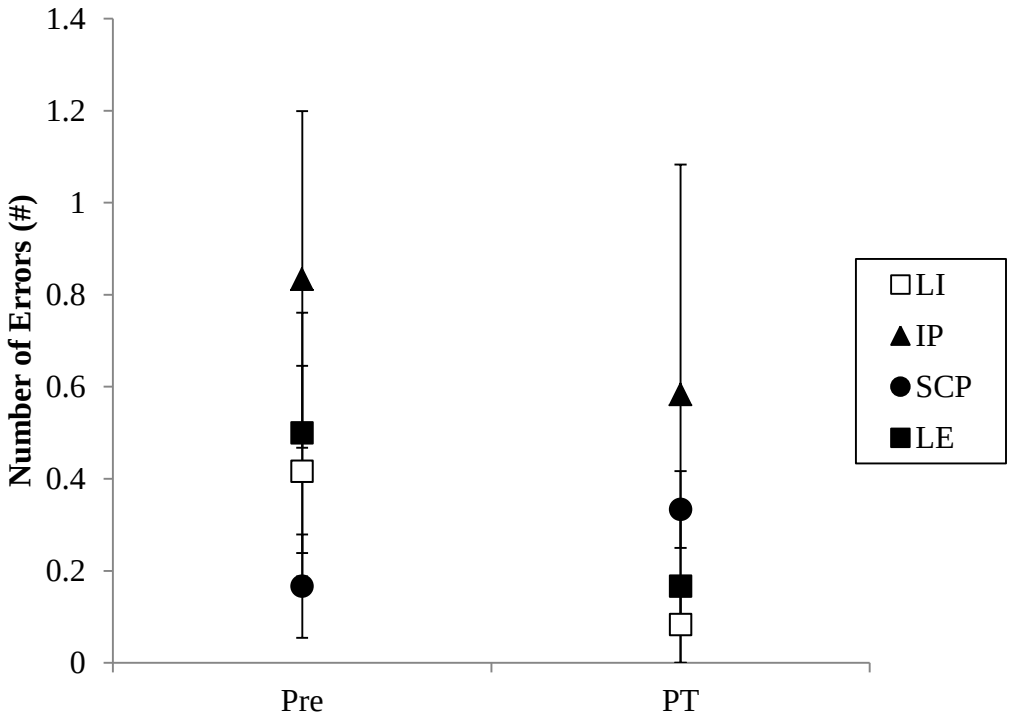


Figure 5: Absolute Error during Acquisition, Retention and Transfer Phases
Absolute Error data (ms) for the learner with an inexperienced peer (LI), inexperienced peer (IP), self-control (SCP), control (CO), and learner with an experienced peer (LE) groups. Absolute error data (ms) is presented for each block of acquisition (BLK), 10 minutes following the acquisition period in a no-KR post-test (PT), 24-hours after acquisition in a delayed retention test (Ret), 24-hours after acquisition in a delayed time transfer (TME) and 24-hours after acquisition in a delayed pattern transfer test (PAT).

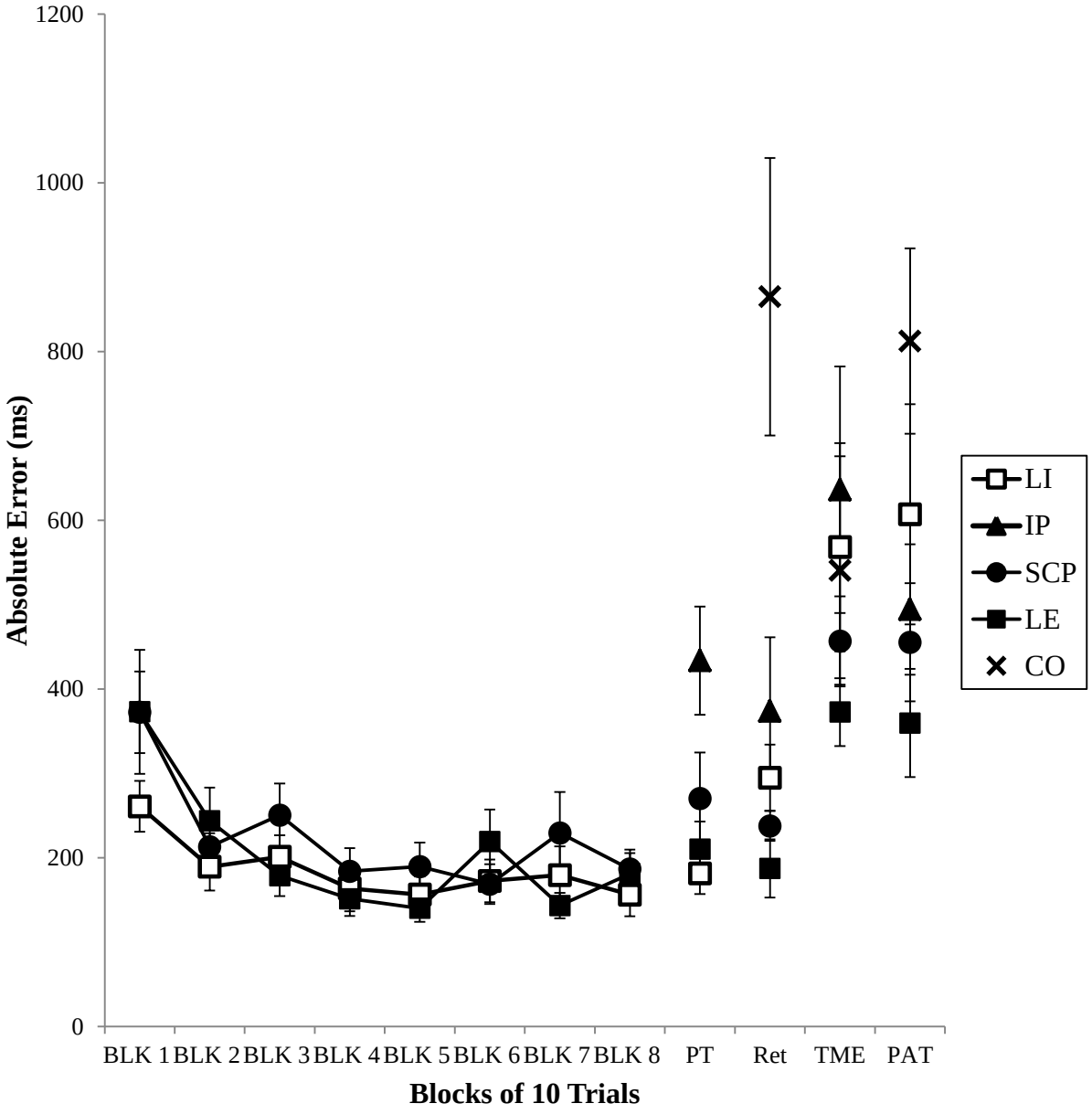


Figure 6: Constant Error during Acquisition, Retention and Transfer Phases
Constant Error data (ms) for the learner with an inexperienced peer (LI), inexperienced peer (IP), self-control (SCP), control (CO), and learner with an experienced peer (LE) groups. Constant error data (ms) is presented for each block of acquisition (BLK), 10 minutes following the acquisition period in a no-KR post-test (PT), 24-hours after acquisition in a delayed retention test (Ret), 24-hours after acquisition in a delayed time transfer (TME) and 24-hours after acquisition in a delayed pattern transfer test (PAT).

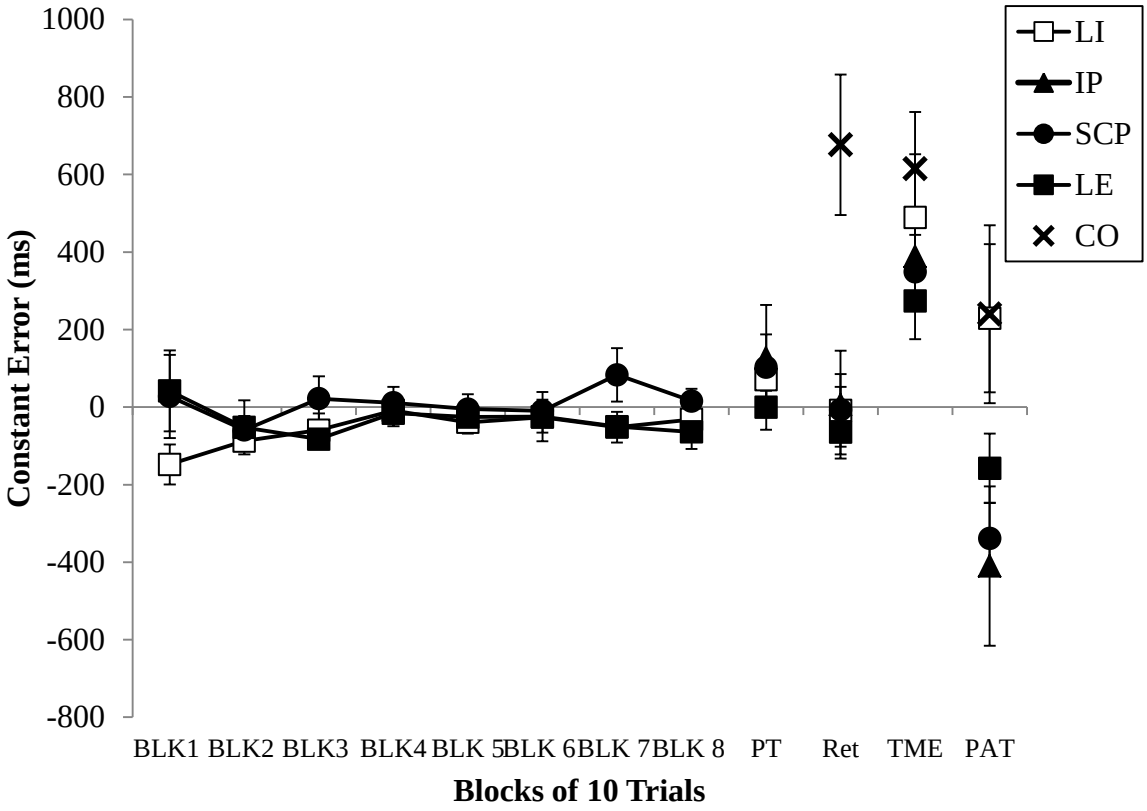


Figure 7: Variable Error during Acquisition, Retention and Transfer Phases
Variable Error data (ms) for the learner with an inexperienced peer (LI), inexperienced peer (IP), self-control (SCP), control (CO), and learner with an experienced peer (LE) groups. Variable error data (ms) is presented for each block of acquisition (BLK), 10 minutes following the acquisition period in a no-KR post-test (PT), 24-hours after acquisition in a delayed retention test (Ret), 24-hours after acquisition in a delayed time transfer (TME) and 24-hours after acquisition in a delayed pattern transfer test (PAT).

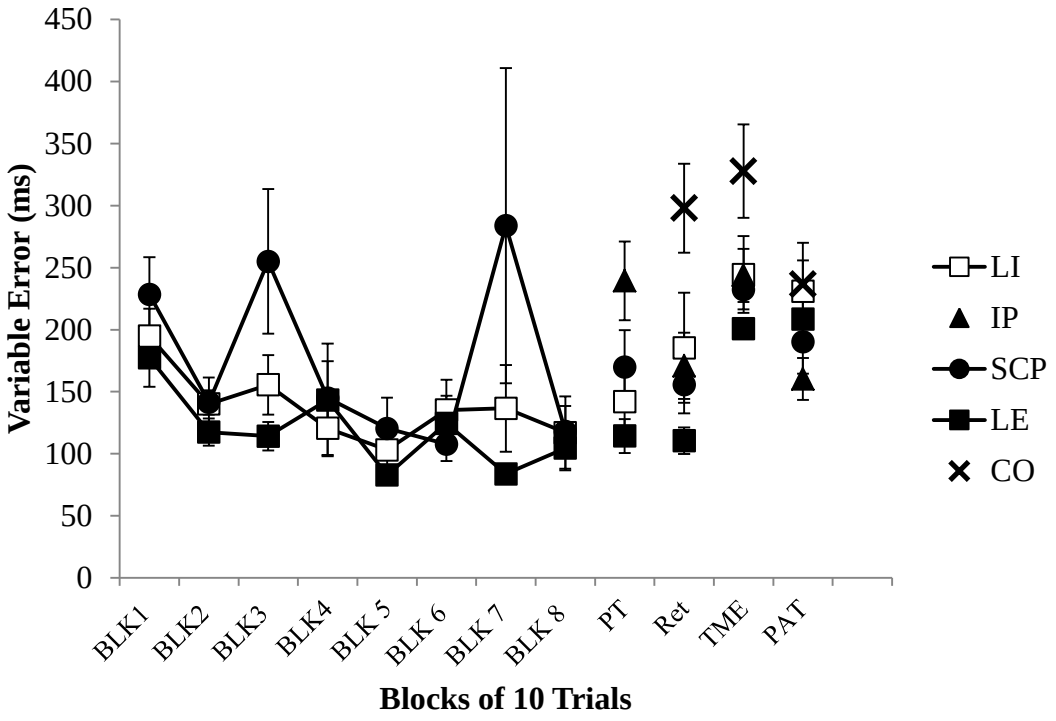


Figure 8: Number of Errors Committed during Acquisition, Retention and Transfer Phases

The average number of errors committed (#) for the learner with an inexperienced peer (LI), inexperienced peer (IP), self-control (SCP), control (CO), and learner with an experienced peer (LE) groups. The Average number of errors committed are presented for each block of acquisition (BLK), 10 minutes following the acquisition period in a no-KR post-test (PT), 24-hours after acquisition in a delayed retention test (Ret), 24-hours after acquisition in a delayed time transfer (TME) and 24-hours after acquisition in a delayed pattern transfer test (PAT).

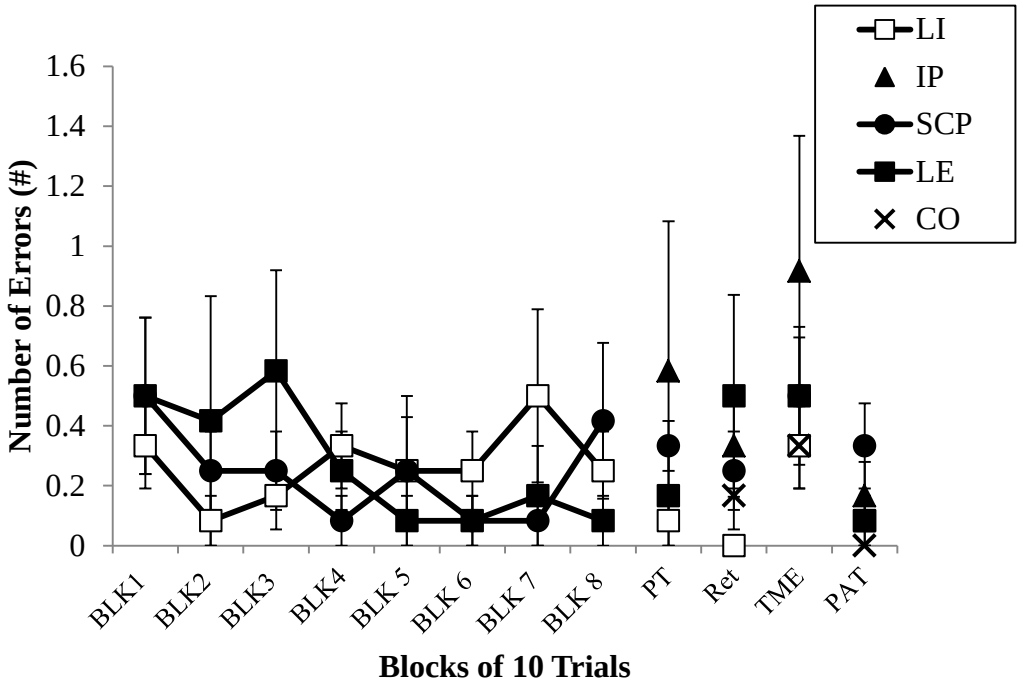


Figure 9: Absolute Error for the SCP Group

Absolute error data (ms) for the SCP group during each block of acquisition while self-controlling their KR schedule (BLK), 10 minutes following self-control in a no-KR post-test (PT_1), 24-hours after self-control in a delayed retention test (Ret_1), 24-hours after self-control in a delayed time transfer (TME_1) and 24-hours after self-control in a delayed pattern transfer test (PAT_1). Additionally, absolute error data (ms) is presented for the SCP group following the opportunity to provide KR in a no-KR post-test (PT_2), 24-hours after providing KR in a delayed retention test (Ret_2), 24-hours after providing KR in a delayed time transfer (TME_2) and 24-hours after providing KR in a delayed pattern transfer test (PAT_2).

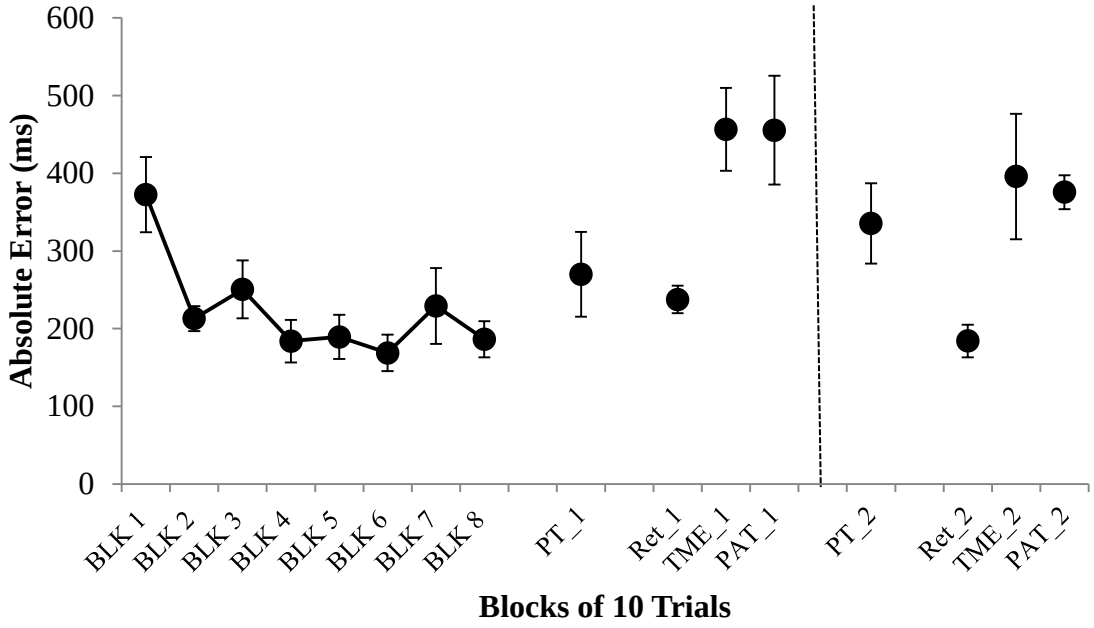


Figure 10: Constant Error for the SCP Group

Constant error data (ms) for the SCP group during each block of acquisition while self-controlling their KR schedule (BLK), 10 minutes following self-control in a no-KR post-test (PT_1), 24-hours after self-control in a delayed retention test (Ret_1), 24-hours after self-control in a delayed time transfer (TME_1) and 24-hours after self-control in a delayed pattern transfer test (PAT_1). Additionally, constant error data is presented for the SCP group following the opportunity to provide KR in a no-KR post-test (PT_2), 24-hours after providing KR in a delayed retention test (Ret_2), 24-hours after providing KR in a delayed time transfer (TME_2) and 24-hours after providing KR in a delayed pattern transfer test (PAT_2).

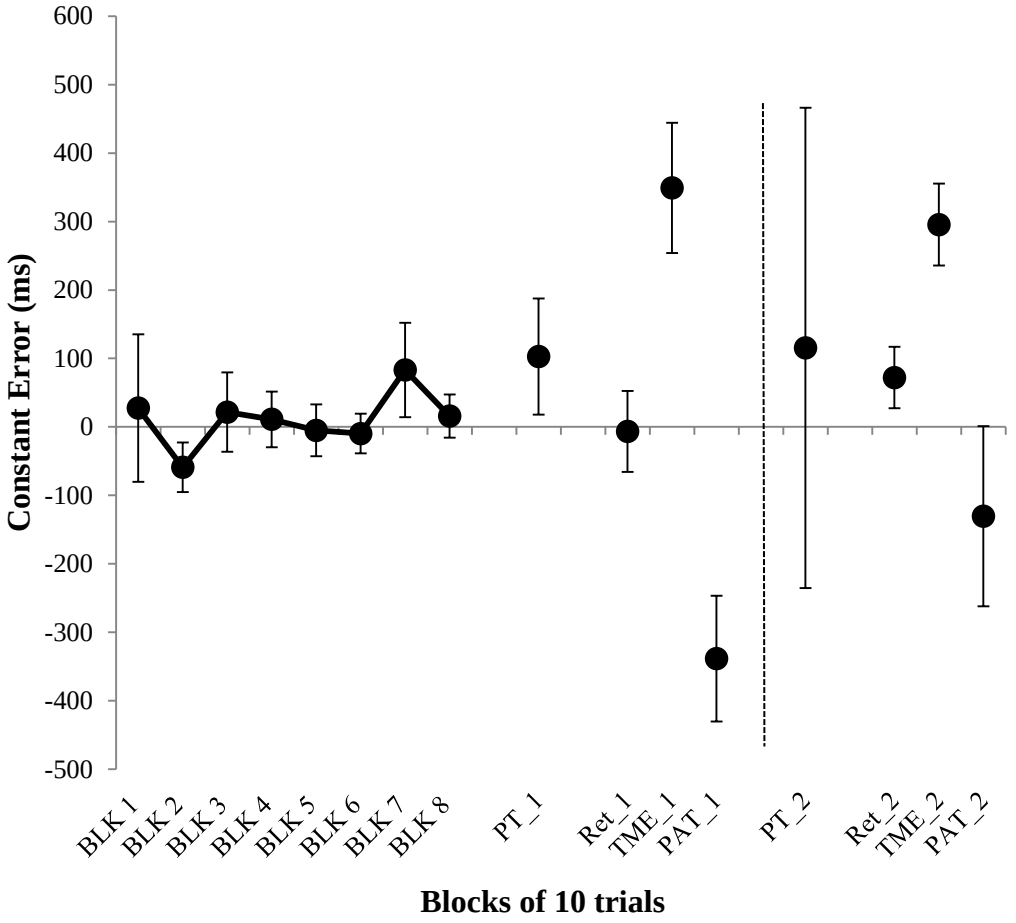


Figure 11: Variable Error for the SCP Group

Variable error data (ms) for the SCP group during each block of acquisition while self-controlling their KR schedule (BLK), 10 minutes following self-control in a no-KR post-test (PT_1), 24-hours after self-control in a delayed retention test (Ret_1), 24-hours after self-control in a delayed time transfer (TME_1) and 24-hours after self-control in a delayed pattern transfer test (PAT_1). Additionally, variable error data is presented for the SCP group following the opportunity to provide KR in a no-KR post-test (PT_2), 24-hours after providing KR in a delayed retention test (Ret_2), 24-hours after providing KR in a delayed time transfer (TME_2) and 24-hours after providing KR in a delayed pattern transfer test (PAT_2).

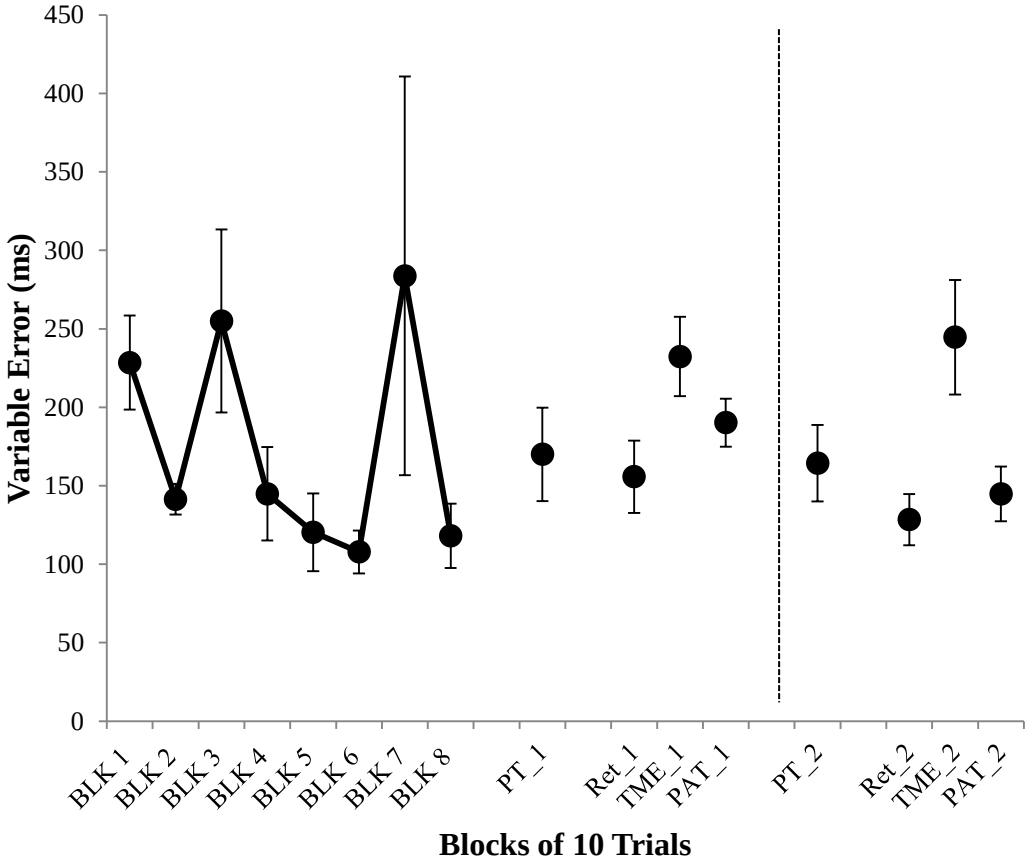


Figure 12: Number of Errors Committed by the SCP Group

The average number of errors committed (#) for the SCP group during each block of acquisition while self-controlling their KR schedule (BLK), 10 minutes following self-control in a no-KR post-test (PT_1), 24-hours after self-control in a delayed retention test (Ret_1), 24-hours after self-control in a delayed time transfer (TME_1) and 24-hours after self-control in a delayed pattern transfer test (PAT_1). Additionally, the average number of errors committed (#) is presented for the SCP group following the opportunity to provide KR in a no-KR post-test (PT_2), 24-hours after providing KR in a delayed retention test (Ret_2), 24-hours after providing KR in a delayed time transfer (TME_2) and 24-hours after providing KR in a delayed pattern transfer test (PAT_2).

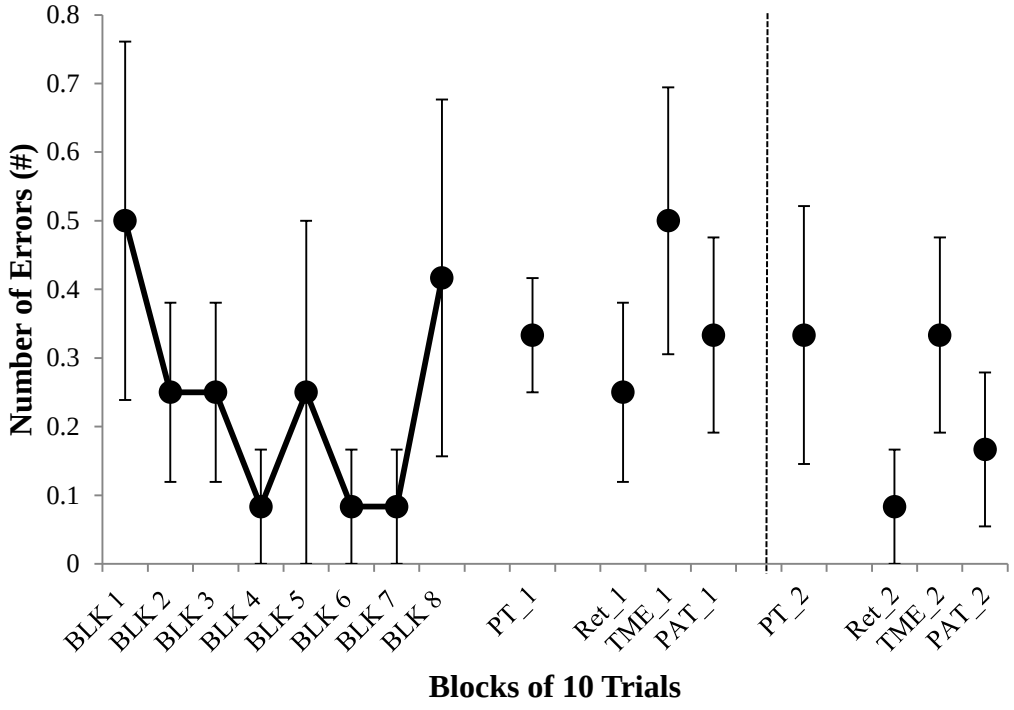


Figure 13: Proportions of KR Trials

Proportion of KR trials provided by the inexperience peer group (IP) and the proportion of KR trials provided by the experienced peer group (SCP) over the course of the acquisition phase (BLK). Additionally, the proportion of KR trials requested by learners who were provided with self-control (SC) over the duration of the acquisition phase (BLK) is presented.

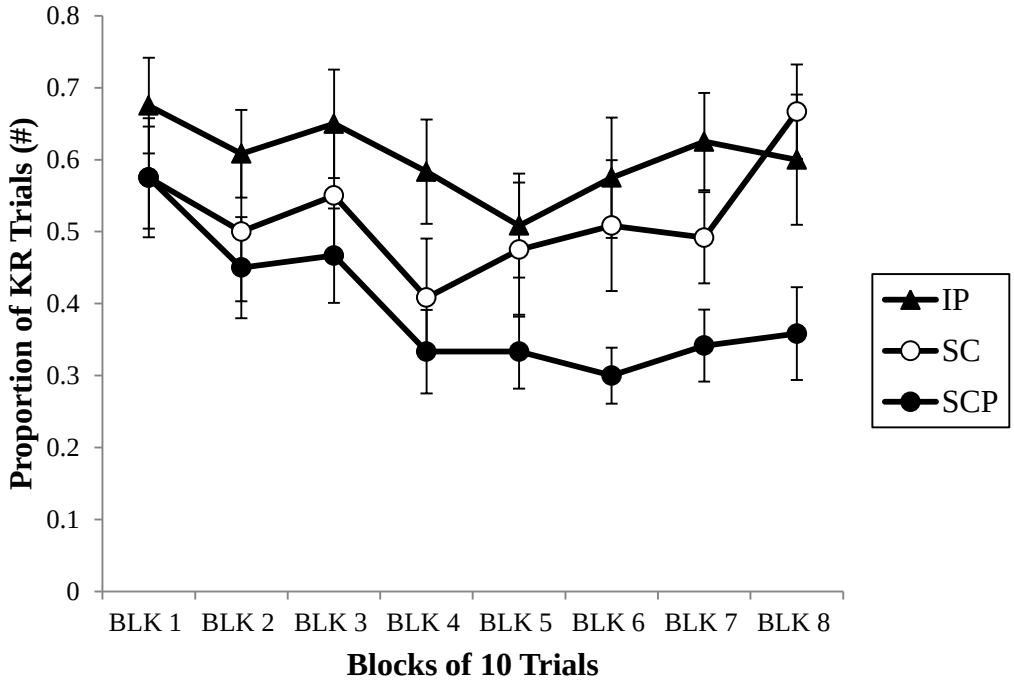


Figure 14: Total KR Presented during Acquisition

Total amount of KR provided by the inexperience peer group (IP) and the total amount of KR provided by the experienced peer group (SCP) over the course of the acquisition phase (BLK). Additionally, the total amount of KR that was requested by learners who were provided with self-control (SC) over the duration of the acquisition phase (BLK) is presented.

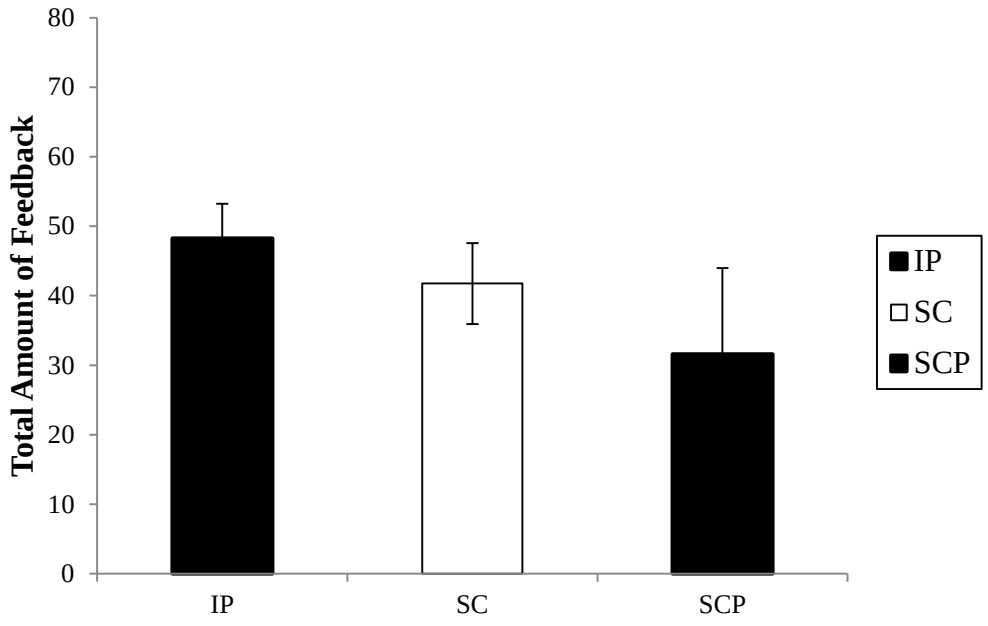


Figure 15: KR Trials Requested and Provided by SCP Group
Total number of KR trials requested by each participant in the SCP group while self-controlling their KR schedule (SC) compared to the total number of KR trials provided by the SCP group as experienced peer facilitators (SCP).

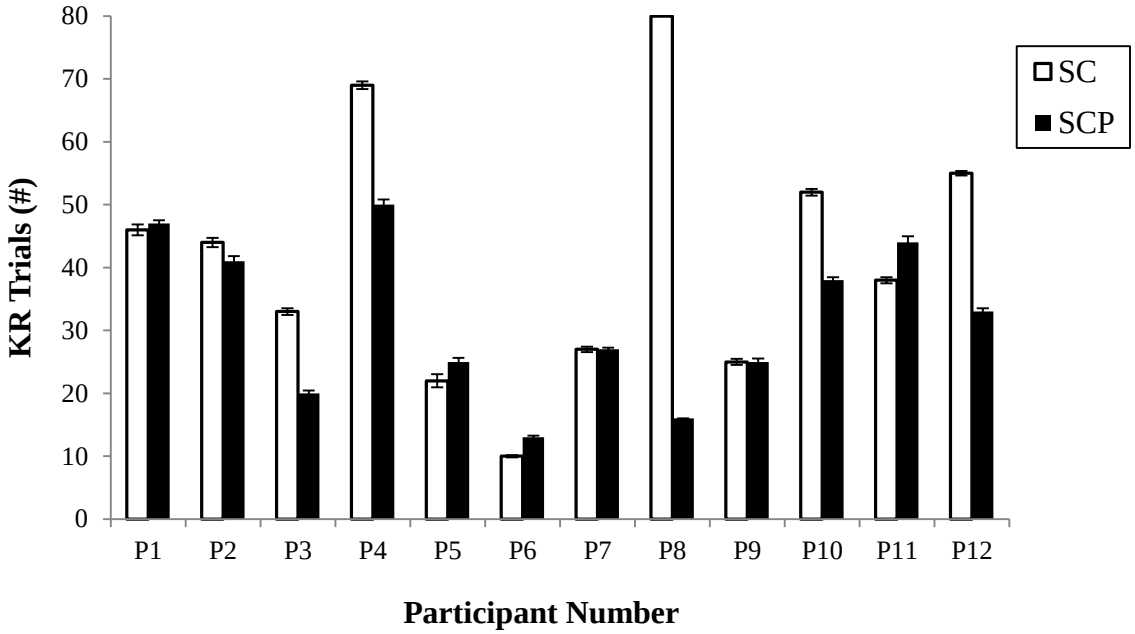


Figure 16: AEKR and AENKR

Absolute error (ms) on trials in which feedback was provided (KR) by the inexperienced peer group (IP) and the experienced peer group (SCP) compared to the absolute error (ms) on trials in which feedback was not provided (NKR) by the inexperienced peer (IP) and experienced peer (SCP) groups. Additionally, the absolute error on trials in which feedback was requested (KR) by the learners who were provided with self-control (SC) compared with the absolute error on trials in which learners refrained from requesting feedback (NKR).

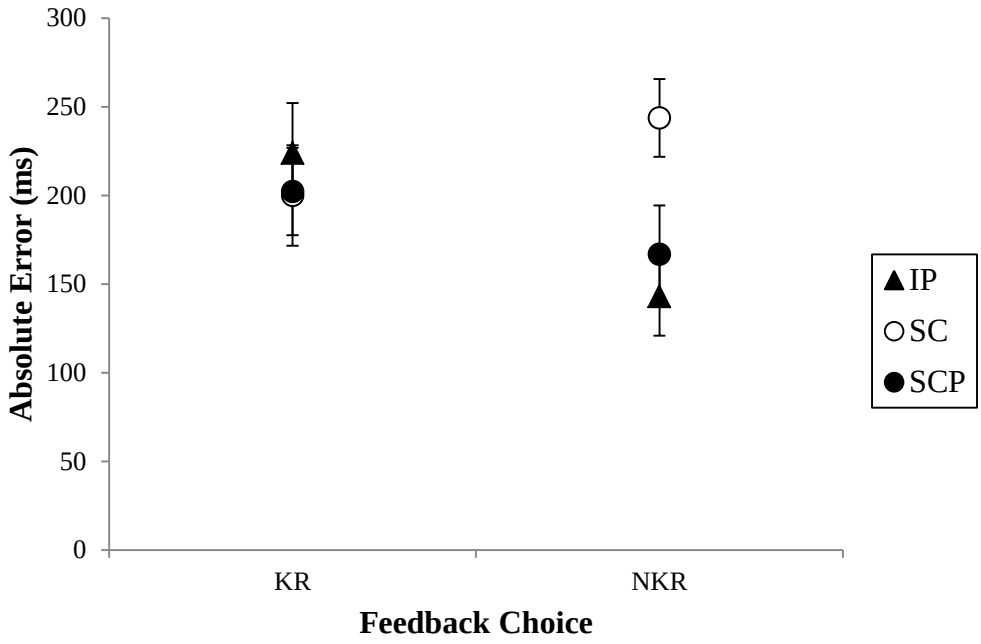


Figure 17: Decision Time

Decision time (ms) on trials in which feedback was provided (KR) by the inexperienced peer group (IP) and the experienced peer group (SCP) compared to the decision time (ms) on trials in which feedback was not provided (NKR) by the inexperienced peer (IP) and experienced peer (SCP) groups. Additionally, the decision time on trials in which feedback was requested (KR) by the learners who were provided with self-control (SC) compared with the decision time (ms) on trials in which learners refrained from requesting feedback (NKR).

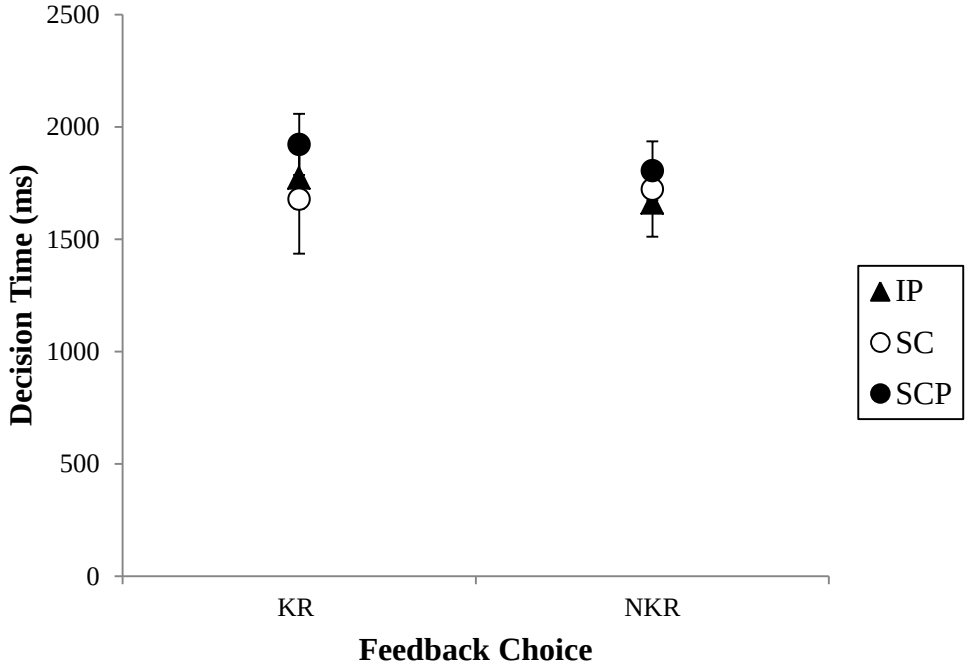


Figure 18: Total Time

Total time (min) the inexperienced peer group (IP) the experienced peer group (SCP) and the learners who were provided with self-control (SC) needed to complete the acquisition phase of the experiment.

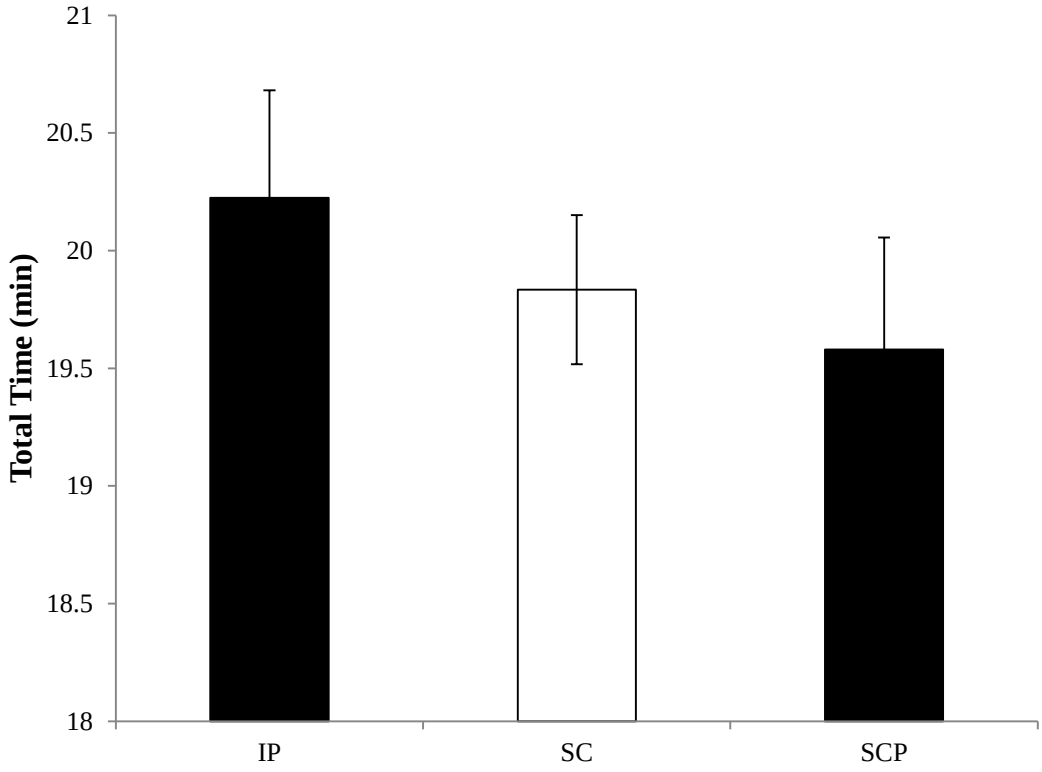
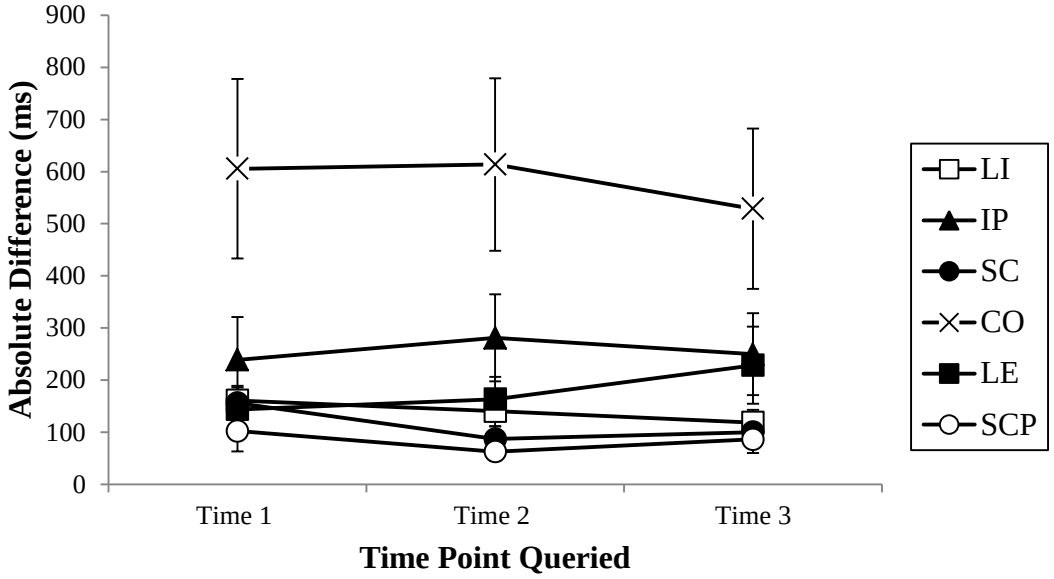


Figure 19: Absolute Difference Scores

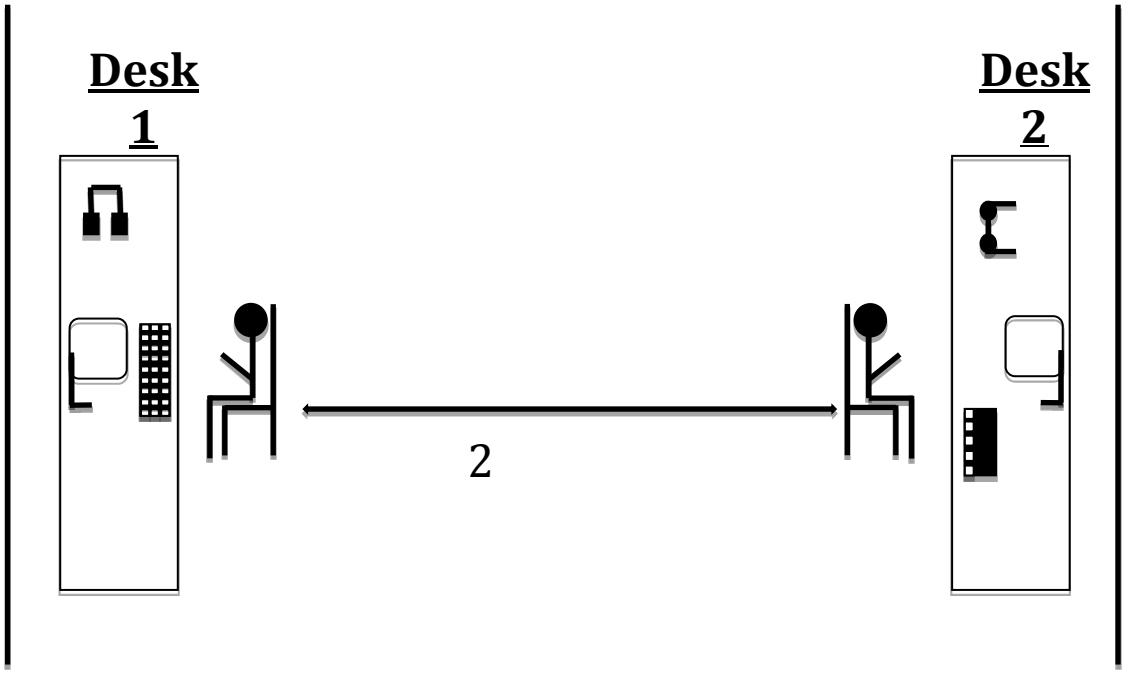
Absolute difference scores (ms) are presented at three time points ranging from after the first block of acquisition (time 1), to after acquisition (time 2) and finally to before retention (time 3). Scores are provided for the learner with an inexperienced peer group (LI), the inexperienced peer group (IP), the learner with an experienced peer group (LE), the learners who were provided with self-control (SC), the experienced peer group (SCP) and the control group (CO).



APPENDIXES

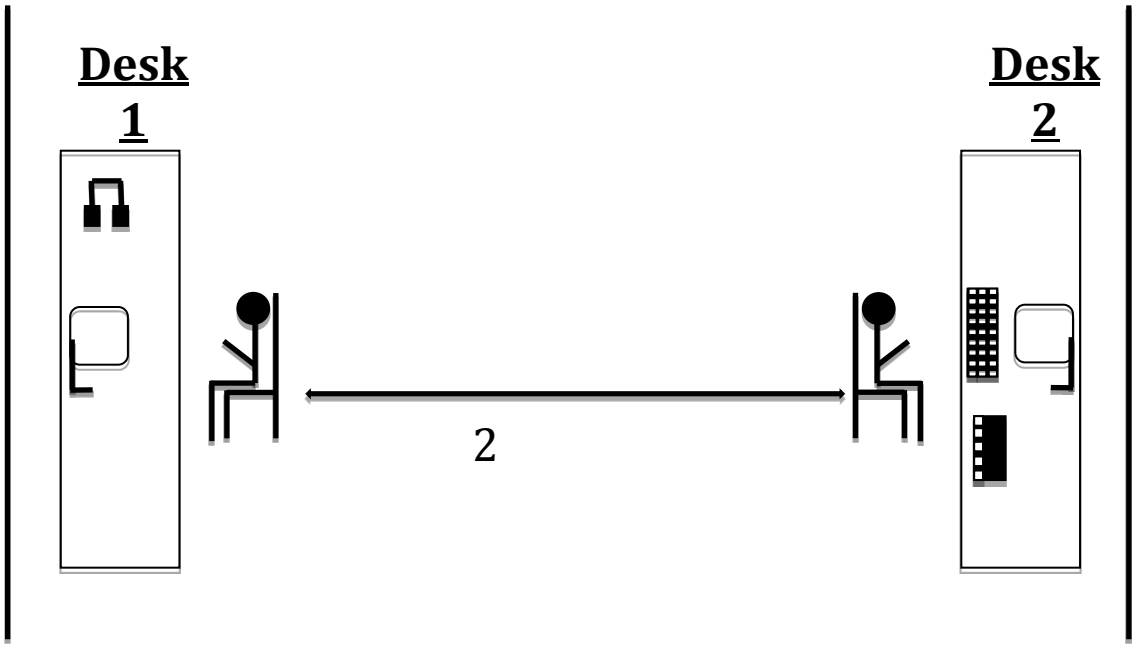
Appendix A: Experimental Design_1

Visual representation of the acquisition period for the [SCP + LE] and [IP + LI] pairings. The peer facilitators will sit at Desk 1 and utilize industrial grade headphones, a computer monitor and a standardized keyboard. The participant at desk 2 will physically practice the motor task and utilize liquid crystal goggles, a Dell computer monitor, and a serial response box.



Appendix B: Experimental Design_2

Visual representation of the first acquisition period for members of the SCP and the CO groups. The participant in the CO group will sit at Desk 1 and wear industrial grade headphones while they observe a Dell computer monitor. At Desk 2 the member of the SCP group will respond to stimuli using a serial response box, and determine when to receive KR using a wireless keyboard.



Appendix C: Practice Conditions

Summary of practice conditions and the practice requirements.

Day	Period	SCP	IP	LI	LE	CO
1	*Pre-Test*	10 Trials Physical Practice No KR	-	-	-	-
	Acquisition	80 Trials Physical Practice Self-Controlled KR	-	-	-	80 Trials Observation
	Immediate Retention	10 Trials Physical Practice No KR	-	-	-	-
2	*Delayed Retention*	30 Trials Physical Practice No KR	-	-	-	30 Trials Physical Practice No KR
	Pre-Test	-	10 Trials Physical Practice No KR	10 Trials Physical Practice No KR	10 Trials Physical Practice No KR	-
	Acquisition	80 Trials Provide KR to LE	80 Trials Provide KR to LI	80 Trials Physical Practice No Control of KR	80 Trials Phys No Control of KR	-
	Immediate Retention	10 Trials Physical Practice No KR	10 Trials Physical Practice No KR	10 Trials Physical Practice No KR	10 Trials Physical Practice No KR	-
3	*Delayed Retention*	30 Trials Phys No KR	30 Trials Phys No KR	30 Trials Phys No KR	30 Trials Phys No KR	-

Appendix D: Questionnaire Information

Summary of temporal placement of questionnaires

Day	Period	SCP	IP	LI	LE	CO
1	*Before Acquistion*	Demographic + Motivation	-	-	-	Demographic + Motivation
	After First Block	Judgment of Learning	-	-	-	Judgment of Learning
	End of the Acquisition Period	Motivation + Judgment of Learning + Feedback Questions	-	-	-	Motivation + Judgment of Learning + Feedback Questions
2	*Before Retention*	Motivation + Judgment of Learning	-	-	-	Motivation + Judgment of Learning
	Before Acquisition	Motivation	Demographic + Motivation	Demographic + Motivation	Demographic + Motivation	-
	After First Block	Judgment of Learning	Judgment of Learning	Judgment of Learning	Judgment of Learning	-
	End of the Acquisition Period	Motivation + Judgment of Learning + Feedback Questions	Motivation + Judgment of Learning + Feedback Questions	Motivation + Judgment of Learning + Feedback Questions	Motivation + Judgment of Learning + Feedback Questions	-
3	*Before Retention*	Motivation + Judgment of Learning	Motivation + Judgment of Learning	Motivation + Judgment of Learning	Motivation + Judgment of Learning	-

Appendix E: Recruitment Poster

PARTICIPANTS NEEDED FOR RESEARCH IN MOTOR LEARNING

We are looking for volunteers to take part in a study examining the effects of self-control of feedback schedules on movement learning.

We are looking for willing volunteers between the ages of 18-25 who are right hand dominant with normal to corrected normal vision.

As a participant in this study, you would be asked to:
Learn a spatial-timing task over two sessions in the lab (60 min total).

Task: You will be asked to push buttons in response to numbers presented on a computer screen.

Day 1 (40 min): You will get 80 attempts at the task where you can get feedback about your performance

Day 2 (20 min): You will attempt the task 30 times on Day 2 without feedback

Each session will take place in the Motor Skills Acquisition Lab (WH 137)

Participation in this study is completely voluntary.
You may refuse to participate, refuse to answer any questions, or withdraw from the study at any time.

For more information or to volunteer for this study,
please contact:

The Principal Investigator Dr. Jae Patterson
jpatterson@brocku.ca
(905) 688-5550 Ext. 3769
OR
The Principal Student Investigator Matthew McRae
brockumotorlearning@gmail.com
(905) 688-5550 Ext. 5905

For ethical questions or concerns please contact
The Research Ethics Office
905-688-5550 x3035
reb@brocku.ca

This study has been reviewed by, and received ethics clearance through the Brock University Research Ethics Board.

REB File Number (14-004)

Appendix F: Letter of Invitation

Title of Study: Examining peer-controlled KR schedules during the learning of a movement-timing task

Principal Investigator: Jae Patterson, Professor, Department of Kinesiology, Brock University

Student Principal Investigator: Matthew McRae, MSc-Candidate, Department of Kinesiology, Brock University

Student Investigator: Sharon Lai, MSc-Candidate, Department of Kinesiology, Brock University

I Matthew McRae, MSc-Candidate, from the department of Kinesiology, Brock University, invite you to participate in a research project entitled: "Examining peer controlled KR schedules during the learning of a movement timing task".

The purpose of this research project is to examine when peers provide feedback to another learner. Should you choose to participate you will be asked to respond to a series of six numbers that will appear on a computer monitor by depressing the corresponding buttons. You will be asked to depress the buttons with your index finger on your non-dominant hand. The goal of the motor task will be to complete the sequence of six numbers in a goal time of 2500ms.

As a participant in this study, you would be asked to participate in two testing sessions. The first session will last approximately 40minutes and the second will last approximately 20minutes (60minutes Total).

If you choose to participate you will be randomly assigned to one of four conditions using a visual-basic software program. Your role will change dependent upon the condition you are placed in. However, in all conditions a partner will complete the protocol with you.

This experiment will be conducted only at Brock University and can be considered a single-site project.

If you have any pertinent questions about your rights as a research participant, please contact the Brock University Research Ethics Officer (905 688-5550 ext 3035, reb@brocku.ca)

If you have any questions or are interested in participating in this study please feel free to contact me
Thank you,
Matthew McRae _____

Matthew McRae	Sharon Lai	Jae Patterson
MSc-Candidate	MSc-Candidate	Professor / Supervisor
(905) 688-5550 Ext. 5905	(905) 688-5550 Ext. 5905	(905) 688-5550 Ext. 3769
mm08zm@brocku.ca	sl09xe@brocku.ca	jpatterson@brocku.ca

If you are interested in participating in this study please contact us by email:
brockumotorlearning@gmail.com.

This study has been reviewed and received ethics clearance through Brock University's Research Ethics Board

Ethics Review Board File Number: 14-004

Appendix G: Informed Consent (CO Group)

Project Title: Examining peer-controlled KR schedules during the learning of a movement-timing task.

Principal Investigator	**Principal Student Investigator**	**Student Investigator**
Jae Patterson, Professor	Matthew McRae – MSc Candidate	Sharon Lai
Department of Kinesiology	Department of Kinesiology	Department of Kinesiology
Brock University	Brock University	Brock University
(905) 688-5550 Ext. 3769	(905) 688-5550 Ext. 5905	(905) 688-5550 Ext. 5905
jpatterson@brocku.ca	mm08zm@brocku.ca	sl09xe@brocku.ca

Invitation

You are asked to participate in a research study entitled "Examining peer-controlled KR schedules during the learning of a movement-timing task" that will be conducted by Matthew McRae from the department of Kinesiology at Brock University. The results of this study will contribute to faculty research. The purpose and objectives of the study are to: Compare conditions of observer controlled feedback schedules and the impact they may have on the acquisition of motor skills.

Participation Procedures

If you decide to volunteer in this study we will ask you to participate in an experiment conducted in the Motor Skill Acquisition Laboratory (WH137) on two separate days. The first session will last approximately 40 minutes. The second session will occur at a minimum of 24 hours later and will last approximately 20 minutes.

You have been randomly assigned to this experimental condition by a computer program from a list of five conditions. If you choose to participate you will be asked to observe another learner. Specifically, sitting quietly to the left of the learner you will view a performer who will have the opportunity to request feedback after every trial. When the learner asks for feedback they will receive three pieces of information: 1) If they completed the series correctly; 2) If they were too fast or too slow; 3) Their timing error with the direction of their error. You will be asked to complete the same task as the learner the next day. We ask that you observe 80 attempts of the task on the first day. During scheduled breaks, we will ask you some brief survey questions about when you would have selected feedback, about your motivation levels, and about how well you believe you and the learner will preform in retention. On the second day, we will ask you to complete 12 attempts of the task ***without feedback***, 12 attempts of the task in a longer amount of time than previously required (3300ms), and then 12 attempts of the same task while responding to different numbers. On the second day, we will also ask you a few brief questions about how you think you learned the task.

Potential Benefits and Risks

In this study there are some potential risks that must be addressed. Specifically, you will be in contact with a research device. This device provides no greater risk than pushing buttons on a standardized keyboard. However, there are scheduled breaks if you feel they are necessary. Additionally, since you will complete this experiment with

another person we recognize that you may be worried about the opinion of your partner. As a result, if you feel worried about this issue you may leave without penalty. Finally, we cannot ensure that your partner will keep your identity anonymous. To address this concern we have asked your partner to sign a participant informed consent letter. The informed consent letter will ask your partner to keep your identity confidential and we ask that you do the same in return. Although you will not directly benefit, your participation will lead to a better understanding of how we learn skilled movements and how we can optimize and teach movements in rehabilitation, work, and sport settings.

Confidentiality

To keep your information confidential you will be provided with a code number. Your name will not be used in this study but your code will be associated with your behavioural data on a master list. The master list is a single electronic file that will contain your code and initials. This file will only be available to the primary investigator under a password-protected computer.

Participation in this study is voluntary and you are free to withdrawal at any time. You have the right to refuse any question(s) that you find objectionable or that make you feel uncomfortable. You may withdrawal your consent at any time and discontinue participation without penalty.

The researcher will provide you with formal written debriefing form at the end of this study. In this form you be will provided with information regarding the purpose of this study.

Your data will only be accessed by the investigators and will be on file in a secure location for a period of five years. After this time has passed the data and any other materials will be destroyed by Matthew McRae using a paper shredder following. The Master list will be destroyed by the deletion of the document on the password protected computer upon completion of the data collection process.

Voluntary Participation

In signing this consent for, you should understand that:

You may ask questions at any given time during participation.

Your participation is voluntary and that refusal to participate will involve no penalty.

You can refuse participation at any time during the progress of the experiment. Subsequently, any data collected will not be included in the results of the experiment.

The researcher might be known to you. However, after the data collection, your identity will be protected under a participant coding system and a secure filing system.

Publication of Results

Results will be available at the office of Dr. Jae Patterson within approximately four months of the completion of the study. If you are unable to visit the office in person an electronic copy of your results can be sent to your private email. It is expected that the results will be presented at academic conferences and will be submitted for publication in peer-reviewed journals. The data could be combined with data from other similar studies

conducted in the Motor Skills Acquisition Lab at Brock University prior to submission to peer reviewed journals.

Contact Information and Ethics Clearance

If you have any questions about this study or require further information, please contact Jae Patterson using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University 14-004**.** If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Informed Consent to Participate

As a participant in this research project, I clearly understand that what I am agreeing to do, that I am free to decline involvement or withdrawal from this project at any time, and that steps are being taken to protect my safety and anonymity. Additionally, I agree to keep the anonymity of my paired participant confidential. I have read this participant information letter and the accompanying consent form. I have had any questions, concerns, or complaints answered to my satisfaction. I have been provided with a copy of this letter.

Name	**Date**
Signature	
Witness Name	
Witness Signature	

Appendix H: Informed Consent (IP Group)

Project Title: Examining peer-controlled KR schedules during the learning of a movement-timing task

Principal Investigator **Principal Student Investigator** **Student Investigator**

Jae Patterson, Professor	Matthew McRae – MSc Candidate	Sharon Lai – MSc Candidate
Department of Kinesiology	Department of Kinesiology	Department of Kinesiology
Brock University	Brock University	Brock University
(905) 688-5550 Ext. 3769	(905) 688-5550 Ext. 5905	(905) 688-5550 Ext. 5905
jpatterson@brocku.ca	mm08zm@brocku.ca	sl09xe@brocku.ca

Invitation

You are asked to participate in a research study entitled "Examining peer-controlled KR schedules during the learning of a movement-timing task" that will be conducted by Matthew McRae from the department of Kinesiology at Brock University. The results of this study will contribute to faculty research. The purpose and objectives of the study are to: Compare conditions of peer-controlled feedback schedules and the impact they may have on the acquisition of motor skills.

Participation Procedures

If you decide to volunteer in this study we will ask you to participate in an experiment conducted in the Motor Skill Acquisition Laboratory (WH137) on two separate days. The first session will last approximately 40 minutes. The second session will occur at a minimum of 24 hours later and will last approximately 20 minutes.

You have been randomly assigned to this experimental condition by a computer program from a list of five conditions. If you choose to participate you will be asked to observe another learner. During this period you will have the opportunity to control when the learner is provided with feedback. In this context, you will be asked to provide feedback as efficiently as possible so that the learner can effectively learn the task. Feedback that the learner will receive will include three pieces of information: 1) If they completed the series correctly; 2) If they were too fast or too slow; 3) Their timing error with the direction of their error. You will also be asked to complete the same task as the learner the next day. We ask that you provide feedback to learners over the course of 80 trials the first day. During scheduled breaks, we will ask you some brief survey questions about when you provided feedback, about your anxiety levels, about your motivation levels, and about how well you believe you and the learner will preform in retention. On the second day, we will ask you to complete 12 attempts of the task *without feedback*, 12 attempts of the task in a longer amount of time than previously required (3300ms), and then 12 attempts of the same task while responding to different numbers. On the second day, we will also ask you a few brief questions about how you think you learned the task.

Potential Benefits and Risks

In this study there are some potential risks that must be addressed. Specifically, you will be in contact with a research device. This device provides no greater risk than pushing buttons on a standardized keyboard. However, there are scheduled breaks if you

feel they are necessary. Additionally, since you will complete this experiment with another person we recognize that you may be worried about the opinion of your partner. As a result, if you feel worried about this issue you may leave without penalty. Finally, we cannot ensure that your partner will keep your identity anonymous. To address this concern we have asked your partner to sign a participant informed consent letter. The informed consent letter will ask your partner to keep your identity confidential and we ask that you do the same in return. Although you will not directly benefit, your participation will lead to a better understanding of how we learn skilled movements and how we can optimize and teach movements in rehabilitation, work, and sport settings.

Confidentiality

To keep your information confidential you will be provided with a code number. Your name will not be used in this study but your code will be associated with your behavioural data on a master list. The master list is a single electronic file that will contain your code and initials. This file will only be available to the primary investigator under a password-protected computer.

Participation in this study is voluntary and you are free to withdrawal at any time. You have the right to refuse any question(s) that you find objectionable or that make you feel uncomfortable. You may withdrawal your consent at any time and discontinue participation without penalty.

The researcher will provide you with formal written debriefing form at the end of this study. In this form you be will provided with information regarding the purpose of this study.

Upon completion of the data collection process the master list will be destroyed. Specifically, the document will be deleted off of the password-protected computer.

Your data will only be accessed by the investigators and will be on file in a secure location for a period of five years. After this time has passed your data will be destroyed by Matthew McRae using a paper shredder.

Voluntary Participation

In signing this consent for, you should understand that:

You may ask questions at any given time during participation.

Your participation is voluntary and that refusal to participate will involve no penalty.

You can refuse participation at any time during the progress of the experiment. Subsequently, any data collected will not be included in the results of the experiment.

The researcher might be known to you. However, after the data collection, your identity will be protected under a participant coding system and a secure filing system.

Publication of Results

Results will be available at the office of Dr. Jae Patterson within approximately four months of the completion of the study. If you are unable to visit the office in person an electronic copy of your results can be sent to your private email. It is expected that the results will be presented at academic conferences and will be submitted for publication in peer-reviewed journals. The data could be combined with data from other similar studies

conducted in the Motor Skills Acquisition Lab at Brock University prior to submission to peer reviewed journals.

Contact Information and Ethics Clearance

If you have any questions about this study or require further information, please contact Jae Patterson using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University 14-004**.** If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Informed Consent to Participate

As a participant in this research project, I clearly understand that what I am agreeing to do, that I am free to decline involvement or withdrawal from this project at any time, and that steps are being taken to protect my safety and anonymity. Additionally, I agree to keep the anonymity of my paired participant confidential. I have read this participant information letter and the accompanying consent form. I have had any questions, concerns, or complaints answered to my satisfaction. I have been provided with a copy of this letter.

Name	**Date**
Signature	
Witness Name	
Witness Signature	

Appendix I: Informed Consent (LI & LE Groups)

Project Title: Examining peer-controlled KR schedules during the learning of a movement-timing task

Principal Investigator **Principal Student Investigator** **Student Investigator**

Jae Patterson, Professor	Matthew McRae – MSc Candidate	Sharon Lai – MSc Candidate
Department of Kinesiology	Department of Kinesiology	Department of Kinesiology
Brock University	Brock University	Brock University
(905) 688-5550 Ext. 3769	(905) 688-5550 Ext. 5905	(905) 688-5550 Ext. 5905
jpatterson@brocku.ca	mm08zm@brocku.ca	sl09xe@brocku.ca

Invitation

You are asked to participate in a research study entitled "Examining peer-controlled KR schedules during the learning of a movement-timing task" that will be conducted by Matthew McRae from the department of Kinesiology at Brock University. The results of this study will contribute to faculty research. The purpose and objectives of the study are to: Compare conditions of observer controlled feedback schedules and the impact they may have on the acquisition of motor skills.

Participation Procedures

If you decide to volunteer in this study we will ask you to participate in an experiment conducted in the Motor Skill Acquisition Laboratory (WH137) on two separate days. The first session will last approximately 40 minutes. The second session will occur at a minimum of 24 hours later and will last approximately 20 minutes.

You have been randomly assigned to this experimental condition by a computer program from a list of four conditions. If you choose to participate you will be asked to push buttons in response to numbers presented on a computer screen. During this time a peer will observe your practice period and decide when to provide you with feedback about your performance. When the peer provides feedback it will include three pieces of information: 1) If you completed the series correctly; 2) If you were too fast or too slow; 3) Your timing error with the direction of your error. We will ask you to complete 80 attempts of the task on the first day. During the breaks, we will ask you some brief survey questions about when you would have selected feedback, about your anxiety levels, about your motivation levels, and about how well you believe you will preform in retention. On the second day, we will ask you to complete 12 attempts of the task *without feedback*, 12 attempts of the task in a longer amount of time than previously required (3300ms), and then 12 attempts of the same task while responding to different numbers. On the second day, we will also ask you a few brief questions about how you think you learned the task.

Potential Benefits and Risks

In this study there are some potential risks that must be addressed. Specifically, you will be in contact with a research device. This device provides no greater risk than pushing buttons on a standardized keyboard. However, there are scheduled breaks if you feel they are necessary. Additionally, since you will complete this experiment with

another person we recognize that you may be worried about the opinion of your partner. As a result, if you feel worried about this issue you may leave without penalty. Finally, we cannot ensure that your partner will keep your identity anonymous. To address this concern we have asked your partner to sign a participant informed consent letter. The informed consent letter will ask your partner to keep your identity confidential and we ask that you do the same in return. Although you will not directly benefit, your participation will lead to a better understanding of how we learn skilled movements and how we can optimize and teach movements in rehabilitation, work, and sport settings.

Confidentiality

To keep your information confidential you will be provided with a code number. Your name will not be used in this study but your code will be associated with your behavioural data on a master list. The master list is a single electronic file that will contain your code and initials. This file will only be available to the primary investigator under a password-protected computer.

Participation in this study is voluntary and you are free to withdrawal at any time. You have the right to refuse any question(s) that you find objectionable or that make you feel uncomfortable. You may withdrawal your consent at any time and discontinue participation without penalty.

The researcher will provide you with formal written debriefing form at the end of this study. In this form you be will provided with information regarding the purpose of this study.

Upon completion of the data collection process the master list will be destroyed. Specifically, the document will be deleted off of the password-protected computer.

Your data will only be accessed by the investigators and will be on file in a secure location for a period of five years. After this time has passed your data will be destroyed by Matthew McRae using a paper shredder.

Voluntary Participation

In signing this consent for, you should understand that:

You may ask questions at any given time during participation.

Your participation is voluntary and that refusal to participate will involve no penalty.

You can refuse participation at any time during the progress of the experiment. Subsequently, any data collected will not be included in the results of the experiment.

The researcher might be known to you. However, after the data collection, your identity will be protected under a participant coding system and a secure filing system.

Publication of Results

Results will be available at the office of Dr. Jae Patterson within approximately four months of the completion of the study. If you are unable to visit the office in person an electronic copy of your results can be sent to your private email. It is expected that the results will be presented at academic conferences and will be submitted for publication in peer-reviewed journals. The data could be combined with data from other similar studies

conducted in the Motor Skills Acquisition Lab at Brock University prior to submission to peer reviewed journals.

Contact Information and Ethics Clearance

If you have any questions about this study or require further information, please contact Jae Patterson using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University 14-004**.** If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Informed Consent to Participate

As a participant in this research project, I clearly understand that what I am agreeing to do, that I am free to decline involvement or withdrawal from this project at any time, and that steps are being taken to protect my safety and anonymity. Additionally, I agree to keep the anonymity of my paired participant confidential. I have read this participant information letter and the accompanying consent form. I have had any questions, concerns, or complaints answered to my satisfaction. I have been provided with a copy of this letter.

Name	**Date**
Signature	
Witness Name	
Witness Signature	

Appendix J: Informed Consent (SCP Group)

Project Title: Examining peer-controlled KR schedules during the learning of a movement-timing task

Principal Investigator	**Principal Student Investigator**	**Student Investigator**
Jae Patterson, Professor	Matthew McRae – MSc Candidate	Sharon Lai – MSc Candidate
Department of Kinesiology	Department of Kinesiology	Department of Kinesiology
Brock University	Brock University	Brock University
(905) 688-5550 Ext. 3769	(905) 688-5550 Ext. 5905	(905) 688-5550 Ext. 5905
jpatterson@brocku.ca	mm08zm@brocku.ca	sl09xe@brocku.ca

Invitation

You are asked to participate in a research study entitled "Examining peer-controlled KR schedules during the learning of a movement-timing task" that will be conducted by Matthew McRae from the department of Kinesiology at Brock University. The results of this study will contribute to faculty research. The purpose and objectives of the study are to: Compare conditions of peer-controlled feedback schedules and the impact they may have on the acquisition of motor skills.

Participation Procedures

If you decide to volunteer in this study we will ask you to participate in an experiment conducted in the Motor Skill Acquisition Laboratory (WH137) on three separate days. The first and second sessions will last approximately 40 minutes. The third session will occur at a minimum of 24 hours after the second testing period and will last approximately 20 minutes.

You have been randomly assigned to this experimental condition by a computer program from a list of five conditions. If you choose to participate you will be asked to push buttons in response to numbers presented on a computer screen during the first testing session. After each trial you will have the opportunity to select feedback. Feedback in this study will take the form of 1) If you completed the series correctly; 2) If you were too fast or too slow; 3) your timing error with the direction of your error. In total you will complete 80 trials during this testing session.

Once you have completed the first testing session you will be asked to return approximately 24hours later to observe another learner. During this period the learner will complete the same task you completed in the first testing session. However, the learner will not have the opportunity to control his or her own feedback schedule. Instead you will have the opportunity to control when this learner is provided with feedback. In this context, you will be asked to provide feedback as efficiently as possible so that the learner can effectively learn the task.

For the third testing session you will be asked to complete the same task you completed on the first day without any feedback.

Potential Benefits and Risks

In this study there are some potential risks that must be addressed. Specifically, you will be in contact with a research device. This device provides no greater risk than pushing buttons on a standardized keyboard. However, there are scheduled breaks if you feel they are necessary. Additionally, since you will complete this experiment with

another person we recognize that you may be worried about the opinion of your partner. As a result, if you feel worried about this issue you may leave without penalty. Finally, we cannot ensure that your partner will keep your identity anonymous. To address this concern we have asked your partner to sign a participant informed consent letter. The informed consent letter will ask your partner to keep your identity confidential and we ask that you do the same in return. Although you will not directly benefit, your participation will lead to a better understanding of how we learn skilled movements and how we can optimize and teach movements in rehabilitation, work, and sport settings

Confidentiality

To keep your information confidential you will be provided with a code number. Your name will not be used in this study but your code will be associated with your behavioural data on a master list. The master list is a single electronic file that will contain your code and initials. This file will only be available to the primary investigator under a password-protected computer.

Participation in this study is voluntary and you are free to withdrawal at any time. You have the right to refuse any question(s) that you find objectionable or that make you feel uncomfortable. You may withdrawal your consent at any time and discontinue participation without penalty.

The researcher will provide you with formal written debriefing form at the end of this study. In this form you be will provided with information regarding the purpose of this study.

Upon completion of the data collection process the master list will be destroyed. Specifically, the document will be deleted off of the password-protected computer.

Your data will only be accessed by the investigators and will be on file in a secure location for a period of five years. After this time has passed your data will be destroyed by Matthew McRae using a paper shredder.

Voluntary Participation

In signing this consent for, you should understand that:

You may ask questions at any given time during participation.

Your participation is voluntary and that refusal to participate will involve no penalty.

You can refuse participation at any time during the progress of the experiment. Subsequently, any data collected will not be included in the results of the experiment.

The researcher might be known to you. However, after the data collection, your identity will be protected under a participant coding system and a secure filing system.

Publication of Results

Results will be available at the office of Dr. Jae Patterson within approximately four months of the completion of the study. If you are unable to visit the office in person an electronic copy of your results can be sent to your private email. It is expected that the results will be presented at academic conferences and will be submitted for publication in peer-reviewed journals. The data could be combined with data from other similar studies

conducted in the Motor Skills Acquisition Lab at Brock University prior to submission to peer reviewed journals.

Contact Information and Ethics Clearance

If you have any questions about this study or require further information, please contact Jae Patterson using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University 14-004**.** If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Informed Consent to Participate

As a participant in this research project, I clearly understand that what I am agreeing to do, that I am free to decline involvement or withdrawal from this project at any time, and that steps are being taken to protect my safety and anonymity. Additionally, I agree to keep the anonymity of my paired participant confidential. I have read this participant information letter and the accompanying consent form. I have had any questions, concerns, or complaints answered to my satisfaction. I have been provided with a copy of this letter.

Name	**Date**
Signature	
Witness Name	
Witness Signature	

Appendix K: Questionnaire Package (CO Group)

CO: _____

Day 1: Before Acquisition

Demographic Questionnaire

Gender: Male ☐ Female ☐

Age: _____Years

Dominant Hand: Right ☐ Left ☐

Do you have normal to corrected normal vision? Yes ☐ No ☐

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

1) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

After First Block

Judgment of Learning Question

Instructions: If practice was to end at this moment and *the learner* was asked to complete the delayed retention test how well would *the learner* preform? In the space provided please estimate *the learner's* movement time in milliseconds (ms).

2) _____ ms

At the end of Acquisition

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

3) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: If practice was to end at this moment and *the learner* was asked to complete the delayed retention test how well would *the learner* preform? In the space provided please estimate *the learner's* movement time in milliseconds (ms).

4) _____ milliseconds

Feedback Questionnaire

Instructions: Please indicate which option best describes the feedback schedule of the learner with self-control (SC).

5) When did the learner with SC request feedback?

- After Perceived Good Trials
- After Perceived Bad Trials
- After Perceived Good and Bad Trials Equally
- Randomly
- Unsure
- Other _____

6) When did the learner with SC not request feedback?

- After Perceived Good Trials
- After Perceived Bad Trials
- After Perceived Good and Bad Trials Equally
- Randomly
- Unsure
- Other _____

Before Delayed Retention

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

7) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: How well do you believe *you* will preform during the retention test? In the space provided please estimate *your* movement time in milliseconds (ms).

8) _____ ms

Appendix L: Questionnaire Package (IP Group)

IP: _____

Day 1: Before Acquisition

Demographic Questionnaire

Gender: Male ☐ Female ☐

Age: _____Years

Dominant Hand: Right ☐ Left ☐

Do you have normal to corrected normal vision? Yes ☐ No ☐

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

1) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

After First Block

Judgment of Learning Question

Instructions: If practice was to end at this moment and *the learner* was asked to complete the delayed retention test how well would *the learner* preform? In the space provided please estimate *the learner's* movement time in milliseconds (ms).

2) _____ milliseconds

At the end of Acquisition

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

3) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: If practice was to end at this moment and *the learner* was asked to complete the delayed retention test how well would *the learner* preform? In the space provided please estimate *the learner's* movement time in milliseconds (ms).

4) _____ milliseconds

Feedback Questionnaire

Instructions: Please indicate which option best describes how you provided feedback during the acquisition period.

5) When did you provide feedback to the learner?

- After Perceived Good Trials
- After Perceived Bad Trials
- After Perceived Good and Bad Trials Equally
- Randomly
- Other _____

6) When did you not provide feedback to the learner?

- After Perceived Good Trials
- After Perceived Bad Trials
- After Perceived Good and Bad Trials Equally
- Randomly
- Other _____

Instructions: Using the scale below, please circle a number that best reflects the effectiveness of how well you delivered feedback to the learner.

1	2	3	4	5	6	7	8	9	10
"Ineffective"			"Moderately Effective						"Extremely Effective"

7) How effective do you perceive your feedback schedule will be at facilitating the learning of the motor skill?

1 2 3 4 5 6 7 8 9 10

<u>Day 2: Before Delayed Retention</u>

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

8) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: How well do you believe *you* will preform during the retention test? In the space provided please estimate *your* movement time in milliseconds (ms).

9) _____ ms

Appendix M: Questionnaire Package (LE & LI Groups)

LE or LI: _____

Day 1: Before Acquisition

Demographic Questionnaire

Gender: Male ☐ Female ☐

Age: _____Years

Dominant Hand: Right ☐ Left ☐

Do you have normal to corrected normal vision? Yes ☐ No ☐

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

1) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

After First Block

Judgment of Learning Question

Instructions: If practice was to end at this moment and *you* were asked to complete the delayed retention test how well would *you* preform? In the space provided please estimate *your* movement time in milliseconds (ms).

2) _____ ms

At the end of Acquisition

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

3) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: If practice was to end at this moment and *you* were asked to complete the delayed retention test how well would *you* preform? In the space provided please estimate *your* movement time in milliseconds (ms).

4) _____ ms

Feedback Questionnaire

Instructions: Please indicate which option best describes how you were provided feedback during the acquisition period.

5) Do you think you received feedback after the right trials?

- Yes
- No

6) If NO, when would you have liked to receive feedback?

- After Perceived Good Trials
- After Perceived Bad Trials
- After Perceived Good and Bad Trials Equally
- Randomly
- Other _____

Instructions: Using the scale below, please circle a number that best reflects how well feedback was delivered to you.

1 2 3 4 5 6 7 8 9 10

"Ineffective" "Moderately Effective" "Extremely Effective"

7) How well did the feedback schedule provided to you facilitate the learning of this task?

1 2 3 4 5 6 7 8 9 10

Before Delayed Retention

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1 2 3 4 5 6 7 8 9 10

"Not at all" "Somewhat" "Very"

8) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: How well do you believe *you* will preform during the retention test? In the space provided please estimate *your* movement time in milliseconds (ms).

9) _____ ms

Appendix N: Questionnaire Package (SCP Group)

SCP: _____

Day 1: Before Acquisition

Demographic Questionnaire

Gender: Male ☐ Female ☐

Age: _____Years

Dominant Hand: Right ☐ Left ☐

Do you have normal to corrected normal vision? Yes ☐ No ☐

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

1) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

After First Block

Judgment of Learning Question

Instructions: If practice was to end at this moment and *you* were asked to complete the delayed retention test how well would *you* preform? In the space provided please estimate *your* movement time in milliseconds (ms).

2) _____ milliseconds

At the end of Acquisition

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

3) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: If practice was to end at this moment and *you* were asked to complete the delayed retention test how well would *you* preform? In the space provided please estimate *your* movement time in milliseconds (ms).

4) _____ milliseconds

Feedback Questionnaire

Instructions: Please indicate which option best describes how you provided feedback during the acquisition period.

5) When did you request feedback?

- After Perceived Good Trials
- After Perceived Bad Trials
- After Perceived Good and Bad Trials Equally
- Randomly
- Other _____

6) When did you not request feedback?

- After Perceived Good Trials
- After Perceived Bad Trials
- After Perceived Good and Bad Trials Equally
- Randomly
- Other _____

Day 2: Before Delayed Retention

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

7) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: How well do you believe *you* will preform during the retention test? In the space provided please estimate *your* movement time in milliseconds (ms).

8) _____ ms

As a peer facilitator:

Before Acquisition:

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

9) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

After First Block:

Judgment of Learning Question

Instructions: If practice was to end at this moment and *the learner* was asked to complete the delayed retention test how well would *the learner* preform? In the space provided please estimate *the learner's* movement time in milliseconds (ms).

10) _____ milliseconds

At the end of Acquisition

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1	2	3	4	5	6	7	8	9	10
"Not at all"				"Somewhat"					"Very"

11) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: If practice was to end at this moment and *the learner* was asked to complete the delayed retention test how well would *the learner* preform? In the space provided please estimate *the learner's* movement time in milliseconds (ms).

12) _____ milliseconds

Feedback Questionnaire

Instructions: Please indicate which option best describes how you provided feedback during the acquisition period.

13) When did you provide feedback to the learner?

- After Perceived Good Trials
- After Perceived Bad Trials
- After Perceived Good and Bad Trials Equally
- Randomly
- Other _____

14) When did you not provide feedback to the learner?

- After Perceived Good Trials
- After Perceived Bad Trials

- After Perceived Good and Bad Trials Equally
- Randomly
- Other _____
-

Instructions: Using the scale below, please circle a number that best reflects the effectiveness of how well you delivered feedback to the learner.

1 2 3 4 5 6 7 8 9 10
"Ineffective" "Moderately Effective "Extremely Effective"

15) How effective do you perceive your feedback schedule will be at facilitating the learning of the motor skill?

1 2 3 4 5 6 7 8 9 10

Day 3: Before Delayed Retention

Motivation Questionnaire

Instructions: Using the scale below, please circle a number that best reflects how you feel at this time.

1 2 3 4 5 6 7 8 9 10
"Not at all" "Somewhat" "Very"

16) How motivated are you to learn this task?

1 2 3 4 5 6 7 8 9 10

Judgment of Learning Question

Instructions: How well do you believe *you* will preform during the retention test? In the space provided please estimate *your* movement time in milliseconds (ms).

17) _____ milliseconds

Appendix O: Debriefing Form

Title of Study: Examining peer-controlled KR schedules during the learning of a movement-timing task

Thank you for agreeing to participate in this study. The general purpose of this study is to examine the potential learning benefits associated with providing a peer with control over another learner's feedback schedule. To examine this research question we used five experimental groups (e.g., A, B, C, D, E) that were broken down into two main research pairings (e.g., A-B & C-D). In each of these research pairings the first participant would physically practice the task and the second participant would observe the protocol.

In the first research-pairing (e.g., A-B, where A is physically practicing and B is observing) participant B controlled the feedback schedule of participant A despite never practicing the task for themselves. In contrast, in the second research-pairing (e.g., C-D where C is physically practicing and D observing) participant D was asked to physically practice the task before determining when to provide feedback to participant C.

In group E participants were simply asked to observe a participant in group D. Specifically, learners in group E viewed the time period where participants in group D physically practiced the experimental task.

All 5 groups were then asked to complete the same task you did today. As you completed the task today we measured the difference between your performance and the goal (i.e., Absolute Error). This absolute error data will now be analyzed and the mean of each group's absolute error will be compared to provide us with an answer to our research question.

Again, we thank you for your participation in this study. We kindly ask you to avoid discussing this study with other potential participants until the semester is over. Prior knowledge of the purpose of our study can invalidate results. We greatly appreciate your cooperation.

If the results from this study are published into an academic journal or presented at academic conferences, no names or participant numbers that directly link you to the study will be used. Additionally, only mean scores will be reported and presented.

If you have any questions or wish to receive your individual performance scores (Note: Individual results are only available after a four-month waiting period) feel free to contact Dr. Jae Patterson (email: jpatterson@brocku.ca; telephone: 905 688-5550 ext. 3769).

This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University [14-004]. If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Thank you,
-Motor Skills Acquisition Lab