

The “When” and the “What”: Effects of Self-Control of Feedback about Multiple Critical
Movement Features on Motor Performance and Learning

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

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August 2013

ACKNOWLEDGEMENT

I would like to thank my dissertation committee: Drs. Jeff Fairbrother, Mark Hector, Clare Milner, and Joe Whitney. Your guidance and exceptional knowledge allowed me to complete this project. I would also like to thank my parents, Kerstin and Björn, and my sisters, Emilie and Johanna, for their unconditional love and support in my various endeavors. Moreover, I would like to thank Susanne for all her support, love, and encouragement during each stage of my doctoral program. Moreover, I would like to thank fellow sport psychology and motor behavior graduate students for their friendship and support. A special thank-you goes to Ary, Chris, Dave, Kevin, Kevin, Susannah, and Trevor. Finally, I would like to thank Dr. Rodney Pratt for the life changing experience of studying in the USA.

ABSTRACT

The effect of allowing learners to control selected aspect(s) of their learning environment (e.g., augmented feedback) has been shown to be beneficial during skill acquisition. Although Chiviacowsky and Wulf (2002, 2005) indicated that learners in a self-control protocol preferred feedback after so-called good performances rather than bad ones, Aiken, Fairbrother, & Post (2012) found no such preference in learners using video knowledge of performance (KP) for a basketball set shot. Laughlin (2012) reported that participants given self-control over four different types of instructional assistance displayed individualized request patterns tied to task proficiency and personal preferences. For example, learners' requests for knowledge of results (KR) increased throughout acquisition while those for KP decreased. Together, Aiken et al. (2012) and Laughlin (2012) indicated that learner's decisions about the timing and content of requested feedback are more complex than previously demonstrated. The purpose of this study was to examine feedback request behaviors and self-control effects in a protocol allowing learners to manage the provision of KP about four different critical features of a fairly complex task (ergometer rowing). The use of KP allowed an exploration of how learners' feedback requests were tied to their success on each movement element and their perceptions of proficiency. The inclusion of a yoked control group extended Laughlin's design to test whether or not a self-control benefit would be seen in a protocol that placed a relatively high information-management burden on the participants. Results revealed that the Self-Control (SC) group achieved significantly higher mean form scores during acquisition and retention, and also significantly lower heart rate during retention compared to the yoked (YK) group. Additionally, responses to a post-practice interview showed that SC participants' requests for KP followed both good and bad trials, and were used for both error correction and confirmation of success. These findings indicated that self-control of KP for multiple critical features benefits learning of a

complex task. The pattern of KP requests indicated that participants generally focused on the easier critical features early in practice. Moreover, participants used KP more for correction early, but increased its use for success confirmation as they gained proficiency.

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CHAPTER 1

Introduction

The effect of allowing learners to control selected aspect(s) of their learning environment, such as deciding when to receive augmented feedback, has been shown to benefit motor skill acquisition (e.g., Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997; Janelle, Kim, & Singer, 1995; Zimmerman, 1989). For example, benefits have been documented for allowing individuals control over access to video demonstration (Wulf, Raupach, & Pfeiffer, 2005), practice schedule (Wu & Magill, 2011), amount of practice (Post, Fairbrother, & Barros, 2011), and use of physical assistance devices (Hartman, 2007; Wulf & Toole, 1999). For augmented feedback manipulations, benefits have been observed when allowing learners control over the provision of concurrent feedback (e.g., Huet, Camachon, Fernandez, Jacobs, & Montagne, 2009; Huet, Jacobs, Carnachon, Goulon, & Montagne, 2009), knowledge of results (KR) (Chen, Hendrick, & Lidor, 2002; Chiviacowsky & Wulf, 2002; Chiviacowsky, Wulf, Medeiros, Kaefer, & Tani, 2008; Patterson & Carter, 2010; Hansen, Pfeiffer, & Patterson, 2011), and knowledge of performance (KP) (Aiken, Fairbrother, & Post, 2012; Janelle et al., 1995, 1997). Self-control benefits have been demonstrated using a variety of different tasks, including several involving object projection (Aiken et al., 2012; Bund & Weimeyer, 2004; Chiviacowsky, Wulf, de Medeiros, Kaefer, & Tani, 2008; Chiviacowsky, Wulf, de Medeiros, Kaefer, & Wally, 2008; Hodges, Edwards, Luttin, & Bowcock, 2011; Janelle et al., 1995, 1997; Post, Fairbrother, & Barros, 2010; Wulf, et al., 2005), sequential key-pressing (Chiviacowsky & Wulf, 2002; 2005; Patterson & Carter, 2010; Wu & Magill, 2011), balancing (Chiviacowsky, Wulf, Lewthwaite, & Campos, 2011), regulation of walking speed (Huet et al., 2009a), operating a flight simulator

(Huet et al., 2009b), and skiing on a simulator (Wulf, Clauss, Shea, & Whitacre, 2001; Wulf & Toole, 1999).

The typical protocol used in most self-control research has compared a self-control (SC) group to a yoked (YK) group (Wulf, 2007). Participants in SC groups are allowed control over selected aspect(s) of their learning environment and yoked participants then receive the treatment according to a schedule created by the requests of their counterparts in the SC group. For example, if a participant in the SC group asks for feedback on every third trial, the yoked counterpart will receive feedback on the same trials. Typically, participants in self-control and yoked conditions are matched by gender and personal characteristics (e.g., handedness or skill level) as well. The yoking procedure was first introduced in the research examining self-controlled feedback effects. Because self-control participants often request feedback after a relatively small number of trials (Chiviacowsky & Wulf, 2002; Janelle et al., 1997), yoking to match frequency is used to control for potentially confounding effects of reduced feedback frequency. The yoking procedure has become fairly commonplace, however, even in studies not examining feedback.

Some research on the effects of self-controlled feedback has indicated that participants reported a preference for receiving feedback after successful trials. For example, Chiviacowsky and Wulf (2002) found that 10 out of 15 SC participants reported requesting KR after mostly good trials and seven out of 11 YK participants indicated that they would have preferred KR after good trials. Chiviacowsky and Wulf used a key pressing task that required participants to press four keys on a keypad. The participants' goal was to accurately achieve goal movement times. In contrast, Aiken, Fairbrother, and Post (2012) found no preference for feedback after good trials in a study that allowed learners self-control over video KP when learning a basketball

set shot. Instead, participants reported requesting feedback to both confirm successful performance and identify errors. Aiken et al. suggested that this lack of preference might have been due to the information-rich nature of video KP and the complexity of the experimental task. Specifically, participants could use the video KP on any given trial to focus on more than one critical feature of the set shot. Ultimately, this freedom could have created a dilemma in which one element of the performance (e.g., the follow-through) was perceived as good while another was bad (e.g., elbow position).

Aiken et al. (2012) argued that information-rich feedback such as video KP for a relatively complex task can place a learner in a dilemma because attention can be devoted to more than a single aspect of instructional support during learning. In the case of video KP, it might be problematic to identify reasons for feedback requests if conflicting information is presented. For example, a participant might not be able to indicate a preference for feedback after a good trial when feedback for most trials may in fact contain information about both successful and unsuccessful aspects of the performance. In some cases, however, the capability to manage multiple self-control opportunities might be beneficial for learning. In Aiken et al., both the SC and YK groups were allowed to look at a poster with instructional cues whenever they desired, and both groups did so. Despite the requirement to manage their use of both the instructional cues and the video KP, the SC group still showed a learning benefit. Presumably, self-control over multiple aspects of instructional support is not problematic for learning, but it may affect request behavior during acquisition.

Laughlin (2012) examined this issue of self-control over multiple aspects of instructional support in greater detail. In his study, participants learning to juggle were allowed control over the administration of four types of instructional assistance: instructions, video demonstration,

verbal KP about the most critical flaw, and verbal KR about the duration of each attempt. Results indicated that participants' requests for instructions, video demonstration, and KP decreased as they progressed through four consecutive days of practice while requests for KR increased. In combination, the pattern of requests and results related to task performance, self-efficacy, and a post-training interview were consistent with Chiviacowsky and Wulf's (2005) argument that learners base their support requests on personal needs and preferences. Interestingly, the overall pattern of requests (e.g., the reduced reliance on instructions) was also consistent with ideas about how people progress through stages of learning (e.g., Fitts & Posner, 1967), but some individual behaviors indicated less than optimal learning strategies. The post-training interviews revealed that participants used instructions to grasp general concepts of the juggling skill and to refresh their memory. Video demonstrations were used to obtain a visual image of the movement patterns and to comprehend more details of the skill. KP was used to identify technical flaws, monitor technical corrections, identify new goals, and enhance confidence. KR was used to confirm performance progress and to improve confidence and motivation. Laughlin's results confirmed that participants in a self-control protocol can effectively manage multiple forms of instructional assistance and that their request behavior in doing so changed as practice progressed, but the lack of a yoked or other control group did not allow a determination of whether or not self-control facilitated learning more so than any other approach.

One logical extension of Laughlin's study that would also help resolve the dilemma noted by Aiken et al. (2012) when feedback contains information about multiple features of a relatively complex task. Presumably, a continuous task requiring whole-body coordination would afford participants several opportunities to focus on multiple critical features within a single trial. A

good candidate task would be learning to row on an ergometer. For example, a novice learning the rowing cycle during a 30 s trial might have a relatively good recovery sequence on the first cycle followed by a relatively bad pull sequence on the third cycle. Currently, preferences for good- or bad-trial feedback are unexplored for continuous tasks. Using a complex continuous task such as rowing can help determine how participants potentially focus on different critical features for which feedback is provided and if their requests are tied to success or error correction (or both). Additionally, the inclusion of a yoked control group would demonstrate whether or not such an instructional approach actually facilitates learning (i.e., by producing a so-called self-control benefit).

Statement of the Problem

The purpose of this study was to examine the effects of self-controlled KP on self-control request behavior and the performance and learning of proper technical form for rowing on a dynamic indoor rower.

Method Summary

Dependent variables:	1. Distance
	2. Form score
	3. Heart rate
Independent variables:	Experimental condition (i.e., SC group and YK group)
Additional data:	Observed feedback request behavior for SC group
	Post-practice interview
Participants:	24 undergraduate / graduate students at the University of Tennessee with no rowing experience

- Task:** Participants were trained to display correct rowing form on a dynamic indoor rowing ergometer at 18 cycles per minute.
- Design:** SC and YK groups were compared across four experimental phases: pretest, acquisition, retention, and transfer. Transfer required participants to row at a 28 cycles per min pace.

Research Hypothesis

Based on existing self-control research, the following hypotheses were tested.

1. SC group would demonstrate higher form scores during acquisition than the YK group.
2. SC group would demonstrate higher form scores during retention testing than the YK group.
3. SC group would demonstrate higher form scores during transfer testing than the YK group.
4. SC group would achieve greater distance during acquisition than the YK group.
5. SC group would achieve greater distance during retention testing than the YK group.
6. SC group would achieve greater distance during transfer testing than the YK group.
7. SC group would demonstrate lower heart rate during acquisition than the YK group.
8. SC group would demonstrate lower heart rate during retention testing than the YK group.
9. SC group would demonstrate lower heart rate during transfer testing than the YK group.

In addition to these hypotheses, there were two issues that did not lead to such clear expectations. The current literature is unclear with respect to expectations regarding participant reasons for selecting feedback. Chiviacowsky and Wulf's (2002) findings suggest that there would be a preference for feedback following successful trials. Aiken et al.'s (2012) results suggest instead that a strong prediction cannot be made. It is also expected that feedback request

behaviors will change as practice progresses, but there is currently no empirical basis for predicting what the specific behaviors might be.

Assumptions

The principal investigator assumed that:

1. Participants were naïve to the purposes of the study.
2. Participants had limited experience with the experimental task.
3. Participants performed the experimental tasks to the best of their ability throughout the entire experiment.

Delimitations

1. Participants were limited to undergraduate and graduate students.
2. The study was conducted in a laboratory setting using a dynamic indoor rower. Results may not generalize to learning the analogous on-the-water rowing technique.

Limitations

1. The number of practice trials participants completed during acquisition was limited to 30, which might not have been sufficient to fully acquire a complex continuous skill, such as rowing.
2. Requested/scheduled KP feedback was provided based on the most recent practice trial. Participants were not given summary KP.

Definition of Terms

Acquisition: Time period during which the learner first acquires a new skill.
This phase is also referred to as practice.

Augmented feedback:	Feedback about the performance of a movement that would not be known without the aid of some external source.
Catch:	The catch is a momentary event that follows the recovery phase and precedes the power phase. It involves the participant's shins being vertical to the floor, balls of feet in full contact with the footplate, trunk pivot slightly forward (i.e., shoulders in front of hips), shoulders relaxed, and full elbow extension.
Complex skill:	A motor skill involving multiple-degrees-of-freedom movements and generally requires more than one practice session to learn. An example would be performance on a ski simulator, a basketball shot, or competitive rowing.
Concurrent feedback:	Performance-related information provided during skill execution (Magill, 2001).
Feedback:	Performance-related information provided during and or after skill execution (Magill, 2001).
Finish:	The finish is a momentary event that follows the power phase and precedes the recovery phase. It involves full knee extension, participant's trunk being reclined to approximately 30 degrees past perpendicular, and elbow flexion to where the handle is positioned by the lower ribs.
Flexibility:	The ability to achieve maximum range of motion in various limb joints, such as the spine and lower and upper extremities.
Heart rate:	The number of heartbeats the heart completes per minute.

Indoor rower:	Stationary rowing ergometer that simulates on-water rowing (Elliot, Lyttle, & Birkett, 2002).
Instructional support:	Any form of augmented feedback available that may enhance individuals' learning.
Knowledge of performance:	Performance-related kinematic information, such as technical form, about the completion of a movement.
Knowledge of results:	Performance-related information, such as accuracy and movement time, about the outcome of a movement.
Novice:	A learner with little or no experience of a certain task or movement skill.
Pace:	The number of rowing cycles a participant completes in one minute.
Power phase:	Phase consists of a press-pry-pull sequence in which legs-back-arms move in a series of overlapping movements. The phase begins with knee extension to push the footplate away from the seat. As the participant approaches full knee extension, extension of the hip begins. The final movement is pulling of the handle to the lower ribs.
Range of motion:	See flexibility.
Recovery phase:	Phase consists of an arms-back-legs move (i.e., reverse of the power phase) in a series of overlapping movements. The phase begins with elbow extension followed by hip flexion to move the handle passed the knees. Once the handle clears the participant's

kneecaps, flexion of the knee begins to bring the footplate to the seat and shins to vertical.

Retention: An assessment of performance following a period of no practice. Retention determines the degree to which the learner retained the practiced motor skill.

Self-control: Allowing a learner to control certain aspect(s) of a learning environment. For example, participants in a motor learning study may control the provision of KP feedback.

Self-regulation: The degree to which learners – behaviorally and cognitively – are active in their own learning of a skill (Zimmerman, 1989).

Transfer: An assessment of performance following a period of no practice and retention testing. Transfer determines the degree to which the learner's practiced motor skill carry over to a skill that is slightly different.

Yoked: A control group that receives feedback on the same schedule as their counterparts in the experimental group (i.e., self-control group)

Chapter 2

Review of Literature

The purpose of this chapter is to provide a review of previous research related to this study. Information on the effects of self-control manipulation and feedback on motor learning will be presented in separate sections. A section on rowing will present a brief overview of how the activity is organized and a description of task demands as they are relevant to the study. Finally, a conclusion will be offered as to how the reviewed literature is relevant to the study.

Self-Control

Early motor learning literature indicated that skill acquisition was enhanced via the provision of knowledge of results (i.e., KR) (Bilodeau, 1956). Further, the same literature argued that no learning could occur in the absence of KR. Subsequent research on this topic, however, revealed that learners' performance benefitted from receiving 100% KR during acquisition (i.e., feedback after each practice trial) while diminishing significantly during retention testing compared to learners who received less frequent KR (for a review see Salmoni, Schmidt, & Walter, 1984). Salmoni and colleagues interpreted these findings with the guidance hypothesis, which suggested that learners tend to become dependent on feedback that guides them during practice (the guidance hypothesis is discussed further in subsequent paragraphs). They reasoned that offering less frequent KR encouraged learners to engage in problem solving behaviors and avoid dependency on augmented feedback. More recent motor learning studies, examining self-control effects, indicated that allowing learners control over selected aspects of their practice environment benefits acquisition of both simple and complex motor tasks (Janelle, Kim, & Singer, 1995; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997). These authors argued that providing learners with self-control in a practice environment might enhance

confidence, information processing, learning strategies, and motivation. Others have noted that the self-control effect allows learners to tailor a practice environment to fit their specific learning preferences and needs (Chiviacowsky & Wulf, 2002).

The typical protocol used in most self-control research has compared a SC group to a YK group (Wulf, 2007). Participants in SC groups are allowed control over selected aspect(s) of their learning environment and yoked participants then receive the treatment according to a schedule created by the requests of their counterparts in the SC group. For example, if a participant in the SC group asks for feedback on every third trial, the yoked counterpart will receive feedback on the same trials. Typically, participants in self-control and yoked conditions are matched by gender and personal characteristics (e.g., handedness or skill level) as well. Janelle et al. (1995) conducted the first published motor learning study that examined the self-control effect on skill acquisition. Their study included five experimental groups providing participants various KR frequencies, including one SC group and one YK group. The experimental task was to learn how to throw a golf ball underhanded (non-dominant hand) as close as possible to the center of a circular target. The acquisition phase involved 40 trials for which KR (i.e., accuracy) was provided and retention testing included 20 No-KR trials. The results showed that the SC control group achieved significantly better accuracy than all other groups during retention. Subsequent research examined SC feedback effects in more detail and also sought to determine if the benefit extended to other forms of instructional support (e.g., demonstrations).

Janelle et al. (1997) examined whether participants with control over provision of KP would learn a complex task differently compared to other more traditional protocols for administering KP. They recruited 48 right-handed participants to participate in an experiment

that assessed the learning of a left-handed (i.e., non-dominant hand) ball throw. After watching the throwing mechanisms demonstrated by a video recording of a highly skilled left-handed thrower, the participants were assigned to one of four experimental groups: (1) *KR only* (group received no KP about throwing form, but was able to view the accuracy of each throw), (2) *summary KP* (group received video KP and verbal KP after every five trials), (3) *self-controlled KP* (group received video KP and verbal KP whenever requested), or (4) *yoked control* (group received video KP and verbal KP on the schedule determined by their counterparts in the self-control group). For the latter three experimental groups, video KP was presented for the last two trials of a block while the instructor verbally cued participants about their most critical flaw in throwing form. For example, the instructor might have provided a statement, such as "The primary flaw in your delivery at this point is that you are attempting to throw without striding forward" (Janelle et al., p. 272), followed by a cue phrase suggesting corrections for how the participant could improve his/her throw. Results of this study showed that experimental groups that received KP achieved significantly better throwing form during acquisition than the *KR only* group. Further, the *self-controlled KP* group achieved significantly better throwing form and accuracy during retention testing than all other groups. This study extended previous research on self-controlled KR benefits by showing that self-control over KP also facilitate learning.

Building on the work of Janelle et al. (1995; 1997), Chen, Hendrick, and Lidor (2002) examined whether observed self-control benefits were influenced by the higher degree of autonomy offered to learners in a self-controlled environment compared to more traditional instructional settings. Their study included four experimental groups. One group was informed at the beginning of acquisition that they would receive feedback only when requested. Another group received the same initial information and, in addition, group members were reminded

about the feedback option after each trial throughout acquisition. These two groups were matched with corresponding YK groups. All four experimental groups were required to learn a relatively simple sequential key-pressing task. Chen et al. found that both SC groups outperformed their yoked counterparts during both immediate and delayed retention testing. Their findings suggested that self-controlled protocols offering various degrees of autonomy benefit learning compared to yoked conditions without autonomy. These findings indicated that SC behaviors prompted by the researcher still promoted motor learning.

Early work on self-control manipulations emerges directly from literature about the effects of self-regulation on learning. Self-regulation refers to how individuals achieve specific goals through self-generated behaviors, feelings, and thoughts. It is a conscious approach that requires learners to actively select actions to advance in a learning environment (Zimmerman, 2002). For effective self-regulation to occur, learners ought to believe in their capability to control their behaviors, motivation, and thoughts, and also the environment (Schunk & Zimmerman, 2009). For learners to improve their self-regulation, there are numerous approaches identified as means for achieving various goals, such as: Managing time, goal setting, adopting strategies to achieve goals, rearranging one's environment to meet goals, monitoring progress based on performance, linking results to actual causes, evaluating methods, and altering methods as needed (Zimmerman, 2002). Ultimately, self-regulation is the ability to direct learning through a conscious and systematic process of setting goals and, thereafter, adjusting behaviors to achieve those goals.

According to Zimmerman (1989), "students can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process" (p.329). In other words, students must go about their learning by means

applicable to achieve goals in learning environment. This approach often involves three key components: (1) use of specific learning strategies; (2) awareness of self-efficacy; and (3) commitment to goals. Learning strategies include behaviors directed at acquiring information or skill, such as organizing information, researching information, and rehearsing. Self-efficacy includes learners' beliefs about their own capabilities to implement actions needed to achieve goals (Bandura, 1997). Goals are set as references against which progress can be checked. Normally, goals are also specific, timely, and based on learners' needs. Of Zimmerman's components, self-efficacy is thought to be influenced by the learners' personal characteristics. Hence, it is the learners' belief in self that ultimately regulates their use of different learning strategies and goal commitment. Zimmerman (1989) and Bandura (1977; 1978) described self-regulation as a process that is influenced by both behavioral events and the environment. Self-regulation is dynamic and will vary in degree depending on personal, environmental, and behavioral traits.

To date, motor learning researchers – using a range of different approaches – have investigated self-control effects in real world and laboratory settings. For example, research studies have measured benefits for allowing individuals control over access to video demonstration (Wulf, Raupach, & Pfeiffer, 2005), practice schedule (Wu & Magill, 2011), amount of practice (Post, Fairbrother, & Barros, 2011), and use of physical assistance devices (Hartman, 2007; Wulf & Toole, 1999). For augmented feedback manipulations, benefits have been observed when allowing learners control over the provision of concurrent feedback (e.g., Huet, Camachon, Fernandez, Jacobs, & Montagne, 2009; Huet, Jacobs, Carnachon, Goulon, & Montagne, 2009), outcome-related feedback (i.e., knowledge of results or KR) (Chen, Hendrick, & Lidor, 2002; Chiviawosky & Wulf, 2002; Chiviawosky, Wulf, Medeiros, Kaefer, & Tani,

2008; Hansen, Pfeiffer, & Patterson, 2011; Patterson & Carter, 2010), and performance-related feedback (i.e., knowledge of performance or KP) (Aiken, Fairbrother, & Post, 2012; Janelle et al., 1995; Janelle et al., 1997). Self-control benefits have been demonstrated using a variety of different types of tasks, including several involving object projection (Aiken et al., 2012; Bund & Weimeyer, 2004; Chiviawowsky, Wulf, de Medeiros, Kaefer, & Tani, 2008; Chiviawowsky, Wulf, de Medeiros, Kaefer, & Wally, 2008; Hodges, Edwards, Luttin, & Bowcock, 2011; Janelle et al., 1995, 1997; Post, Fairbrother, & Barros, 2010; Wulf, et al., 2005), sequential key-pressing (Chiviawowsky & Wulf, 2002; 2005; Patterson & Carter, 2010; Wu & Magill, 2011), balancing (Chiviawowsky, Wulf, Lewthwaite, & Campos, 2011), adjusting walking speed to clear virtual sliding doors (Huet et al., 2009a), operating a flight simulator (Huet et al., 2009b), and skiing on a ski simulator (Wulf, Clauss, Shea, & Whitacre, 2001; Wulf & Toole, 1999).

Some research on the effects of self-controlled feedback has indicated that participants reported a preference for receiving feedback after successful trials. For example, Chiviawowsky and Wulf (2002) conducted a study in which they asked SC participants when and why they requested feedback and YK participants when and why they would have preferred to receive feedback. Their results showed that the SC group achieved better performance on the experimental task compared to the YK group during transfer testing. Responses to the post-practice questionnaire showed that 10 out of 15 self-control participants reported requesting feedback after mostly good trials and seven out of 11 yoked participants indicated that they would have preferred feedback after good trials. Analysis of the SC group's performance in KR trials vs. No-KR trials showed that KR trials were performed more accurately than the No-KR trials. Based on these findings, Chiviawowsky and Wulf reasoned that learners with self-control

over KR consciously requested feedback to confirm successful performance rather than to correct unsuccessful performance.

Chiviawsky and Wulf (2005; 2007) designed two follow-up studies to further explore the phenomenon of learners' preference for feedback after successful performance. For their 2005 study, they compared two self-control conditions: *self-control before* and *self-control after*, while learning a key pressing task. Their findings showed that the *self-control after* group outperformed the *self-control before* group in overall performance accuracy. Chiviawsky and Wulf argued that self-evaluation is a key component of self-control effects. Hence, it is only after learners have performed a skill that an informed choice can be made as to whether feedback is needed. Chiviawsky and Wulf's (2007) did not include self-control conditions. Instead, the study explored the effects of providing learners KR for their three most successful trials vs. KR for their three least successful trials out of six trials in each block. Results indicated that KR for successful performance benefitted learning more than KR for unsuccessful performance.

Succeeding Chiviawsky and Wulf's three studies (2002; 2005; 2007), Huet and colleagues (Huet, Camachon, Fernandez, Jacobs, & Montagne, 2009a; Huet, Jacobs, Camachon, Goulon, & Montagne, 2009b) examined at self-controlled procedures for concurrent feedback. Their object was to examine whether self-control over concurrent feedback offered an advantage for learning. Their research included two different experimental tasks: (1) regulation of walking speed (Huet et al., 2009a) and (2) control of virtual plane in a flight simulator (Huet et al., 2009b). In the first study, participants walked through a virtual corridor where sliding doors opened and closed in a rhythmic pattern. The participants were asked to adjust their walking speed so that they passed through the virtual doors when they were fully open. The experimental protocol included four groups: ghost doors, gauge, yoked, and control. Throughout acquisition,

the ghost doors group and gauge group were allowed to control the provision of concurrent feedback (i.e., KR) by pushing a button. When participants in the ghost doors group pushed the button a set of ghost doors would appear. These doors indicated where the participants would be, if they maintained their current speed, when the virtual doors were fully opened. When participants in the gauge group pushed the button a gauge appeared to the left of the virtual screen. The gauge provided a reference indicating whether the participants' current walking speed would match the opening and closing of the virtual doors. Participants in the control group received no concurrent feedback. The results showed that the gauge group outperformed all other groups, while the ghost doors group's performance was the worst among the four experimental groups. These findings suggested that self-control over selected concurrent feedback benefit learning. In order for the concurrent feedback to be useful it cannot appear ambiguous to the learner. In their second study, Huet and Colleagues showed that self-controlled concurrent feedback benefitted learning how to descend a virtual aircraft. The principal apparatus for this study included an aviation game joystick and a virtual projection system. The virtual airplane's elevation was altered by either pushing the joystick forward or backwards. For this relatively simple task, revealed findings suggested that self-controlled concurrent feedback do benefitted learning of a continuous task.

As an extension to Chiviacowsky and Wulf (2002; 2005; 2007) and Janelle et al. (1997), Aiken et al. (Aiken, Fairbrother, & Post, 2012) conducted an experiment designed to examine self-control participants' request patterns for video KP and whether the effects of self-controlled video KP benefit the learning of basketball set shot technique. The study included two experimental groups: SC group and YK group. The SC group was told they could ask for video KP about their performance at any time during acquisition, while yoked participants received

video KP based on the schedule created by their counterpart in the SC group. Throughout acquisition, both groups had access to a poster board with written cues illustrating correct basketball set shot technique. At the end of acquisition all participants completed a post-practice questionnaire. Results revealed that self-control participants achieved significantly higher form scores during transfer testing and also that they utilized the poster board with written cues more frequently during acquisition than yoked participants. In contrast to Chiviacowsky and Wulf's work, participants reported requesting feedback to both confirm successful performance and identify errors. Aiken and colleagues suggested that this lack of preference might have been due to the information-rich nature of video feedback and the complexity of the task. Specifically, participants could use the video feedback on any given trial to focus on more than one of the multiple critical features of the set shot. Ultimately, this could have created a dilemma in which one element of the basketball set shot performance was perceived as good while another was bad.

The learners' dilemma was predicated on the idea that participants might attend to more than a single aspect of instructional support during learning. In the case of video KP, this might be problematic in identifying reasons for feedback requests if conflicting information is presented. In some cases, however, the capability to manage multiple self-control opportunities might be beneficial for learning. In Aiken and colleagues' study, both the self-control and yoked groups were allowed to look at a poster with instructional cues whenever they wanted and both groups did so. Despite the requirement to manage their use of both the instructional cues and the video feedback, the self-control group still showed a learning benefit. Presumably, self-control over multiple aspects of instructional support is not problematic for learning, but it may affect request behavior during acquisition.

Laughlin (2012) examined this issue in greater detail. In his study, participants learning to juggle were allowed control over the administration of four types of instructional assistance: (a) instructions; (b) video demonstration; (c) verbal KP about their most critical flaw; and (d) verbal KR about the duration of each attempt. Results indicated that participants' requests for instructions and video demonstration decreased as they progressed through four consecutive days of practice while requests for KP and KR increased. In combination, the pattern of requests and results related to task performance, self-efficacy, and a post-training interview were consistent with Chiviacowsky and Wulf's (2005) argument that learners base their support requests on personal needs and preferences. Interestingly, the overall pattern of requests (e.g., the reduced reliance on instructions) was consistent with ideas about how people progress through stages of learning (e.g., Fitts & Posner, 1967), but some individual behaviors indicated less than optimal learning strategies. The post-training interviews revealed that participants used instructions to grasp general concepts of the juggling skill and to refresh their memory. Video demonstrations were used to obtain a visual image of the movement patterns and to comprehend more details of the skill. KP was used to identify technical flaws, monitor technical corrections, identify new goals, and enhance confidence. KR was used to confirm performance progress and to improve confidence and motivation. Laughlin's results confirmed that participants in a self-control protocol can effectively manage multiple forms of instructional assistance and that their request behavior in doing so changed as practice progressed, but the lack of a yoked or other control group did not allow a determination if whether or not self-control facilitated learning more so than any other approach.

Based on achieved automaticity proficiency in juggling during retention and transfer testing, participants were categorized into one of three groups: Proficient Learners (i.e., averaged

at least 20 catches per attempt), Emerging Learners (i.e., averaged between 4 and 20 catches per attempt), or Late Learners (i.e., averaged less than 4 catches per attempt). For all three groups, participants approached learning the experimental task in different ways. For example, one Proficient Learner initially asked for instruction, video demonstrations, and KP before shifting to requesting primarily KR almost exclusively. Another Proficient Learner asked for KP exclusively throughout all of acquisition. Two other Proficient Learners asked for hardly any assistance instructions throughout acquisition. One of the Emergent Learners initially asked for video demonstrations, KP, and KR before gradually shifting to exclusive request KR. Two Emergent Learners requested all four types of instructional support on the first day and thereafter gradually shifted to exclusive request KP and KR. Another Emergent Learner asked for hardly any instructional support throughout the four days of practice. Variations in participants' approach were also observed among Late Learners. Three Late Learners asked for hardly any instructional support throughout acquisition. Another Late Learner asked for instruction, video demonstrations, and KP for the first half of acquisition and KP only for the second half. Overall, participants requested KP and KR more frequently than instruction and video demonstrations. Proficient Learners asked for more instructional support than Emerging Learners and Late Learners. Ultimately, Laughlin's study showed that when participants were provided with SC over multiple aspects of instructional support their request behavior changed with skill development and differed among participants. This observation implies a personalized strategic use of instructional support that might be tied to learners' preferences and needs. It stands to reason that learners with self-control over KP while acquiring a complex continuous task might also show this type of behavior with respect to KP addressing different critical features of the experimental task. In other words, their desire for KP on any given feature might change over

time. One logical extension of Laughlin's study that would help resolve the dilemma noted by Aiken et al. (2012) involves the provision of feedback about multiple aspects of a relatively complex task. Presumably, a continuous task requiring whole-body coordination would afford participants several opportunities to focus on multiple critical features within a single trial.

Feedback

Feedback is performance-related information intended to help individuals improve and adjust their performance while acquiring motor skills (e.g., Magill, 1994). Feedback is often provided during and after skill execution, and obtained via performers' sensory mechanisms (i.e., inherent feedback) or from augmenting non-sensory sources (i.e., augmented feedback) or both. Inherent feedback can be exemplified by the pole vaulter who – midair – recognizes an error when hitting the crossbar and sees it fall down into the pit. Likewise, the visual perception of successfully handing over a baton in a sprint relay informs the sprinter that the transfer was all right. Augmented feedback can be observed in most learning environments, such sports. For example, crewmembers of an eight-oared rowboat obtain concurrent numeric feedback (e.g., boat velocity, pace, etc.) voiced by the coxswain seated in the stern (i.e., rear) of the boat. Similarly, a coach conveying elapsed times for 100-meter butterfly swims provides augmented feedback to the swimmers. Researchers have divided augmented feedback further into two types: Knowledge of performance (KP) and knowledge of results (KR) (Gentile, 1972). While KP provides information directed towards the correction of improper movement patterns (e.g., a cross-country skier's "opposite-arm and opposite-leg" motion), KR refers to the outcome of the movement in the environment (e.g., a cross-country skier's time in a 10 km race). Acquiring skills in most domains, such as recreational and sport activities, involves instructors conveying feedback about how to adjust physical movement patterns to improve performance. Ultimately,

the provision of feedback, while acquiring a skill, is believed to allow learners to comprehend whether features of a practiced skill are successfully or unsuccessfully performed.

There are different methods instructors may choose to convey augmented feedback to learners (Magill, 1994). First, an instructor can choose to provide *concurrent feedback* or *terminal feedback* or both. *Concurrent feedback* is categorized as information about performance given to individuals while they practice a skill (e.g., cyclists receive constant information about their altitude, heart rate, and speed via their cyclometer in a road race), while *terminal feedback* is information about performance given after the skill has been completed (e.g., the score divers receive after a dive). Second, an instructor will have to decide timing for providing feedback. The timing of feedback can be either delayed by some period of time or immediate. *Delayed feedback* is exemplified by the gymnast who – at the end of practice – watches video recordings of her performed routines that day, while *immediate feedback* is illustrated by the track and field coach who provides KP and KR to the long jumper immediately after a jump. Third, an instructor can choose to provide verbal or nonverbal augmented feedback or both. *Verbal feedback* is exemplified by the dance instructor who provides cue phrases for how to improve critical features of the waltz, while *nonverbal feedback* can be presented by the same instructor clapping hands to the rhythm of the music playing. Lastly, instructors can choose to present augmented feedback that sums up an accumulation of past performances (e.g., the average distance of javelin throws in one practice) or feedback that describe a distinct performance (e.g., the distance of one javelin throw) or both. Ultimately, the presentation of feedback for a particular skill is determined by its nature and the performance setting. For example, while concurrent KP would seem beneficial for performers participating in endurance

events, such as the marathon, immediate terminal KP is arguably more constructive for performers of discrete skills, such as power lifting.

Motor learning researchers have examined the effectiveness of providing various forms of feedback when learning coordination and movement sequences of different skills (e.g., Debaere, Wenderoth, Sunaert, Van Hecke, & Swinnen, 2003; Park, Shea, & Wright, 2000; Schmidt & Wulf, 1997; Swinnen, Walter, Lee, & Serrien, 1993; Verschueren, Swinnen, Dom & De Weerd, 1997; Winstein & Schmidt, 1990). The majority of these studies have concluded that most methods for providing feedback have positive effects on skill acquisition. However, observed positive effects seem to diminish during retention tests when no feedback is given (e.g., Schmidt & Bjork, 1992; Schmidt & Wulf, 1997). These findings have been interpreted with the guidance hypothesis (Salmoni, Schmidt, & Walter, 1984), which suggests that learners tend to become dependent on feedback that guides them during practice. It is believed that causes for this dependency include: Excessive augmented feedback might cause learners to bypass inherent cognitive processes that, normally, support error detection and skill acquisition (e.g., Landauer & Bjork, 1978; Schmidt, 1991); and content of frequent feedback tend to target minor errors that are due to regular variability within learners' motor system (Winstein & Schmidt, 1990). Interestingly, the adverse phenomenon of providing excessive feedback appears more noticeable when learning simple tasks, involving nominal degrees of coordination, modest demands on attention and memory, and a comparatively short acquisition phase (Park, Shea, & Wright, 2000; Wulf & Shea, 2002). When learning complex and continuous skills, involving multiple degrees of coordination, high demands on attention and memory, and a longer acquisition phase, learners seem to benefit from increased frequency of feedback.

Rowing

Competitive rowing is a form of locomotion that requires the performer to engage in sequences of complex movement patterns (Elliott, Lyttle, & Birkett, 2002). Existing biomechanics and motor behavior research have divided the rowing cycle into four phases: (1) the catch (i.e., a momentary event that involves the rower's shins being vertical, balls of feet in full contact with the footplate, trunk pivot slightly forward, shoulders relaxed, and elbows fully extension), (2) the power phase (i.e., a press-pry-pull sequence during which the rower's legs-back-arms move in a series of overlapping movements. The phase begins with knee extension to push the footplate away from the seat. As the participant approaches full knee extension, extension of the hip begins. The final movement is pulling of the handle to the lower ribs), (3) the finish (i.e., a momentary event that involves the rower's knees being extended, trunk being reclined to approximately 30 degrees past perpendicular, and elbow flexion to where the handle is positioned by the lower ribs, and (4) the recovery phase (i.e., an arms-back-legs sequence that is the reverse of the power phase. The phase begins with elbow extension followed by hip flexion to move the handle passed the knees. Once the handle clears the participant's kneecaps, flexion of the knee begins to bring the footplate to the seat and shins to vertical).

Elliott and colleagues (Elliott, Lyttle, & Birkett, 2002) observed similarities between indoor rowing and on-water rowing. In their study, they examined physical movement patterns among eight national level rowers while rowing the distance of 500 m on both indoor rowers and in single sculls on-water, at rates of 24, 26, and 28 strokes per minute. Variables of interest were force curves, stroke length, and body positions attained throughout the rowing cycle. The conclusion of their study was that rowers' use significantly similar technique for both indoor rowing and on-water rowing. Preceding and succeeding studies, examining similarities between

ergometer rowing and on-water rowing, have come to the same conclusion (e.g., Dawson, Lockwood, Wilson, & Freeman, 1998; Lamb, 1989)

Conclusion

Despite showing that self-control effects are robust for many experimental protocols, current self-control literature concludes dissimilar reasons for why self-control learners request feedback. For example, Chiviackowsky and Wulf (2002) indicated that learners preferred KR following good performance mainly to confirm success while Aiken et al. (2012) reported that learners asked for video KP to both confirm successful performance and identify errors. Aiken et al. argued that the information-rich nature of video KP allowed learners to evaluate more than one task feature, and thus they could focus on both error correction and confirmation of success. Laughlin (2012) showed that SC participants can effectively manage up to four different types of instructional support when learning a motor skill. In order to further explore the effects of self-controlled feedback and learners' preferences for feedback following good and bad performance while learning a complex continuous task, the current study introduced the experimental task of rowing on a dynamic indoor rower. The rowing task is arguably unique to most people and offers multiple task features for self-control participants to consider while learning how to row. The objective of this study was to assess how participants potentially focus on different critical task features while choosing between multiple KP options about those features. This experimental approach should offer new insights into the process of learning a complex task and learners' preference for receiving feedback.

CHAPTER 3

Method

Participants

Twenty-four participants were recruited from the student population at the University of Tennessee at Knoxville. All participants were between 18 and 30 years of age ($M_{\text{age}} = 19.25$ years) and naïve to the purpose of the study. They had no previous experience rowing on indoor rowers or as crewmembers of competitive or recreational oared rowboats. Participants were asked to acknowledge their voluntary participation by providing informed consent (see Appendix A) using a document approved by the University of Tennessee Institutional Review Board. In order to meet inclusion criteria, participants were asked to complete a physical activity readiness questionnaire (PAR-Q; screening tool designed to exclude participants who might have possible risk related to exercising; see Appendix B); a field test designed to measure lower back and hamstring flexibility (i.e., the sit-and-reach test; see Appendix C for protocol); and measurements (i.e., height and weight) to calculate their body mass index (BMI). All participants were expected to have a BMI lower than 30 and record no less than *fair* flexibility for the sit-and-reach flexibility test. The PAR-Q assessed whether volunteering participants were suited to participate in this study.

Apparatus and Task

The apparatus was a Concept 2 dynamic indoor rower (Concept 2, Morrisville, Vermont) that measured 1.93 m in length, 62 cm in width, and had a seat height of 55 cm. The design of this indoor rower offered participants a simulation of the actual rowing dynamics experienced while rowing on-water (e.g., Elliott, Lyttle, & Birkett, 2002). Equipped with a PM4 monitor, the indoor rower provided performance data, such as distance rowed, heart rate (via a Garmin heart

rate monitor), pace, and time. In line with Concept 2's guidelines, the dynamic indoor rower's damper lever was set at 4. This setting generated a Drag Factor of 105 that simulated on-water rowing. Participants learned how to row with the goal of achieving technically sound rowing form on the dynamic indoor rower. For this study, technical goals were (1) vertical shins at the catch, (2) arm and leg extended as handle passed over knees during the power phase, (3) upper body angle at 30 degree past perpendicular at the finish, and (4) arm and leg extended as handle passed over knees during the recovery phase. The dynamic indoor rower is illustrated in Figure 1.



Figure 1. *A person rowing on a Concept 2 dynamic indoor rower.*

Procedure

One camcorder (Cannon ZR 960; Cannon, USA, Inc., Lake Success, NY), mounted on a tripod, was situated to capture video images of participants' rowing form. The camcorder was

positioned laterally 2.85 m away from the participant at a 90° angle to the participant's sagittal plane and a height of 0.82 m. Performance data (i.e., distance and heart rate) displayed by the PM4 monitor were recorded with a Concept 2 LogCard (Concept 2, Morrisville, Vermont) and uploaded to a PC computer. Throughout the experiment, participants had access to concurrent feedback about elapsed time and pace via the PM4 monitor. Figure 2 shows a diagram of the equipment setup.

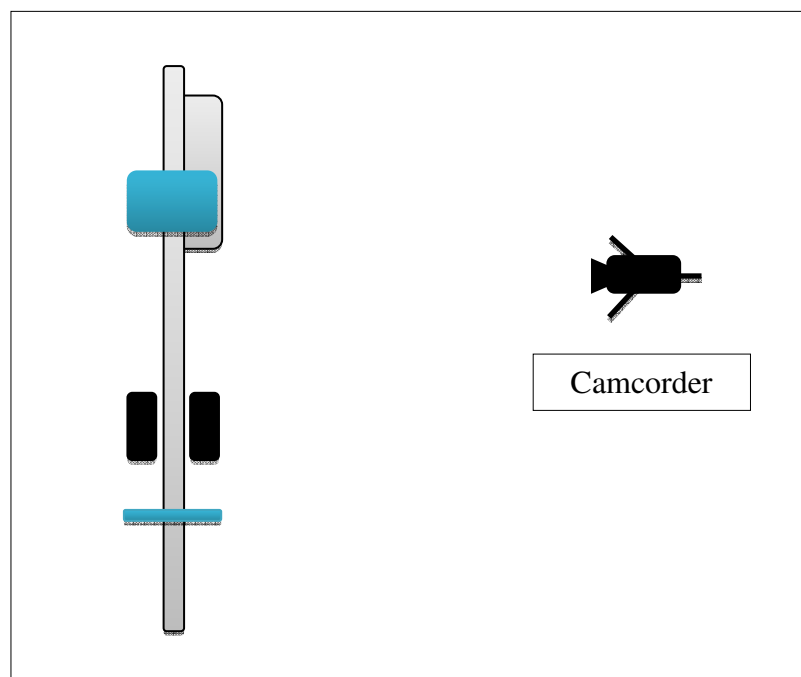


Figure 2. *Equipment setup during data collection (not to scale).*

Upon arriving to the laboratory on Day 1, all participants were asked to acknowledge their voluntary participation by providing informed consent (see Appendix A). Next, all participants were asked to fill out a physical activity readiness questionnaire (PAR-Q; see Appendix B). After completing the PAR-Q, they were asked to perform a sit-and-reach test (see appendix C). Next, participants were given brief information about the study and the opportunity to ask questions. They were all told that the experimental task was to learn to row as well as possible on a dynamic indoor rower, focusing primarily on demonstrating correct form. Next, participants were assigned to the SC and YK groups so that an equal number of men and women were in each group. Participants were then asked to perform a pretest consisting of five 30-s trials at an 18 cycles per min pace (i.e., each 30-s pretest trial included about 9 rowing cycles).

Prior to the assessment, participants were reminded that their primary goal was to improve rowing form not to simply pull on the oar handle as hard as possible (a common mistake).

Figure 3 outlines the experimental protocol.

Day 1	Day 2	Day 3
Instruction / Assessment ○ Introduction to study ○ Informed consent ○ PAR-Q ○ Warm up ○ Flexibility measures ○ Pretest 30 s (90-120 s rest) × 5 at an 18 stroke per min pace 5 min break Practice Session 1 ○ Watch model ○ 15 trials 30 s (90-120 s rest) × 15 at an 18 stroke per min pace	Practice Session 2 ○ 15 trials 30 s (90-120 s rest) × 15 at an 18 stroke per min pace ○ Post-practice interview	Assessment of Learning ○ Retention test 30 s (90-120 s rest) × 5 at an 18 stroke per min pace ○ Transfer test 30 s (90-120 s rest) × 5 at a 28 stroke per min pace

Figure 3. *The experimental protocol includes four sessions scheduled over a three day period. For the Pretest and Retention test, participants completed approximately 45 total cycles each (9 cycles/trial x 5 trials = 45 cycles). For Acquisition, participants completed about 270 cycles (9 cycles/trial x 15 trials = 135 trials in each practice session). For the Transfer test, participants completed approximately 70 cycles (14 cycles/trial x 5 trials = 70 cycles).*

Following the pretest and a 5 min break, the acquisition phase with Practice Sessions 1 and 2 started. For Practice Session 1, all participants watched a video recording of a highly skilled rower on a dynamic indoor rower. The video recording displayed 36 rowing cycles at an 18 cycles per min pace occurring at the span of 120 seconds. During the video, the researcher identified and described critical features of the rowing cycle related to the participants' goal of attaining correct rowing technique, focusing specifically on the catch, the power phase, the finish, and the recovery phase (e.g., Elliott, Lyttle, & Birkett, 2002) (Figure 4 illustrates the rowing cycle):

The Catch: The catch is a momentary event that indicates the end of the recovery phase and the beginning of the power phase. Knees are flexed with shins vertical and the balls of feet in full contact with the footplate. The trunk is pivot slightly forward (i.e., shoulders in front of hips), shoulders relaxed, and elbows fully extended.

The Power Phase: The power phase consists of a press-pry-pull sequence in which legs-back-arms move in a series of overlapping movements. The phase begins with knee extension to push the footplate away from the seat. As the participant approaches full knee extension, extension of the hip begins. The final movement is pulling of the handle to the solar plexus.

The Finish: The finish is a momentary position that indicates the end of the power phase and the beginning of the recovery phase. Knees are fully extended and the participant's trunk reclined approximately 30 degrees past perpendicular. Elbows are flexed to where the handle is positioned at the solar plexus.

Recovery Phase: The recovery phase consists of an arms-back-legs movement (i.e., reverse of the power phase sequence) in a series of overlapping movements. The phase begins with elbow extension followed by hip flexion to move the handle passed the knees. Once the handle clears the knees, flexion of the knee begins to bring the footplate to the seat and shins to vertical.

In order to successfully perform the experimental task of this study, participants were asked to focus on (1) positioning their shins vertical at the catch, (2) maintaining extended elbows until knees were fully extended and handle aligned with kneecaps during the power phase, (3) reclining trunk to 30 degrees past perpendicular at the finish, and (4) maintaining extended knees until elbows were fully extended and handle aligned with kneecaps during the recovery phase.

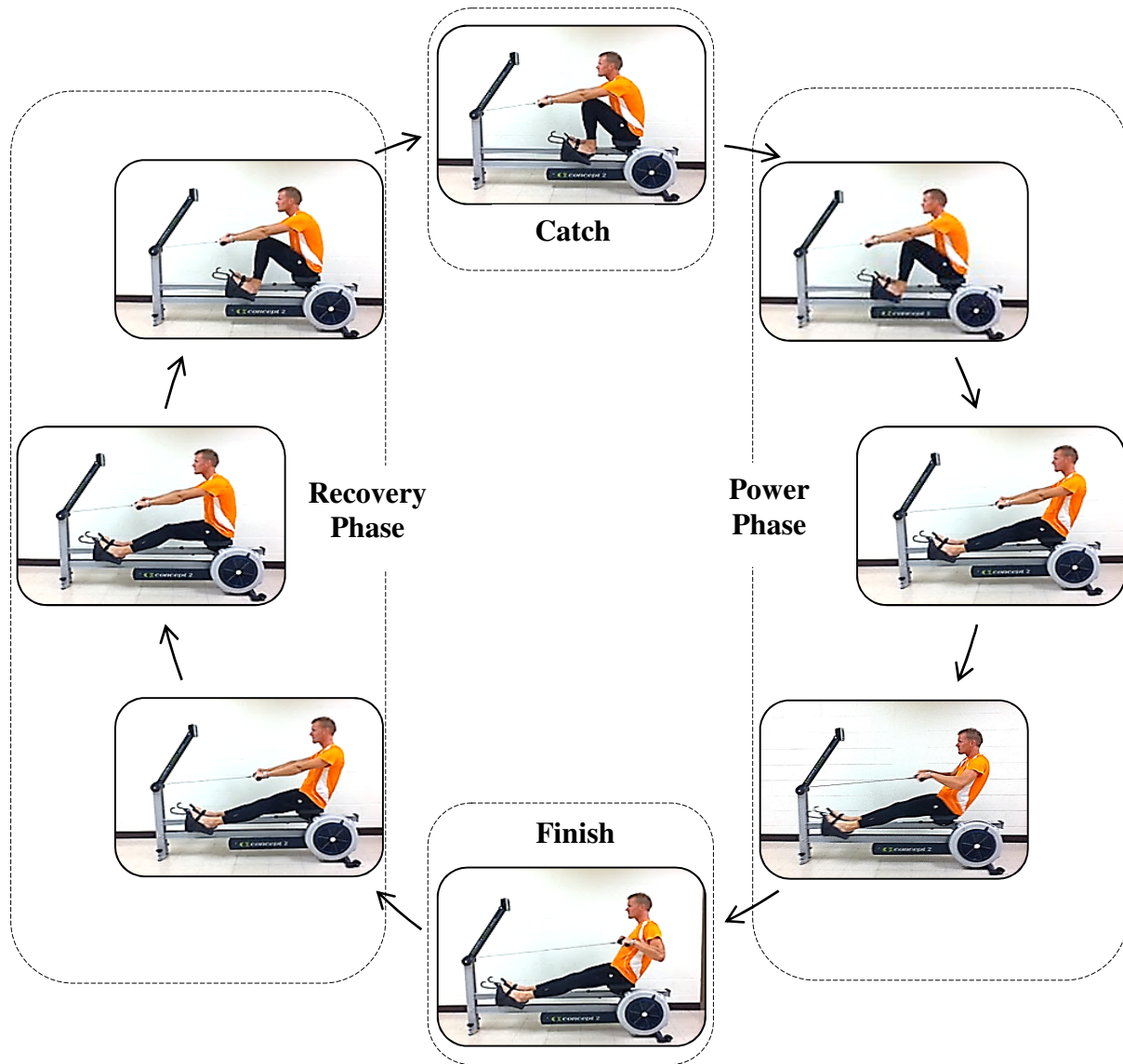


Figure 4. The rowing cycle is divided into the power phase and the recovery phase. While the power phase involves accelerating the handle in a straight line using a legs-back-arms movement in a slightly overlapping sequence, the recovery phase involves an arms-back-legs movement bringing the handle back to a new catch position. Critical features include vertical shin position at the catch, extension of elbows and knees as the handle passes over the knees during both the power and recovery phases, and a 30 degree recline of the upper body (past perpendicular) at the finish.

Throughout the acquisition phase, participants in the SC Group were given control over the provision of terminal feedback about their rowing form, while participants in the YK Group received feedback according to the schedule created by their self-control counterpart. KP addressed one of four different critical features of the rowing cycle: (1) Angle of shins at catch, (2) elbow and knee extension as the handle passed over the knees during power phase, (3) angle of upper body at finish, and (4) elbow and knee extension when handle passed over the knees during recovery phase. In order to provide accurate feedback, the researcher had access to instant video replays of participants' rowing performance for each trial. KP was based on whether participants accurately performed selected critical features during the middle three rowing cycles of the 30-s trials. Participants were awarded 0-1 pt each for the Catch and Finish and 0-2 pt each for the Power Phase and Recovery Phase. KP was verbalized as follows:

(1) Position of shins at catch

- The position of your shins is ([1] too short, [2] good, or [3] over)

(2) Power Phase

- When the oar handle passes over your knees, your ([1] arms and knees are both straight, [2] arms are straight but your knees are bent, [3] arms are bent but your knees are straight, or [4] arms and knees are both bent)

(3) Position of upper body at finish.

- The position of your upper body is ([1] too high, [2] good, or [3] too low)

(4) Recovery Phase

- When the oar handle passes over your knees, your ([1] arms and knees are both straight, [2] arms are straight but your knees are bent, [3] arms are bent but your knees are straight, or [4] arms and knees are both bent)

Throughout acquisition participants were able to view a diagram that depicts the four critical features of the rowing cycle. The diagram provided a visual representation of proper technical form to anchor verbalized KP statements. Similar to the verbalized feedback, the diagram (see Figure 5) highlighted the critical features of the rowing cycle: (1) Shin angle from vertical at the catch, (2) arm and leg extension as handle passed over knees during the power phase, (3) upper body angle from optimal angle (i.e., 30 degree past perpendicular) at the finish, and (4) arm and leg extension as handle passed over knees during the recovery phase.

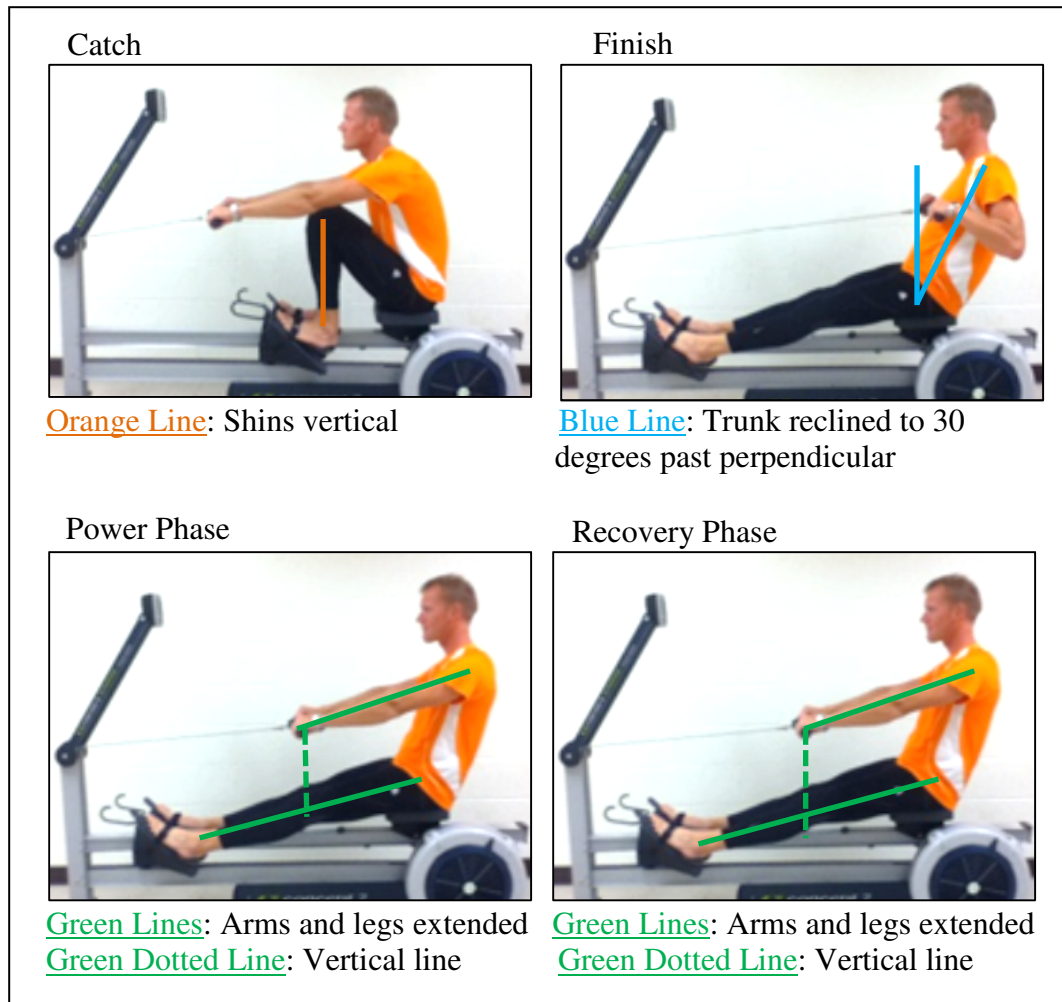


Figure 5. *Diagram illustrating the four critical features of rowing technique related to the verbalized KP. Diagram was viewable throughout acquisition.*

Both practice sessions included 15 30-s trials at an 18 cycles per minute pace (i.e., each 30-s acquisition trial included about 9 rowing cycles). Between trials, participants rested for 90 - 120 s during which they also received feedback if requested (SC group) or scheduled (YK group). The inter-trial interval lasted 90 - 120 s regardless of whether feedback was administered. Following the acquisition phase, all participants completed a post-training interview about their

experience receiving KP while learning proper rowing form. The interview guide is outlined in Appendix D.

On Day 3, approximately 24 h following acquisition, participants' rowing form was assessed using retention and transfer tests. The retention test required participants to complete five 30-s trials at an 18 cycles per minute pace (i.e., each 30-s retention trial included about 9 rowing cycles). The transfer test included five 30-s trials at a 28 cycles per minute pace (i.e., each 30-s transfer trial included about 14 rowing cycles). No KP was provided for retention and transfer tests.

Data treatment and Analysis

The primary dependent variable was form score (based on observer ratings of the angle of shins at the Catch, angle of trunk at the Finish, and extent of knee and elbow extension when the handle passed over the knees during the Power Phase and Recovery Phase. Form score for each trial was obtained by analyzing video segments representing the middle three strokes for each 30-s trial during pretest, acquisition, retention, and transfer. The maximum form score for a trial was 6 points. Form score was based on the following criteria:

Position of shins at the Catch

1 point - good

0 point – too short

0 point – over

Arm and leg extension as handle passed over knees during the Power Phase

2 points – arms and knees were both straight

1 point – arms were straight but knees were bent

1 point – arms were bent but knees were straight

0 point - arms and knees were both bent

Position of upper body at the Finish

1 point - good

0 point – too low

0 point – too high

Arm and leg extension as handle passed over knees during the Recovery Phase

2 points – arms and knees were both straight

1 point – arms were straight but knees were bent

1 point – arms were bent but knees were straight

0 point - arms and knees were both bent

All video segments were digitally captured to a computer and analyzed using Silicon Coach Pro software. Form score for each video segment was rated by a research assistant who was naïve to the purpose of the study. The rater examined the middle three out of five trials during the pretest, retention, and transfer, and all 30 trials during acquisition. For each scored trial, the rater looked at the middle three cycles and awarded scores based on participants' predominant performance for each critical feature. For example, if a participant's position of shins at catch was good for two or three cycles out of the examined three cycles, one point was awarded. Similarly, if a participant's position of upper body at finish was too low or too high for two or three cycles, 0 point was awarded. The rater viewed video clips in random order and was unaware of experimental condition and phase. For each trial, awarded points for each critical feature were summed to create a single overall score, ranging 0 to 6 points. To check for rating reliability, the principal researcher randomly selected 50% of the participants and rated 20% of their trials during the pretest, retention, and transfer (i.e., 12 trials for each phase) and acquisition

(i.e., 72 trials total). Spearman's Rho was calculated to examine the relationship between the research assistant and principal researcher's ratings for the different phases. Results showed a strong linear relationship with a correlation coefficient of 1.00 for the pretest, .98 for acquisition, 1.00 for retention, and .93 for transfer.

Distance and heart rate were also recorded as dependent variables. These data were captured from the dynamic indoor rower's PM4 monitor and downloaded to a PC computer. In addition, participants' responses to the post-training interview were tabulated for the two experimental groups. For the Likert-scale items, paired t-tests were used to compare (1) SC participants' response to the frequency that they asked for KP after *good* and *bad* trials, (2) SC participants' response to the frequency that they asked for KP for *error correction* and to *confirm success*, and (3) YK participants' response to the frequency that they would have preferred to receive feedback after *good* and *bad* trials. A Bonferroni correction was used to protect against error inflation. The corrected alpha value was .017. Participants' responses to follow-up questions (i.e., in the Likert sections) and open-ended questions were audio recorded and transcribed (see Appendix G for transcripts). Responses describing participants' strategies, goals, thoughts about feedback, and other important topics were reviewed and categorized into themes. SC participants' feedback request behaviors were observed throughout acquisition and tabulated.

Form score for pretest, retention, and transfer were averaged into one block each using the mean score of the middle 3 trials. For acquisition, 10 blocks were calculated using each set of 3 consecutive trials (i.e., 1-3, 4-6, etc.). Blocks for distance and heart rate were calculated using the same procedure. Distance, form score, and heart rate were analyzed using multivariate analyses of variance (MANOVA) comparing the SC group and YK group. Each experimental

phase was analyzed separately. Overall means were used for the acquisition analysis. When the MANOVAs revealed significant differences, further analyses were conducted using separate analyses of variance (ANOVA). For acquisition, form scores were analyzed using a 2 (Group) $\times$ 2 (Session) $\times$ 5 (Block) ANOVA with repeated measures on the last two factors. Post hoc procedures focused on Group $\times$ Session interaction between the SC group and YK group. When appropriate, F -ratios for repeated measures factors were reported with the Greenhouse-Geisser (GG) df adjustment. For retention, form scores and heart rate were analyzed using separate univariate ANOVAs comparing the SC and YK groups. Partial eta-squared values (η^2) were reported to indicate effect sizes for significant results. Follow-up testing was conducted using Sidak *post hoc* procedures to compare the SC and YK groups. For all statistical analyses, alpha was set as .05.

CHAPTER 4

Results

Results presented in this chapter include (1) feedback request patterns, (2) performance data (i.e., distance, form score, and heart rate), and (3) post-practice interview responses. As defined by inclusion and exclusion criteria, participants were between 18 and 30 years of age ($M_{\text{age}} = 19.25$ years) and naïve to the purpose of the study. They were all physically fit to participate in this study (PAR-Q). Moreover, all participants recorded a BMI lower than 30 ($M_{\text{BMI}} = 23.30$, $SD = 3.33$) and no less than *fair* flexibility for the sit-and-reach test (Male $M_{\text{Sit-and-Reach}} = 34.81$, $SD = 5.88$, *fair flexibility* > 25; Female $M_{\text{Sit-and-Reach}} = 41.38$, $SD = 6.49$, *fair flexibility* > 28). Two male participants were excluded from the study due to high BMI and *poor* flexibility, and two female participants were excluded due to *poor* flexibility. While some participants recorded inconsistent rowing pace during the pretest, all participants matched target pace for acquisition and retention (i.e., 18 strokes per min), and transfer (i.e., 28 strokes per min). Participants' mean pace was 20.39 strokes per min ($SD = 3.13$) for pretest, 18.35 strokes per min ($SD = 1.84$) for acquisition, 18.94 strokes per min ($SD = 1.09$) for retention, and 26.81 strokes per min ($SD = 1.93$) for transfer.

Feedback Request Observations

Figure 6 shows the SC group's KP and No-KP request pattern during acquisition. Overall, the SC group requested KP for 291 out of the total 360 acquisition trials. KP requests decreased across blocks for both practice sessions. KP requests for each of the four critical features (i.e., Catch, Power Phase, Finish, and Recovery Phase) revealed that SC participants requested KP for the Power Phase and the Recovery Phase more frequently than for the Catch and the Finish. Additionally, the SC group's KP requests for the Power Phase and the Recovery

Phase increased throughout acquisition, while those for the Catch and the Finish decreased. SC participants' full feedback request pattern can be found in Appendix E (see Table 7).

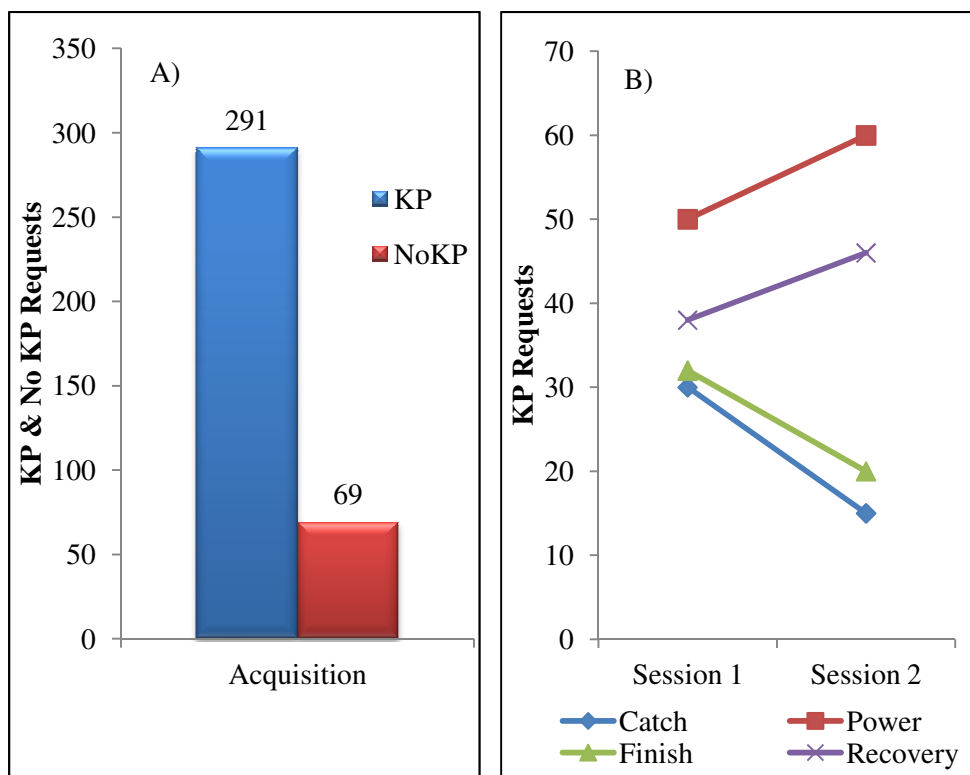


Figure 6. The left panel (A) shows the SC group's total number of KP and No-KP requests during acquisition. The right panel (B) shows the SC group's total number of KP requests for each of the four critical features (i.e., Catch, Power Phase, Finish, and Recovery Phase) during the two practice sessions.

Performance Data

Pretest. There was no observable difference between the SC group and YK group for distance, form scores, and heart rate during the pretest. Mean form score and mean heart rate are

illustrated in Figures 7 and 8. Mean distance was 56 m for the SC group and 55 m for the YK group. Accordingly, the MANOVA revealed no statistically significant differences, $\Lambda_{\text{Wilks}} = .985$, $F(3, 20) = .099$, $p = .960$. No further statistical analyses were conducted.

Acquisition. Figure 7 and Figure 8 show mean form scores and mean heart rate for the SC group and YK group during acquisition, respectively. Average distance over the ten acquisition blocks was 68 m (SD = 1.68) for the SC group and 71 m (SD = 2.83) for the YK group. The MANOVA revealed a statistically significant difference, $\Lambda_{\text{Wilks}} = .541$, $F(3, 20) = 5.655$, $p = .006$, partial $\eta^2 = .459$, for form score ($p = .002$, $\eta^2 = .348$). Comparisons for distance ($p = .444$) and heart rate ($p = .135$) were not statistically significant. Form scores were further analyzed using a 2 (Group) $\times$ 2 (Session) $\times$ 5 (Block) ANOVA with repeated measures on the last two factors. Results indicated significant main effects for session, $F(1, 22) = 83.828$, $p < .000$, $\eta^2 = .792$, and block, $F(4, 88) = 38.595$, $p < .000$, $\eta^2 = .637$. Additionally, the Group $\times$ Session interaction, $F(1, 22) = 5.644$, $p = .027$, $\eta^2 = .204$, and the Session $\times$ Block interaction, $F(4, 88) = 4.231$, $p = .009$, $\eta^2 = .161$, were significant. There were no significant results detected for the Group $\times$ Block interaction ($p = .270$) or the Group $\times$ Session $\times$ Block interaction ($p = .551$). Post hoc procedures following the significant Group $\times$ Session interaction showed that the SC group received a higher mean form score than the YK group during both practice sessions. This difference was significant for Session 2 ($p = .001$), but only approached significance for Session 1 ($p = .054$).

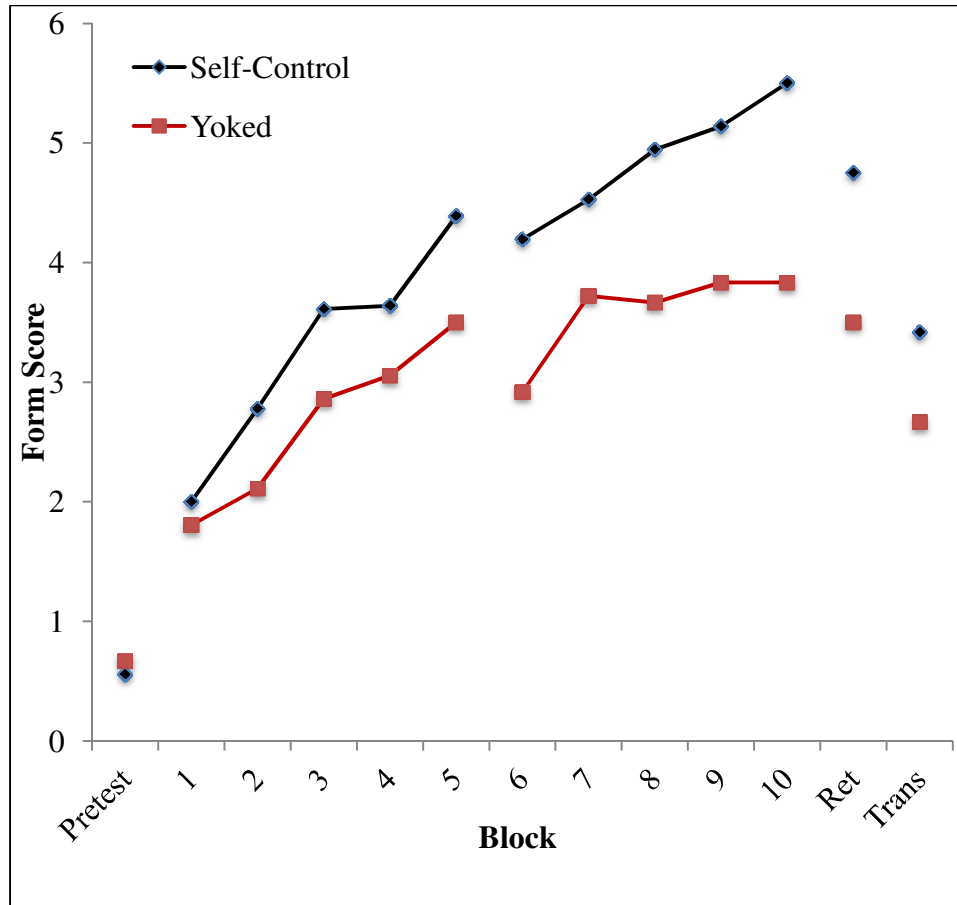


Figure 7. Mean form scores for Self-Control and Yoked groups during the pretest, acquisition blocks (1 – 10), retention (Ret), and transfer (Trans).

Retention. Figures 7 and 8 show mean form scores and mean heart rate for the SC and YK groups during retention, respectively. Mean distance was 65 m for the SC group and 76 m for the YK group. The MANOVA revealed significant differences, $\Lambda_{\text{Wilks}} = .465$, $F(3, 20)$, $p = .001$, $\eta^2 = .535$, for form score ($p = .001$, $\eta^2 = .388$) and heart rate ($p = .004$, $\eta^2 = .321$). No significant difference was detected for distance ($p = .092$). form score and heart rate were further analyzed using separate univariate ANOVAs. These analyses indicated that the SC group

received a significantly higher form score, $F(1, 22) = 13.931, p = .001, \eta^2 = .388$, and significantly lower heart rate, $F(1, 22) = 10.386, p = .004, \eta^2 = .321$, than the YK group.

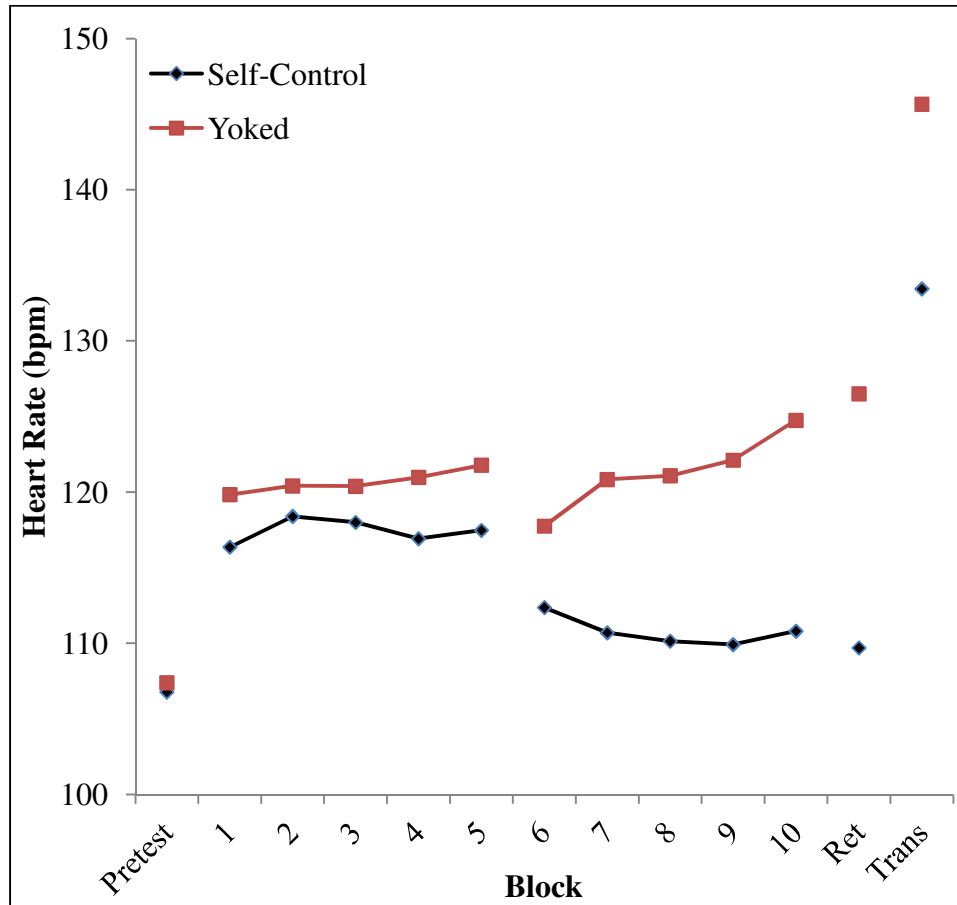


Figure 8. *Mean heart rate (bpm) for the Self-Control and Yoked groups during the pretest, acquisition blocks (1 – 10), retention (Ret), and transfer (Trans).*

Transfer. Figures 7 and 8 show mean form scores and mean heart rate for the SC and YK groups during transfer, respectively. Mean distance was 93 m for the SC group and 98 m for the YK group. The MANOVA was not significant, $\Lambda_{\text{Wilks}} = .771$, $F(3, 20) = 1.982$, $p = .149$, partial $\eta^2 = .229$. No further analyses were conducted.

Post-practice Interviews

Likert-scale questions. Mean scores for SC participants' responses to the Likert-scale items are reported in Table 6. SC participants asked for KP *occasionally* to *often* after good trials and *often* to *always* after bad trials. After the Bonferroni adjustment ($\alpha = .017$), the paired t -test indicated that these two ratings were not significantly different, $t(11) = .026$. SC participants also reported that they used requested feedback *often* to *always* for error correction and *occasionally* to *often* to confirm success. The paired t -test for this comparison was also not significant, $t(11) = .020$. YK participants indicated that they received feedback *often* when they needed it. They also reported that they would have preferred to receive feedback *occasionally* to *often* after good trials and *often* to *always* after bad trials. The paired t -test revealed that the mean score of these responses differed significantly, $t(11) = .007$.

Table 1. *Mean scores for the post-practice interview Likert-scale items.*

Condition	Question	M	SD
Self-Control	How often did you ask for feedback about your technique when you thought your rowing form was relatively <i>good</i> ?	3.50	1.09
	How often did you ask for feedback about your technique when you thought your rowing form was relatively <i>bad</i> ?	4.42	0.79
	How often did you use the feedback you requested for <i>error correction</i> ?	4.58	0.51
	How often did you use the feedback you requested to <i>confirm success</i> ?	3.50	1.38
	How often did you use the feedback you requested for <i>other purposes</i> ?	1.33	0.65
	How often did you receive feedback about your rowing form when you needed it?	3.92	0.79
Yoked	How often would you have preferred to receive feedback about your technique when you thought your rowing form was relatively <i>good</i> ?	3.67	1.07
	How often would you have preferred to receive feedback about your technique when you thought your rowing form was relatively <i>bad</i> ?	4.67	0.49

Note: 1 = never, 2 = seldom, 3 = occasionally, 4 = often, 5 = always.

Follow-up questions. Participants' complete responses to follow-up questions after Likert-scale items are presented in Appendix G (see Table 7). The SC participants shared thoughts on requesting KP when rowing form was presumed to be relatively good (e.g., "I wanted to know if my form was good. To reinforce what I thought was correct form"), and when

form was presumed to be relatively bad (e.g., “I wanted to know specifically what I did wrong at that trial. I guess I used the feedback to improve my form”). The YK participants also shared thoughts on receiving KP when rowing form was presumed to be relatively good (e.g., “I mean, feedback telling me I am doing something right will ultimately imprint the correct movement in my ‘muscle memory’”) and relatively bad (e.g., “I think I would prefer coaches to always provide corrective feedback and every so often throw in comments about what I am doing right. I want to know what I am doing wrong every trial because I want to improve every trial”). Table 2 presents the number of participants who indicated each of the different identified purposes for requesting KP as revealed in the follow-up questions after the Likert-scale items.

Table 2. *Number of participants indicating different purposes for requesting KP in responses to follow-up questions after Likert-scale items.*

Condition	Follow-up Item	Summary	Count
Self-Control	Rowing form presumed relatively good	<i>Confirm good rowing form</i>	11
		<i>Boost confidence</i>	1
		<i>No need to request KP</i>	3
	Rowing form presumed relatively bad	<i>Improve rowing form</i>	12
		<i>No need to request KP</i>	3
	Other purposes	<i>Check for consistency</i>	2
Yoked	Rowing form presumed relatively good	<i>Confirm good rowing form</i>	9
		<i>Boost confidence</i>	1
		<i>No need for KP</i>	4
	Rowing form presumed relatively bad	<i>Improve rowing form</i>	12

Note: Count indicates the number of participants who spoke about listed accounts for each follow-up question. For some follow-up questions participants spoke about more than one account. Only two participants mentioned that they requested KP for other purposes.

Open-ended questions. Table 3 lists the major themes identified in participants' responses to the open-ended questions (see Appendix G for transcripts of participants' full responses). Open-ended questions covered strategies and goals used and/or developed by the SC and YK groups during acquisition. Participants also discussed the quality of presented KP. The predominant strategy used or developed by the SC group was to *approach rowing cycle step-by-step*, while the YK group used available KP to *identify technical errors and correct them*. As for goals, both experimental groups prioritized *improve rowing form*. Finally, both groups thought the verbalized *feedback was good*. Lastly, participants were asked to contemplate whether there was anything else important they wanted to add. In general, participants had nothing substantial to declare in response to this inquiry.

Table 3. Number of participant responses to open-ended questions categorized according to identified themes.

Condition	Interview topic	Theme	Count
Self-Control	Strategies	<i>Approach rowing cycle step-by-step</i>	9
		<i>Identify technical errors and correct them</i>	4
		<i>Try to "feel" the stroke</i>	4
		<i>Mimic mental image of correct rowing form</i>	3
		<i>Use feedback as checklist/reminder</i>	3
	Goals	<i>Improve rowing form</i>	12
		<i>Maintain 18 strokes per min pace</i>	3
		<i>Try not to make a foul of self</i>	1
	Feedback quality	<i>Feedback was good</i>	12
		<i>Feedback was limited</i>	3
Yoked	Strategies	<i>Identify technical errors and correct them</i>	8
		<i>Approach rowing stroke step-by-step</i>	6
		<i>Try to "feel" the stroke</i>	3
	Goals	<i>Improve rowing form</i>	12
		<i>Maintain 18 strokes per min pace</i>	5
		<i>Try not to mess up</i>	1
	Feedback quality	<i>Feedback was good</i>	10
		<i>Feedback was limited</i>	2
		<i>Feedback was not always helpful</i>	1

Note: Count indicates the number of participants who spoke about listed theme for each open-ended question. For some open-ended questions participants spoke about more than one theme.

CHAPTER 5

DISCUSSION

Motor learning research has indicated that allowing learners to control selected aspect(s) of their practice environment benefits motor skill acquisition (e.g., Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997; Janelle, Kim, & Singer, 1995; Zimmerman, 1989). Although some self-control studies examining relatively simple tasks (e.g., Chiviacowsky & Wulf, 2002) have indicated that self-control learners prefer feedback after successful performances, others examining more complex tasks (e.g., Aiken et al., 2012) have reported no such preference. This discrepancy was explained by Aiken et al. who noted that when presented with information-rich feedback about a complex task, learners might attend to more than one critical feature. At times one feature might be good while another might be bad and so learners' would have difficulty indicating a preference for feedback after only so-called good trials. Laughlin (2012) examined how learners manage control of multiple forms of instructional support by observing self-control behaviors among novices learning a continuous juggling task. His findings indicated that learners' self-control requests for feedback changed as they gained proficiency and that their use of instructional support was also guided by personal preferences. Although Laughlin showed that learner's can effectively manage multiple sources of information when learning a relatively complex task, his study lacked the necessary control group to determine if a self-control benefit was present.

The current study was designed to extend Laughlin's examination of self-control over multiple sources of information by adding a yoked control group. Additionally, the use of KP focused on four different critical features for a complex task provided insight into the dilemma that Aiken et al. (2012) identified with respect to the purported preference for feedback after good trials. The purpose of this study was, therefore, to examine the effects of self-controlled

KP on self-control request behavior and the performance and learning of proper technical form for rowing on a dynamic indoor rower.

Summary of Procedures

Upon arriving in the laboratory on Day 1, participants were asked to complete an informed consent form (Appendix A) indicating their voluntary participation in the study. Next, they were asked to fill out a Physical Activity Readiness Questionnaire (PAR-Q; Appendix B). The PAR-Q assessed whether volunteering participants were suited to participate in this study. Next participants completed the sit-and-reach test to determine whether they had at least *fair* lower back and hamstrings flexibility (Appendix C). Participants were told that the experimental task was to learn to row as well as possible on a dynamic indoor rower, focusing primarily on demonstrating correct form. Their initial skill of rowing was assessed in a pretest consisting of five 30-s trials at an 18 cycle per min pace. Their rowing performance was video recorded. Following a 5 minute break, participants watched a video recording of a highly skilled rower on a dynamic indoor rower. During the video, the principal researcher identified and described four critical features of the rowing cycle related to correct technique: (1) the Catch; (2) the Power Phase, (3) the Finish; and (4) the Recovery Phase. Next, participants were assigned to one of two groups: Self-Control (SC group) and Yoked YK group). Participants in the YK Group were matched by gender to their counterpart in the SC Group. SC participants were told that they were allowed to request feedback about their rowing form, while participants in the YK Group received feedback on the schedule created by their Self-Control counterpart. Feedback addressed one of the four instructed critical aspects of the rowing cycle. In order to provide accurate feedback, the researcher had access video replays of the participants' rowing performance for each trial. Next, all participants completed 15 30-s trials at an 18 cycle per min

pace. Between trials, participants rested for 90 - 120 s during which they also received feedback if requested (SC group) or scheduled (YK group).

Upon arriving in the laboratory on Day 2, participants completed 15 more 30-s trials at an 18 cycles per min pace. At the end of Day 2, participants were interviewed about their preferences for feedback and their learning experience (Appendix D). The audio of post-practice interviews were recorded for transcription purposes.

On Day 3, approximately 24 h following acquisition, participants completed tests of retention and transfer. The retention test required participants to complete five 30-s trials at an 18 cycle per min pace, and the transfer test included five additional 30-s trials at a 28 cycle per min pace.

Dependent variables for this study included participants' rowing form score and performance data (i.e., distance and heart rate). In addition, the researcher tabulated the response for the post-practice interview and the SC group's feedback request behaviors.

Summary of Findings

Hypotheses

1. SC group would demonstrate higher form scores during acquisition than the YK group.

This hypothesis was supported. The SC group received a higher mean form score than the YK group during both practice sessions. This difference was significant for Session 2 ($p = .001$), but only approached significance for Session 1 ($p = .054$).

2. SC group would demonstrate higher form scores during retention testing than the YK group.

This hypothesis was supported. The SC group received a significantly higher mean form score than the YK group ($p = .001$).

3. SC group would demonstrate higher form scores during transfer testing than the YK group.

This hypothesis was not supported.

4. SC group would achieve greater distance during acquisition than the YK group.

This hypothesis was not supported.

5. SC group would achieve greater distance during retention testing than the YK group.

This hypothesis was not supported.

6. SC group would achieve greater distance during transfer testing than the YK group.

This hypothesis was not supported.

7. SC group would demonstrate lower heart rate during acquisition than the YK group.

This hypothesis was not supported.

8. SC group would demonstrate lower heart rate during retention testing than the YK group.

This hypothesis was supported. The SC group recorded significantly lower heart rate than YK participants ($p = .004$).

9. SC group would demonstrate lower heart rate during transfer testing than the YK group.

This hypothesis was not supported.

Additional findings:

1. The SC group requested KP for 291 out of the total 360 acquisition trials.

2. The SC group's KP requests decreased across blocks for both practice sessions.
3. SC participants requested KP for the Power Phase and the Recovery Phase more frequently than for the Catch and the Finish. KP requests for the Power Phase and the Recovery Phase increased throughout acquisition while requests for the Catch and the Finish decreased.

Participants' response to the post-practice interview's Likert-scale items:

4. The SC group asked for KP *occasionally* to *often* after so-called good trials and *often* to *always* after so-called bad trials. These two ratings were not significantly different.
5. The SC group used requested feedback *often* to *always* for error correction and *occasionally* to *often* to confirm success. These two ratings were not significantly different.

The YK group reported a preference to receive feedback *occasionally* to *often* after so-called good trials and *often* to *always* after so-called bad trials. These two rating were significantly different, $t(11) = .007$.

Participants' response to the post-practice interview's open-ended questions:

6. The predominant strategy used or developed among SC participants was to *approach rowing cycle step-by-step*, while YK participants used KP to *identify technical errors and correct them*.
7. The predominant goal used or developed for both experimental groups was to *improve rowing form*.
8. Generally, both experimental groups thought the available feedback was good.

Discussion and Conclusions

The present study demonstrated that self-controlled KP benefitted learning of a continuous complex task (i.e., rowing on a dynamic indoor rower) in a protocol that presented learners with KP about multiple critical features. These findings were evidenced by the SC group's higher form scores during acquisition and retention, and lower heart rate in retention. Results were consistent with previous literature that has shown a robust SC effect. Importantly, however, this study also presented potentially conflicting information with respect to whether a trial might be considered *good* or *bad*. Aiken et al. (2012) argued that SC over information-rich video KP for a task involving multiple critical features allowed learners to attend to more than a single aspect of instructional support about their performance. By replacing video KP with more structured verbal KP about specific critical features, this study showed a unique feedback request pattern among its SC participants. By asking SC participants about their reasoning for requesting feedback, this study also presented goals and strategies used when given control over information-rich KP support about multiple features of a complex task. Participants' feedback request behavior, such as frequencies for critical features and participants' reasons for using KP, is discussed further in subsequent paragraphs. Moreover, this study extended Laughlin's (2012) examination of how SC participants can effectively manage multiple forms of instructional assistance by showing a learning benefit compared to a yoked control condition.

Overall, SC participants requested KP for 291 trials out of 360 acquisition trials (i.e., 81% request frequency). Compared to other SC studies, KP request frequency was relatively high (Aiken et al., 2012; Chiviowski & Wulf, 2002; Janelle et al., 1997; Laughlin, 2012). Similar to previous studies, however, was the trend for decreasing frequency of KP requests as participants progressed through acquisition: 35 KP requests during Block 1 to 26 KP requests

during Block 10. A closer look at the SC group's KP requests for the four critical features revealed that they initially asked for KP for the Power Phase and the Recovery Phase more frequently than for the Catch and the Finish. Moreover, the SC group's KP requests for these phases increased throughout acquisition while requests for the Catch and the Finish decreased. This suggests that participants used the autonomy afforded by the self-control provision to strategically tailor KP to fit their needs and preferences. Following the instruction to *improve rowing form* and consistent with reported strategies related to approaching the rowing cycle in a step-by-step manner, SC participants achieved proper technical form for the Catch and the Finish relatively early. In contrast, learning the coordinated sequence of movements in the Power and the Recovery Phases proved to be more challenging. This learning pattern is evident when examining the SC group's mean form scores. The SC group's mean form score during the pretest was low (.56 pt out of 6 pt), but it increased substantially during blocks 1, 2, and 3 (3.61 pt out of 6 pt for Block 3). Form score for the subsequent seven blocks (i.e., Block 4 through Block 10) increased more gradually. This explanation fits well with arguments that SC benefits are related to the capability to tailor the practice experience (Chiviacowski & Wulf, 2002; Janelle et al., 1995; 1997). It has also been argued that providing learners' autonomy over their learning environment prompts deeper information processing, increased motivation, and the use of more effective learning strategies. The current results related to patterns of KP requests in conjunction with the interview responses are consistent with these views.

SC participants' responses to the post-practice interview revealed findings that were consistent with their observed KP request behavior throughout acquisition. The SC group reported no preference for KP following so-called *good* trials or *bad* trials. Further, SC participants reported no preference for using requested KP for error correction or to confirm

successful performance. Interestingly, YK participants reported a significant preference for receiving feedback after so-call *bad* trials rather than so-called *good* trials. Chiviacowsky and Wulf (2002) reported that 67% of participants indicated that they requested feedback mainly after good trials and that no participants reported do doing so after *bad* trials. Aiken et al. (2012) found that their SC participants asked for feedback occasionally after both *good* and *poor* trials. The discrepancy between these findings might be explained by the design of the studies' questionnaires. While Chiviacowsky and Wulf's questionnaire items included dichotomous forced choice response options (e.g., *mostly after you thought you had a good trial* or *mostly after you thought you had a poor trial* [p. 410]), Aiken et al. used a Likert-scale ranging from *rarely* to *frequently* to assess the frequency that participants requested feedback after both *good* and *bad* trials. Aiken et al.'s design allowed participants to report feedback request purposes that could overlap and, therefore, show whether requested feedback had more than one purpose. The results of the current study were consistent with Aiken et al.'s and thus point to the possibility that learners actually do not have a preference for feedback after one type of trial or another, but instead use feedback for a variety of purposes.

To gain a deeper understanding of SC and YK participants' response to Likert-scale items open-ended follow-up questions were asked. Participants revealed that they initially were unfamiliar with the experimental task and, therefore, unable to tell the difference between *good* and *bad trials*. Once the participants had a better understanding of desired movement patterns, they shared several accounts elaborating their response to Likert-scale items. For example, one participant said, "I think I would prefer coaches to always provide corrective feedback and every so often throw in comments about what I am doing right. I want to know what I am doing wrong every trial because I want to improve every trial." Another participant stated, "I wanted to know

if my form was good. To reinforce what I thought was correct form.” A third participant said, “I asked for feedback to perfect my rowing form. I do not know what else I could have used the feedback for. I guess towards the end I alternated feedback for the power phase with feedback for the recovery phase. I did that to make sure my form stayed consistent.” Overall, SC participants’ response to follow-up questions goes hand in hand with their feedback request pattern during acquisition. In other words, SC participants in this study preferred KP following both *good* and *bad* trials and also to *confirm success* and *correct errors*. Observed KP request behavior and response to follow-up questions also showed that participants attended to more than a single KP statement during learning (e.g., one participant said: “If I thought I was bad at one phase I would ask for feedback about it. For example, today (Practice Session 2) I asked for feedback on the Power Phase and the Recovery Phase because I felt I was lacking skill for both”). These shared accounts offered new insight that helped extend both Aiken et al.’s and Laughlin’s (2012) research. It is apparent that participants in this study attended to multiple forms of KP while learning a complex task involving multiple critical features.

Another finding that warrants discussion was participants’ response to open-ended questions about goals, strategies, and the quality of feedback. Participants reported that they used and/or developed strategies and goals to meet the demands of the experimental task. For example, a common strategic approach for the SC group was to learn the rowing stroke *step-by-step* (i.e., learn one phase of the rowing cycle before moving on to the following phase). The strategy most common among YK participants was to use received KP to *identify technical errors and correct them*. In addition, participant in both experimental conditions shared strategies and goals that targeted personal needs and preferences. For instance, participants mentioned that they went about improving their rowing from by “feeling the stroke” and

“mimicking mental images of correct rowing form.” Further, participants in both experimental conditions reported goals that arguably would not help improve performance (e.g., “Try not to mess up or make a foul of self”). Taken together, participants performance, KP request patterns, and response to the post-practice interview provide a complex picture of how learners use SC and how this SC benefits learning. Themes discussed in open-ended questions suggest that SC participants might have incorporated more effective learning strategies and goal setting than YK participants (e.g., Janelle et al. 1995; 1997). For example, the SC group used to a greater extent a *step-by-step* approach and also *imagery* and *kinesthetic* (i.e., *feel*) as part of their learning. In contrast, YK participants reported that they to a greater extent focused on *identifying technical errors and correcting them* and also *maintaining 18 strokes per min pace*. This data suggest that the autonomy afforded SC participants spurred a more creative approach for learning proper rowing form, while YK participants attempted to control what they had control over, such as maintaining targeted pace. Presumably, these differences in cognitive approach might have led to both superior form scores for the SC group, but also a more efficient power application as evidenced by the lower heart rate (i.e., SC heart rate < YK heart rate) while rowing a similar distance during retention. A reasonable explanation for SC participants’ lower heart rate during retention could be that the group’s greater rowing form allowed for better coordination and muscular force during the Power Phase. Assuming that the conditions for both groups were exactly the same, it would be reasonable to argue that better form score would translate to greater distance and lower heart rate would translate to shorter distance. An alternative and yet unexplored explanation for the experimental groups’ reported distance and heart rate during retention could be a dissimilar attentional focus and/or practice experience, such as perceived level of anxiety. In other words, instead of insufficient power output during retention, the YK

group's elevated heart rate could have been due to anxiety. This idea seems justified based on participants' concern about "messing up or making a foul of self." Yet another explanation could be that the YK condition in this study caused a deficit in learning compared to the SC condition. This concern is relevant when considering the restricted autonomy provided to the YK group. However, it is important to recognize that adapted SC and YK conditions exist in real-world settings, such as coach-directed practice for an eight-oared rowboat. While coaching eight rowers in a rowboat it is common that the coach select one or two critical features to focus on during practice. This coach-directed selection of critical features might be susceptible to be mismatched to individual rowers' needs and preferences: While some rowers would be content with their coach's selection, other rowers might have preferred to work on different features of the rowing cycle.

Taken together, this study complemented previous research by resolving the dilemma noted among learners with SC over information-rich KP while learning a complex skill (Aiken et al.) and also by extending Laughlin's (2012) work on learners' feedback request behavior when afforded SC over multiple forms of instructional assistance. The inclusion of an YK group extended Laughlin's design to test whether or not a self-control benefit would be seen in a protocol where SC participants were given control over a relatively high information-management burden. Results revealed that SC participants achieved significantly higher mean form scores during acquisition and retention, and also significantly lower heart rate during retention compared to the YK group. Further, participants' response to the post-practice interview showed that the SC group's requests for KP followed both good and bad trials, and were used for both error correction and confirmation of success. These findings suggest that self-control of KP for multiple critical features benefits learning of a complex task. The pattern

of KP requests indicated that participants generally focused on the easier critical features early in practice. Moreover, participants used KP more for correction early, but increased its use for success confirmation as they gained proficiency.

Recommendations for Future Research

Recommendations for future research are based on observations for this study.

1. In addition to the SC and YK conditions, the inclusion of a coach-directed condition would allow researchers to evaluate whether allowing learners self-controlled feedback holds up against directed feedback from an expert coach.
2. Motor learning research incorporating power generation as a component to self-controlled learning of real-world tasks could be useful to applied coaching. For example, in addition to proper rowing form, it is vital that rowers accelerate the oar handle throughout the Power Phase. For dynamic indoor rowers, this feature can be assessed using the PM4 monitor's *force curve*.
3. The dilemma noted by Aiken et al. (2012) ought to be further explored by means of more in-depth post-practice interviews. Likert-scale items and open-ended questions addressing SC participants' attentional focus and self-talk would extend current motor learning literature.
4. Future research ought to explore alternative explanations to the self-control effect. For example, it would be interesting to learn whether SC and YK conditions might cause experiences, anxiety, and/or attentional focus that are not taken into account.

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APPENDICES

Appendix A

Informed Consent Statement

Informed Consent Statement

An experiment to examine learning a complex skill

You are invited to participate in a research study. The purpose of this study is to investigate how individuals learn a new motor skill. For this study, you will be learning how to row on a Concept 2 dynamic indoor rower. During the study, you will participate in 1 initial assessment and instruction session, 2 separate practice sessions, and 1 testing session over a 3-day period. Each session will last approximately 30-40 minutes. On Day 1, you will complete two sessions. Session 1 will introduce you to the skill of rowing and assess the flexibility in your lower back, hip, knee, and ankle joints. Session 2 will be your first practice session to improve your rowing technique. On Day 2, you will complete your second and last practice session (Session 3). At the end of Session 3 you will be tested to determine your progress in learning to row. Your rowing performances will be video-recorded and stored on a computer for later analysis.

Following Session 3, you will be interviewed briefly (about 5-10 minutes) about your experience of learning to row. Your answers will be audio-recorded for later analysis. On Day 3, you will complete a testing session (Session 4) to assess your learning. Session 4 will consist of two separate tests with a 10 minute break between them. Throughout the study, whenever asked to row, you will be equipped with a heart rate monitor to measure how hard you are working and to ensure that you do not exceed 80% of your maximum heart rate. At the end of Session 4, you will have the opportunity to learn about the research project if you so desire.

If you volunteered for this experiment through the Human Participation in Research (HPR) website in exchange for course credit, your participation will be reported to that website. The experimenter conducting this study is not directly involved in awarding course credit. He simply reports whether or not you participated in the study.

The information in the study records will be kept confidential. Data will be stored securely and will be made available only to persons conducting the study unless you specifically give permission in writing to do otherwise. Once the study is complete, video and audio data will be destroyed. No reference will be made in oral or written reports which could link you to the study.

This study poses minimal risk to participants. If physical injury is suffered in the course of research, the University of Tennessee does not automatically reimburse subjects for medical claims or other compensation. For more information or for answers to other questions about the study, you may contact Bjorn A. Holmberg via the telephone number or email indicated below or his faculty supervisor, Dr. Jeff Fairbrother (865-974-3616; jfairbr1@utk.edu). If you have any questions about your rights as a participant, contact the Research Compliance Services section of the Office of Research at (865) 974-3466.

Initials _____

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed, your data will be returned or destroyed.

I have read the above information and agree to participate in this study. I have received a copy of this form.

Participant's name (please print): _____

Participant's signature: _____ Date: ____/____/____

Investigator's signature: _____ Date: ____/____/____

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Appendix B

Physical Activity Readiness Questionnaire

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
☐	☐	2. Do you feel pain in your chest when you do physical activity?
☐	☐	3. In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
☐	☐	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7. Do you know of <u>any other reason</u> why you should not do physical activity?

If
you
answered

YES to one or more questions

Talk with your doctor by phone or in person **BEFORE** you start becoming much more physically active or **BEFORE** you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- + You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- + Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- + If you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- + If you are or may be pregnant — talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____

DATE _____

SIGNATURE OF PARENT
or GUARDIAN (for participants under the age of majority) _____

WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.



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Appendix C

Sit-and-Reach Test

Sit-and-Reach Test

Protocol for the sit-and-reach flexibility test. This protocol was designed as an instrument to measure lower back and hamstring flexibility (for detailed review see ACSM Guidelines for Exercise Testing and Prescription, 2010). Participant should perform a short warm-up before this test and include some stretches. His/her shoes should be removed. Participant sits with knees fully extended and soles of the feet flat against the sit-and-reach box about 10 centimeters apart. From this position, the participant should slowly reach forward with both hands as far as possible. While the participant maintains stretched position for about two seconds the researcher records the distance of maximum reach to the nearest 0.5 cm (see table below). The best of two trials should be recorded.

Note: The metric ruler's 26 cm mark should be positioned at the foot-line of the 30 cm tall sit-and-reach box. Consequently, participants who reach past their feet will score above 26 cm, while participants who do not reach the foot line will score below 26 cm.



Figure 9. *A person performing the sit-and-reach flexibility test.*

Table 4. *Sit-and-reach flexibility rating scale.*

Adult Men - results in cm	Adult Women - results in cm
Above 39 = Excellent	Above 40 = Excellent
34 to 39 = Very Good	37 to 40 = Very Good
30 to 33 = Good	33 to 36 = Good
25 to 29 = Fair	28 to 32 = Fair
Below 25 = Poor	Below 28 = Poor

Note: Average scores for men and women age 20-30 years old.

Appendix D

Post-Practice Interview Guide

Post-Practice Interview Guide

Self-Control Group

1. How often did you ask for feedback about your technique when you thought your rowing form was relatively *good*?

1	2	3	4	5
Never	Seldom	Occasionally	Often	Always

2. Follow-up: Did you have a specific reason for this choice? If so, please explain.

3. How often did you ask for feedback about your technique when you thought your rowing form was relatively *bad*?

1	2	3	4	5
Never	Seldom	Occasionally	Often	Always

4. Follow-up: Did you have a specific reason for this choice? If so, please explain.

5. How often did you use the feedback you requested for error correction?

1	2	3	4	5
Never	Seldom	Occasionally	Often	Always

6. How often did you use the feedback you requested to confirm success?

1	2	3	4	5
Never	Seldom	Occasionally	Often	Always

7. How often did you use the feedback you requested for other purposes? Please explain.

1	2	3	4	5
Never	Seldom	Occasionally	Often	Always

Yoked Group

1. How often did you receive feedback about your rowing form when you needed it?

1	2	3	4	5
Never	Seldom	Occasionally	Often	Always

2. How often would you have preferred to receive feedback about your technique when you thought your rowing form was relatively *good*?

1	2	3	4	5
Never	Seldom	Occasionally	Often	Always

3. Follow-up: Do you have a specific reason for this choice? If so, please explain.

4. How often would you have preferred to receive feedback about your technique when you thought your rowing form was relatively *bad*?

1	2	3	4	5
Never	Seldom	Occasionally	Often	Always

5. Follow-up: Do you have a specific reason for this choice? If so, please explain.

Self-Control and Yoked Goals

1. Did you use and/or develop any particular strategies while learning how to row? If so, what kind of strategies did you use? Did those strategies change as you practiced?
2. Did you set any particular goals while learning how to row? If so, what were those goals? Did they change as you continued to practice?
3. What do you think about the quality of the feedback that was available to you while you learned?
4. Is there anything else that I have forgotten to ask that you think is important?

Appendix E

Feedback Request

Table 5. SC participants' KP and No-KP request following each trial during acquisition.

ID	501	502	503	504	505	506	507	508	509	510	511	512	
Age	19	19	18	18	19	18	18	19	18	18	19	19	
Gender	M	M	M	M	F	M	M	F	M	M	F	F	
Group	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	
Counterpart	601	602	603	604	605	606	607	608	609	610	611	612	
Practice Session 1 Trial	1	F	F	PP	C	C	C	RP	F	C	C	C	PP
	2	C	PP	PP	C	RP	C	F	RP	C	F	F	PP
	3	No	F	RP	F	RP	C	PP	C	F	PP	F	RP
	4	RP	PP	F	F	PP	PP	F	PP	PP	RP	PP	F
	5	No	C	C	RP	C	PP	No	F	PP	C	PP	C
	6	PP	No	F	PP	F	PP	RP	No	RP	F	RP	PP
	7	No	No	PP	PP	No	PP	C	RP	PP	PP	RP	RP
	8	PP	No	PP	PP	No	PP	No	No	PP	RP	RP	RP
	9	F	PP	PP	RP	RP	F	F	No	F	C	RP	C
	10	C	PP	No	No	C	F	No	RP	F	F	C	RP
	11	PP	RP	RP	RP	No	PP	RP	No	PP	PP	F	PP
	12	No	RP	No	RP	No	C	No	No	PP	RP	F	RP
	13	RP	F	F	C	No	F	No	RP	C	C	PP	PP
	14	PP	C	PP	PP	RP	RP	PP	No	PP	F	PP	RP
	15	C	No	No	F	C	PP	No	No	PP	PP	RP	RP

Note: C = Catch, PP = Power phase, F = Finish, RP = Recovery phase, No = No-KP
Table heading outlines each SC participant's age, gender, and counterpart in the YK group.

Table 5. *Continued.*

ID	501	502	503	504	505	506	507	508	509	510	511	512	
Age	19	19	18	18	19	18	18	19	18	18	19	19	
Gender	M	M	M	M	F	M	M	F	M	M	F	F	
Group	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	
Counterpart	601	602	603	604	605	606	607	608	609	610	611	612	
Practice Session 2 Trial	16	PP	PP	C	C	PP	No	F	RP	PP	C	C	PP
	17	F	RP	F	F	PP	C	PP	PP	PP	F	F	RP
	18	RP	F	F	PP	No	PP	RP	No	PP	PP	PP	RP
	19	No	PP	PP	RP	PP	C	PP	C	RP	PP	RP	PP
	20	C	RP	PP	RP	No	F	No	No	F	RP	RP	RP
	21	PP	No	PP	No	PP	RP	PP	PP	No	PP	C	PP
	22	No	PP	PP	RP	C	F	C	No	RP	RP	F	RP
	23	RP	No	F	No	No	F	PP	No	RP	PP	PP	PP
	24	No	F	PP	No	PP	RP	No	F	RP	RP	PP	RP
	25	PP	No	RP	No	C	RP	No	PP	RP	PP	RP	PP
	26	RP	No	PP	No	PP	PP	PP	No	RP	RP	C	RP
	27	No	PP	PP	No	RP	RP	No	No	RP	PP	C	PP
	28	PP	PP	RP	No	No	PP	No	No	C	RP	F	RP
	29	RP	No	PP	No	RP	F	PP	No	PP	PP	PP	RP
	30	PP	F	No	No	F	RP	PP	No	RP	PP	RP	RP

Note: C = Catch, PP = Power phase, F = Finish, RP = Recovery phase, No = No-KP
 Table heading outlines each SC participant's age, gender, and counterpart in the YK group.

Table 6. *SC participants' performance of critical features targeted in preceding KP trials during acquisition.*

ID	501	502	503	504	505	506	507	508	509	510	511	512
Practice Session 1 Trial	1	G	B	B	B	B	B	B	B	B	G	B
	2	B	G	B	G	B	B	B	G	B	B	B
	3	No	G	G	B	B	G	B	B	G	B	G
	4	B	G	B	G	B	B	B	B	B	B	G
	5	No	B	G	B	B	B	No	G	B	G	G
	6	B	No	G	B	G	B	B	No	B	G	G
	7	No	No	B	G	No	G	G	B	B	B	B
	8	B	No	B	G	No	G	No	No	B	G	B
	9	G	B	G	B	B	B	G	No	B	G	G
	10	G	B	No	No	G	B	No	B	G	G	G
	11	B	B	B	B	No	B	B	No	B	B	B
	12	No	B	No	G	No	G	No	No	B	G	G
	13	B	B	G	B	No	G	No	B	G	G	B
	14	B	G	B	G	B	B	B	No	B	G	G
	15	G	No	No	G	G	G	No	No	B	B	G

Note: B = bad performance, G = good performance, No = No-KP.

Table 6. *Continued.*

ID		501	502	503	504	505	506	507	508	509	510	511	512
Practice Session 2 Trial	16	B	B	G	G	B	No	G	B	B	G	G	B
	17	G	B	B	G	B	B	B	B	B	G	G	B
	18	G	B	G	G	No	G	G	No	G	B	G	B
	19	No	B	B	B	B	G	B	G	B	B	B	B
	20	G	G	G	B	No	B	No	No	G	B	G	B
	21	G	No	G	No	G	B	G	B	No	B	G	B
	22	No	G	G	G	B	B	G	No	B	G	G	G
	23	B	No	G	No	No	G	B	No	B	B	B	B
	24	No	G	B	No	B	B	No	G	B	G	G	B
	25	B	No	B	No	B	B	No	B	G	B	G	G
	26	G	No	G	No	B	B	G	No	B	G	B	G
	27	No	B	G	No	B	B	No	No	G	B	G	G
	28	G	G	G	No	No	B	No	No	G	G	G	B
	29	B	No	B	No	G	G	B	No	G	B	G	G
	30	G	G	No	No	G	B	G	No	G	G	G	G

Note: B = bad performance, G = good performance, No = No-KP.

Table 7. *SC participants' KP and No-KP requests for all trial blocks during acquisition.*

Features	Practice Session 1					Practice Session 2					Totals		
	Block										Practice Session		Overall
	1	2	3	4	5	6	7	8	9	10	1	2	
Catch	12	5	3	4	6	5	4	2	3	1	30	15	45
Power Phase	7	13	12	7	11	14	14	9	12	11	50	60	110
Finish	10	8	4	5	5	8	2	6	0	4	32	20	52
Recovery Phase	6	6	9	10	7	6	9	10	11	10	38	46	84
Total KP	35	32	28	26	29	33	29	27	26	26	150	141	291
Total No-KP	1	4	8	10	7	3	7	9	10	10	30	39	69
Total # of Trials	36	36	36	36	36	36	36	36	36	36	180	180	360

Note: Catch, Power Phase, Finish, and Recovery Phase indicate the number of times each critical feature was targeted in KP request.

Appendix F

Performance Data

Table 8. *Participants' mean distance during the pretest (Pre), acquisition blocks (1 – 10), retention (Ret), and transfer (Trans).*

ID	Blocks												
	Pre	1	2	3	4	5	6	7	8	9	10	Ret	Trans
501	81	64	65	60	62	59	69	66	62	63	60	58	91
502	64	56	61	68	66	64	74	71	71	73	73	70	93
503	86	82	91	89	93	94	90	93	92	91	92	95	112
504	54	71	74	74	72	68	73	76	74	76	76	76	98
505	42	57	59	64	65	65	63	50	46	48	52	49	76
506	36	67	69	75	69	70	71	70	68	66	63	61	85
507	71	80	80	80	79	77	75	69	70	72	71	63	105
508	48	51	59	57	54	57	60	55	55	50	46	54	75
509	55	79	79	74	72	70	73	68	72	70	70	65	97
510	30	70	75	74	76	80	82	80	76	70	73	74	114
511	62	62	60	60	57	57	60	63	62	62	63	62	98
512	46	44	46	55	49	52	63	62	60	56	54	56	75
602	71	80	86	80	78	76	80	84	83	81	84	82	100
611	34	50	47	47	47	51	55	63	61	57	61	69	94
608	44	70	74	76	83	89	92	91	87	86	85	89	100
609	68	43	65	75	71	81	71	67	64	62	61	63	105
612	59	68	67	63	65	67	74	75	73	74	73	70	96
604	54	67	66	67	63	58	62	60	56	52	50	50	77
605	52	53	51	48	51	49	50	53	57	54	60	65	77
603	54	72	81	82	87	90	88	90	92	96	97	90	121
606	52	68	84	93	83	81	77	80	84	87	92	99	114
607	43	55	56	51	53	58	62	67	71	67	67	62	87
601	63	82	83	81	80	67	81	90	92	94	101	100	121
610	66	84	76	78	77	73	79	73	67	69	68	68	80

Note: ID # 500 – 512 represent SC participants; ID # 600 – 612 represent YK

participants

Table 9. *Participants' mean form scores during the pretest (Pre), acquisition blocks (1 – 10), retention (Ret), and transfer (Trans).*

ID	Blocks												
	Pre	1	2	3	4	5	6	7	8	9	10	Ret	Trans
501	0.67	1.33	2.33	3.67	2.33	3.00	5.33	3.33	3.00	3.67	5.33	4.33	3.67
502	0.67	1.67	2.33	0.67	1.67	5.00	3.00	5.33	5.00	4.67	5.00	3.33	2.67
503	0.33	3.33	2.00	5.00	4.00	3.67	4.33	5.00	4.33	5.33	6.00	5.67	3.67
504	0.00	1.33	2.00	2.67	3.67	5.67	6.00	6.00	6.00	6.00	6.00	5.00	4.00
505	0.67	1.00	3.00	4.00	4.00	3.67	3.67	4.00	6.00	5.67	6.00	5.00	3.67
506	1.00	1.67	2.67	4.00	3.33	5.00	4.67	4.67	5.33	5.00	6.00	5.00	3.33
507	1.00	2.33	3.67	4.33	5.00	4.67	6.00	5.67	5.67	6.00	6.00	5.00	4.00
508	0.33	2.00	1.67	3.00	3.33	3.00	4.00	3.33	5.33	5.00	6.00	5.33	3.33
509	0.67	1.67	2.33	3.00	3.33	3.67	2.33	2.33	3.00	3.67	3.33	3.67	2.00
510	0.00	2.67	4.33	4.67	3.67	4.00	2.67	3.33	4.00	4.67	4.33	4.33	3.67
511	1.33	3.33	3.67	4.67	5.00	5.67	5.00	5.67	6.00	6.00	6.00	5.67	2.67
512	0.00	1.67	3.33	3.67	4.33	5.67	3.33	5.67	5.67	6.00	6.00	4.67	4.33
602	0.00	2.67	2.67	4.33	4.00	4.67	4.33	4.67	4.33	3.67	6.00	5.33	4.33
611	0.00	0.67	1.00	2.00	2.00	3.67	2.67	3.00	3.00	4.00	3.67	3.00	3.00
608	0.00	0.67	1.00	3.00	3.00	4.00	3.00	3.67	4.00	3.67	3.67	2.67	1.00
609	1.00	1.67	3.00	3.67	2.33	3.33	1.00	3.67	3.67	4.00	4.67	4.00	4.00
612	1.33	4.33	4.00	4.00	4.67	4.67	4.33	4.67	4.33	4.33	4.67	4.33	2.00
604	0.00	0.67	2.33	2.67	4.33	4.33	3.67	4.33	4.00	4.67	4.00	4.00	3.67
605	1.00	1.00	1.67	2.00	4.00	3.67	3.00	3.00	3.33	4.33	4.00	3.67	1.33
603	1.67	1.33	0.67	2.33	2.67	3.67	2.33	3.00	3.00	3.00	3.00	2.00	1.67
606	1.33	3.00	2.67	2.67	2.33	2.33	2.33	3.33	3.33	4.67	3.67	3.33	2.33
607	0.00	1.67	1.00	1.00	1.33	2.67	2.33	3.33	2.67	2.33	2.00	2.67	3.00
601	0.00	1.67	1.67	2.67	2.00	2.00	3.00	4.00	4.00	3.67	3.00	3.00	2.67
610	1.67	2.33	3.67	4.00	4.00	3.00	3.00	4.00	4.33	3.67	3.67	4.00	3.00

Note: ID # 500 – 512 represent SC participants; ID # 600 – 612 represent YK

participants

Table 10. *Participants' mean heart rates during the pretest (Pre), acquisition blocks (1 – 10), retention (Ret), and transfer (Trans).*

ID	Blocks												
	Pre	1	2	3	4	5	6	7	8	9	10	Ret	Trans
501	127	141	136	123	121	115	101	84	87	82	92	101	129
502	107	103	105	111	110	109	109	107	103	105	107	109	119
503	122	123	131	127	130	130	120	124	127	126	124	126	162
504	106	111	116	117	116	118	114	111	109	105	107	119	136
505	120	119	121	131	127	132	124	124	118	123	127	120	136
506	110	130	132	136	132	132	126	121	121	120	117	114	129
507	108	117	115	115	115	116	109	104	104	104	105	100	127
508	116	124	131	122	120	121	120	119	120	120	117	134	139
509	95	116	116	114	114	113	114	116	115	117	119	106	127
510	89	101	104	101	104	107	99	103	103	103	105	98	132
511	115	118	117	118	115	117	102	107	106	108	107	85	154
512	67	94	97	101	100	101	111	108	109	105	103	105	110
602	114	125	135	124	126	120	103	103	102	103	108	123	150
611	96	101	93	95	97	96	110	114	111	109	110	118	139
608	113	132	137	140	140	141	145	148	144	147	144	146	159
609	102	105	119	120	120	128	107	119	108	110	111	105	128
612	132	157	146	146	141	145	150	152	148	146	148	141	160
604	108	114	114	114	115	113	122	118	116	114	114	120	128
605	115	117	115	116	117	113	108	112	122	117	118	129	137
603	100	114	115	115	122	130	116	124	131	139	145	135	166
606	96	106	115	123	119	120	122	122	130	132	138	119	140
607	108	120	115	114	116	120	101	99	101	99	102	114	124
601	95	111	115	111	116	111	112	122	126	132	140	129	165
610	110	136	127	126	122	124	118	118	114	117	119	138	153

Note: ID # 500 – 512 represent SC participants; ID # 600 – 612 represent YK

participants

Appendix G

Post-Practice Interview Data

Table 11. *SC participants' response to the post-practice interview's Likert-scale items Q1, Q3, Q5, Q6, and Q7.*

ID	Rating				
	Q1	Q3	Q5	Q6	Q7
501	3	5	5	5	2
502	3	5	4	3	1
503	5	5	5	1	1
504	2	5	5	5	1
505	2	4	4	3	1
506	3	5	5	5	3
507	3	4	4	2	2
508	4	4	4	4	1
509	5	5	5	5	1
510	3	3	5	2	1
511	4	3	5	3	1
512	5	5	4	4	1

M: 3.50 4.42 4.58 3.50 1.33

SD: 1.09 0.79 0.51 1.38 0.65

Note: 1 = never, 2 = seldom, 3 = occasionally,

4 = often, 5 = always

Q1 - How often did you ask for feedback about your technique when you thought your rowing form was relatively good?

Q3 - How often did you ask for feedback about your technique when you thought your rowing form was relatively bad?

Q5 - How often did you use the feedback you requested for error correction?

Q6 - How often did you use the feedback you requested to confirm success?

Q7 - How often did you use the feedback you requested for other purposes?

Table 12. *YK participants'*
responses to the post-practice
interview Likert-scale items Q1, Q2,
and Q4.

ID	Rating		
	Q1	Q2	Q4
602	3	2	4
611	4	3	5
608	3	5	5
609	4	3	5
612	5	4	5
604	5	5	5
605	3	4	4
603	4	4	5
606	5	5	5
607	3	3	4
601	4	2	5
610	4	4	4

M: 3.92 3.67 4.67

SD: 0.79 1.07 0.49

Note: 1 = never, 2 = seldom, 3 =

occasionally, 4 = often, 5 = always

Q1 - How often did you receive feedback about your rowing form when you needed it?

Q2 - How often would you have preferred to receive feedback about your technique when you thought your rowing form was relatively good?

Q4 - How often would you have preferred to receive feedback about your technique when you thought your rowing form was relatively bad?

Table 13. *SC participants' responses to the post-practice interview follow-up questions for Likert-scale items Q1, Q3, and Q7.*

ID	Item	Response
501	<i>Good</i>	It was to make sure that I did things right. The more feedback I get the more I can fix any mistakes.
	<i>Bad</i>	I pretty much always asked for feedback when I thought my rowing form was bad. I asked for feedback because I thought I was doing mistakes. That was my main reason.
	<i>Other</i>	Main reason was to check whether my form was right.
502	<i>Good</i>	Just to make sure that what I felt made sense. I wanted to know that I was doing things correctly. I wanted to get the technique down and boost my confidence.
	<i>Bad</i>	Because I wanted to perform the rowing stroke correctly. Instead of just sitting down and row whatever I wanted to improve and get things right.
	<i>Other</i>	No. I cannot think of any other reasons.
503	<i>Good</i>	There is no good reason to not ask for advice. I mean, I am new to rowing and there were technical things I worked on for each trial. I just wanted to pinpoint correct form and make sure I did things right.
	<i>Bad</i>	Sometimes when I thought my rowing form was relatively bad I did not worry about that piece. Since I could identify it myself I felt like I should just skip it and try something else that I felt was almost Ok. You know, if I felt that I was doing the power phase really bad I would asked for feedback about a different part of the stroke.
	<i>Other</i>	I could not think of any other purposes than success and failure.
504	<i>Good</i>	I felt that when I got my rowing form down there was no need for feedback.
	<i>Bad</i>	I needed to know what part of my rowing form was bad so that I could work on fixing it.
	<i>Other</i>	I do not think there were any other purposes.

Table 13. *Continued.*

ID	Item	Response
505	<i>Good</i>	I said seldom because whenever I thought I had a phase right and asked you for feedback it was to make sure my thinking was right. At first I did not really know what I was doing. It was more a confirmation kind thing. Just to make sure I was doing things right.
	<i>Bad</i>	Well, I asked for feedback to improve my rowing form. There were a few times when I noticed I did not have proper technique but I knew exactly what I needed to do to improve my form. Those times I choose not to bother you for feedback. Instead, I tried to improve my own form and see if it worked.
	<i>Other</i>	I do not think I used feedback for other purposes. I used it to either conform that I was rowing correctly or to get feedback when I rowed poorly.
506	<i>Good</i>	I wanted to know if my form was good. To reinforce what I thought was correct form.
	<i>Bad</i>	First it was because I was working on just the catch and then the power phase. Today it was more the finish and recovery phase. I used the feedback to correct any errors in my form.
	<i>Other</i>	Sometimes I asked for feedback to make sure I did not forget how to do things right. I would ask for feedback to see if I remembered things without always thinking about them.
507	<i>Good</i>	Most of the time if you told me I did things well I would not necessarily ask for feedback about that part again. If I did, it was to confirm that I still got good rowing form.
	<i>Bad</i>	Sometimes when I knew it was bad I did not ask for feedback. Since I knew what was wrong I just had to work on it some more on my own. But for the most part, if I did something wrong I would ask for feedback.
	<i>Other</i>	One thing would be to make sure I did not do something I was not aware of.
508	<i>Good</i>	I wanted to improve my rowing but I did not know how I was doing. I used the feedback to check my form and that I was doing things right.
	<i>Bad</i>	I wanted to know specifically what I did wrong at that trial. I guess I used the feedback to improve my form.
	<i>Other</i>	Never. I used the feedback to check my form only.

Table 13. *Continued.*

ID	Item	Response
509	<i>Good</i>	I did not want to waste any practice rounds. I can always ask for feedback to improve or maintain my form.
	<i>Bad</i>	I asked for feedback to see if I needed to improve my rowing. I guess I just wanted to improve my stroke.
	<i>Other</i>	Never. Those were the only two reasons I saw. I asked for feedback to fix something I did wrong or confirm I was doing it right.
510	<i>Good</i>	I tried to master all of the phases so I would ask for feedback to see if I got the movements down.
	<i>Bad</i>	If I thought I was bad at one phase I would ask for feedback about it. For example, today (Practice Session 2) I asked for feedback on the power phase and the recovery phase because I felt I was lacking skill for both.
	<i>Other</i>	I would say never. I mainly confirmed success today and yesterday was more error correction.
511	<i>Good</i>	Usually, when I asked for feedback when I thought my form was good, I just wanted to hear you say it before I moved on to a different phase.
	<i>Bad</i>	Similar to my last response. If I knew I was doing something wrong I would ask for feedback and try to correct whatever I was doing wrong. I would try to correct my form before moving on to a different part of the rowing stroke.
	<i>Other</i>	I mainly used the feedback to confirm good form or correct bad form. I did not really think about other purposes.
512	<i>Good</i>	I just wanted to make sure that when I thought I did Ok that was actually the case.
	<i>Bad</i>	I asked for feedback to check on my form and to see how I can make it better.
	<i>Other</i>	I asked for feedback to perfect my rowing form. I do not know what else I could have used the feedback for. I guess towards the end I alternated feedback for the power phase with feedback for the recovery phase. I did that to make sure my form stayed consistent.

Table 14. *YK participants' responses to the post-practice interview follow-up questions for Likert-scale items Q2 and Q4.*

ID	Item	Response
602	<i>Good</i>	Doing things the right way should not need confirmation.
	<i>Bad</i>	You cannot better if you do not have constructive criticism.
611	<i>Good</i>	I kind of sensed that when I was doing something good I could feel it. Doing something wrong was harder to detect. I guess I could feel doing something wrong too but I did not always know how to fix it.
	<i>Bad</i>	It is easy to develop bad habits. The more I do something - good or bad - the more it will stick. I wanted to learn about my mistakes before they became "muscle memory."
608	<i>Good</i>	Just to know that I was doing well and to keep doing what I was doing. If I was doing something well I could keep repeating it on the next trial.
	<i>Bad</i>	Kind of the same reason as for your first question. I would want to know so that I could fix it the next time. Overall I think I would have preferred feedback when I thought my rowing form was good.
609	<i>Good</i>	You cannot carry people through providing them feedback on everything they are doing right... "You are doing good, you are doing good... good... good." I need to know... I need to work on things that I am bad at. So, to improve I need to work on the things I am doing incorrectly. To learn about the things you are doing well is more a confidence thing. I need to know that I am doing some of it right... "you are doing a few things right but you need to work on this." Part of it is a confidence issue and the other part is just to know that what I am doing is correct.
	<i>Bad</i>	I think I would prefer coaches to always provide corrective feedback and every so often throw in comments about what I am doing right. I want to know what I am doing wrong every trial because I want to improve every trial.
612	<i>Good</i>	For me personally, I like to know what I am doing wrong so that I can fix it instead of constantly saying that something is good. To fix something you need to know if something is wrong. It is nice to hear when you are doing something right but for me constructively it is better to hear when I am doing something wrong.
	<i>Bad</i>	I want to be told when I am doing something wrong so that I can correct it. I think it is more productive than always being told that I am doing something correctly.

Table 14. *Continued.*

ID	Item	Response
604	<i>Good</i>	I would have preferred to receive as much feedback as possible. No matter if the feedback was based on good or bad performance... with no knowledge about rowing, I think feedback is both helpful and necessary to learn. Positive feedback after a trial I thought was good told me I was doing things right.
	<i>Bad</i>	I mean, if my form is bad I would want you to tell me what I need to fix to make it better.
605	<i>Good</i>	I would have preferred more feedback on my overall rowing form. That way I would have known if my form really was good.
	<i>Bad</i>	If my overall rowing form was bad I would have liked to know all parts that were bad. That way I would know what to work on to improve my form.
603	<i>Good</i>	I mean, feedback telling me I am doing something right will ultimately imprint the correct movement in my muscle memory.
	<i>Bad</i>	There is always something to improve and I wanted to improve my rowing. Actually, I want to get back on the machine right now to see if I can improve some more.
606	<i>Good</i>	Because even if I think I am doing alright I want to know if there is something I can improve. There is always room for improvements.
	<i>Bad</i>	I want to know what I did wrong and what improvement I need to make.
607	<i>Good</i>	Sometimes I asked for feedback just to confirm that my rowing form was Ok. I just wanted to confirm that what I was thinking was correct.
	<i>Bad</i>	As a beginner I saw you as my teacher. I wanted to do my best and to improve my rowing form. I trusted your feedback and used it to improve my form.
601	<i>Good</i>	If someone doesn't tell me that I am doing well or correct me and I think that I am doing it the right way, I'll continue to do it that way. You know, without feedback I will not change the way I row.
	<i>Bad</i>	I just wanted to correct the problem at the root right away instead of waiting and possibly mess things up more.

Table 14. *Continued.*

ID	Item	Response
610	<i>Good</i>	I said often because I wanted to know if I was doing things right. I kept asking for feedback because I was not always sure if my form was good or bad
	<i>Bad</i>	Same as for your last question. I wanted to know if my form was good or bad. Knowing what I did bad helped me to improve my rowing form.

Table 15. *SC participants' responses to the post-practice interview open-ended questions about used/developed strategies (S), goals (G), quality of available feedback (Q), and other important topics (O).*

ID	Item	Response
501	S	Well, I noticed that when I am focused on one aspect of the rowing stroke that I did much better. If I was just looking around, not concentrating, it messed up my form. In order to improve, I had to stay concentrated. This approach change over time. . . Starting out I had no strategy but after a few trials I realized what I needed to do.
	G	My main goal was just to get better and by receiving feedback I was able to know whether I was getting better or not. So yes, I believe that I did. At first I did not really have any goal but then again after the first couple of trials I set this goal to get better.
	Q	I liked the feedback. I thought the feedback was very helpful.
	O	Nope. I think you pretty much covered it all.
502	S	I had this vision of how to paddle on-water and that was how I approached the first few trials. However, paddling is very different from rowing. It took me sometime before I got used to the idea of traveling backwards. Once I got it and started to improve my technique I found it easier to actually feel the stroke. It helped me improve my form.
	G	I do not think I sat any goals. I really did not. I just rowed and tried to get better.
	Q	I think the feedback was good. It was awesome actually. I did not know what I was doing so the feedback you gave me help a lot. By asking for feedback I was able to figure out "this is what I am supposed to do." I ended up compiling the feedback you gave me. I mean, for each part of the rowing stroke I looked at the pictures and compared it to what I as feeling. I also listened to your feedback to make sure I was doing the stroke correctly.
	O	No, I do not think so.

Table 15. *Continued.*

ID	Item	Response
503	S	For all trials I tried to make myself a pattern. I tried to maintain my pace at 18 strokes per minute and focused on the repetition. I did not try to do anything fancy... When I felt my rowing form was choppy, you know legs-back-arms, I tried to smoothen it a little. I created a pattern in my mind: Drive-lean-pull and emphasized the segments of the stroke.
	G	My goal was to get at least halfway decent. I know my form was absolutely horrible when I first started. I did not have the foggiest clue of what I was doing. I just tried to get Ok at it. I guess at first I did not want to make a fool of myself.
	Q	I think the feedback was limited but I think it was designed to be limited. What you gave me was good and it helped me. It was enough for me to pinpoint and improve what I was doing.
	O	Nothing really. I think you covered it all.
504	S	The only strategy I used to learn would be to ask for feedback and determine what was wrong with my previous form and fix it. Once I confirmed good rowing form I did not ask for feedback as much.
	G	The only goal I had was to get my form down. Practice trial 1 through 30 I tried to do everything as close to perfect as possible.
	Q	I thought the feedback worked pretty well. It helped me. I did not have any problems with it. It might have been helpful if you could ask for additional feedback. But with 30 trials to figure things out it worked well.
	O	I do not believe so.

Table 15. *Continued.*

ID	Item	Response
505	S	The first day I did not really have a strategy. Mainly because I did not know much about rowing. Though, anytime I thought I was doing a poor job I would ask you for feedback and then try to improve my rowing form. After asking for feedback I would choose not to receive feedback on the next trial and that way figure things out myself. Later I would ask for confirmation that I got things right. Today (Day 2) I tried to work on things I felt uncomfortable with or to make sure I was still doing things correctly. I did not have a major strategy. I went for how it felt and how I thought I was doing.
	G	Well, my main goal was to get the proper technique down. I do not think I was very successful yesterday (Day 1). But today I got it down better. I especially improved my power phase today. As I continued to practice my goal was form because I am sure form is more important than how fast you can go. It makes sense to me that you want correct form before you worry about speed.
	Q	I think it definitely helped me. Especially today when I worked on my power phase. Yesterday I do not think I asked once about the power phase. Today, once I asked about it, things got a heck of a lot clearer and I was able to improve my overall form.
	O	I think that when it comes to technique it really helped out to ask for feedback. For other people who are learning to row I think it is important for them to get involved and to keep asking questions. If you do not ask questions you are not going to learn or get any better.

Table 15. *Continued.*

ID	Item	Response
506	S	My strategy was to take things step by step. I started with the catch and then work at the transition between the catch and the finish (power phase). Next, I worked on the finish, the recovery phase, and then back to the catch. I would work through the whole stroke and later go back to see what I had learned. If I got it I moved on to the next phase. My strategy did not change. I used it for trial 1 and it worked pretty well. Saw no reason to change my approach.
	G	My goal was always to improve my rowing form. I knew I had 30 trials and set the goal to get better as I practiced. I do not think my goals changed from Day 1 to Day 2.
	Q	I think the feedback was Ok. I normally got what I expected. Though, at times it was a little vague and that is why I say the feedback was Ok. It was not great but not bad either.
	O	Not that I can think of at the moment.
507	S	Something that helped was to organize the stroke into stages. Instead of fixing everything at once I worked on one thing at the time. You know, if I knew my arms and legs were bent I would work on straighten them one at the time. Keeping pace also helped to get the right form. I did not really change my strategy. If anything I changed my rhythm to improve my form
	G	My main goal was to get my form right. And it did not really change.
	Q	Well, I noticed that you always gave the feedback in the same format and that was necessarily not a problem. One thing that would have been more helpful in a no experimental setting would be if you identified and pointed out things instead of me figuring things out myself.
	O	No. I do not think so.

Table 15. *Continued.*

ID	Item	Response
508	S	I guess I developed strategies to correct my mistakes. And then... I think my strategy changed a lot from that I first started. At first I did not grasp all the steps. It is first today (Day 2) that I feel that I know them. At first I did not understand how the stroke flowed and how to put things together. I think it helped to visualize the steps in my head and mimic that vision.
	G	My goal was just to do as well as I could. I guess the hardest part was to keep the right strokes per minute. I tried to stay at 18 but it was really hard. But yeas, I think I kept the same goals for all trials.
	Q	It was good. I mean, it definitely helped. I knew kind of what I was doing wrong but it helped to know whether my arms and legs were straight or not. By asking for feedback I knew what to focus on and how to change my form. Also, I think it helped that I could only ask for one part of the stroke. Asking for one part at the time helped me focus on that part.
	O	No. There is nothing I can think of.
509	S	I wanted to get each phase down before I moved on to the next one. I wanted to make sure I got it so I went in order: The catch, then the back lean, the power phase, and lastly the recovery phase. Every so often, I also tried to check back to see if I was still doing the catch right... if I was still doing the back lean right and the finish. I would check occasionally as I was working on a particular phase. It was the strategy I used the whole time. I guess I found the catch and the lean back to be kind of easy and that's why I started out with them. The power phase and the recovery phase I had to work harder to get. I started with the easy stuff and moved on to the harder stuff.
	G	My goal was to get all the positions and my technique as correct as I could. My goal did not really change.
	Q	It was helpful to know what I was doing wrong. I mean, hearing that my legs were bent or that my arms were bent helped me realize the real problem. Obviously, I would have liked to ask for more detail but over the course of 30 trials I found the feedback to be enough to learn. In fact, I found your setup to be more helpful than other learning situations. I know that when I have learned other things, the coach or someone will give me a bunch of things to work on and so I do not really focus on learning one thing. I focus on learning all of it at once and that approach makes things difficult. When you only focus on one thing at the time you can learn to master it and then move on.
	O	Nope. I cannot think of anything else.

Table 15. *Continued.*

ID	Item	Response
510	S	I tried to work on each phase separately. Eventually I would try to combine them and achieve good rowing form. Later I would focus on the phases I still struggled with. Occasionally I would defocus all phases and just see how my body was working things out. That seemed to help. I mean, sometimes when I focused one just one phase the other three went bad.
	G	My only goal was to learn how to row. I guess on Day 1 I tried to get a base and today (Day 2) I worked on the things I struggled with.
	Q	I think the instructions I got after the pretest helped the most. I corrected a lot right there. During the 30 practice trials we focused more on one thing at the time and that process was slower. I enjoyed it though and think the focused approach helped me with precision of the overall rowing form.
	O	I do not think so.
511	S	Well, originally I did not know anything about the rowing stroke at all. I think I pulled with everything at the same time. Though, after the instructions you gave I realized the stroke was legs, back, arms... Kind of a three step movement. So that helped me. I think for today (Day 2) and yesterday (Day 1) I kept working on the legs-back-arms and arms-back-legs movement.
	G	If I had any goal it would probably be to get the stroke correct. I would focus on one thing at the time and ask for feedback about it. Ultimately, my goal was to improve my rowing.
	Q	I thought it was good because you would tell me "your legs are straight and your arms are straight" and that meant I was doing alright. If you said "your legs are straight but your arms are bent" I knew what I had to focus and work on... You know, I knew I had to keep my arms straight longer in the power phase or straighten them right away in the recovery phase. The feedback was to the point but they helped me figure out what I needed to do.
	O	No. I do not think so. Not that I know.

Table 15. *Continued.*

ID	Item	Response
512	S	At first I tried to mimic the pictures on the wall. It helped some. Next I mentally pictured how one would row in a boat. I thought about the power phase and how to carry out the movement... I have watched Olympic rowing on ESPN and I kind of tried to do things like rowers in real boats.
	G	I guess my goal was always to perfect my rowing form. I wanted to achieve the different positions as they were pictured in the photos.
	Q	I think the feedback was good. It did not necessarily explain what I needed to do but it helped me figure things out on my own. I guess it helped me visualize what I needed to change.
	O	Nothing that I can think of.

Table 16. *YK participants' responses to the post-practice interview open-ended questions about used/developed strategies (S), goals (G), quality of available feedback (Q), and other important topics (O.)*

ID	Item	Response
602	S	Looking at the movement from a step-by-step kind of view and knowing that legs and arms needed to be straight in the middle of the power phase and recovery phase helped. I guess starting out I just tried to row and the step-by-step approach developed over time.
	G	I wanted to balance and improve the rhythm. I mainly worked on perfecting the step-by-step movement in the stroke. Guess this focus developed towards the end of yesterday (Day 1).
	Q	I think the feedback available was limited and not always useful. You would give me information about some part of the stroke and sure that was good. However, I did not always feel comfortable with the other parts. I would have preferred if you analyzed and informed me about the whole stroke.
	O	No
611	S	Strategy wise I think I was looking for the correct feel of how rowing is supposed to feel. When the resistance felt right I was like "this is what I want to come back to." When I lost it my thought was "how do I get back to that?" I was not always sure how to do it but I could kind of sense how to. Yesterday (Day 1) I focused more on achieving correct rowing form. It was first today (Day 2) that I focused on the correct feel.
	G	I just wanted to row accurately and that goal did not really change. I mean, at first I focused on getting the stroke rate down. However, once I got the catch down and a better feel I hit the stroke rate and could focus more on my rowing form.
	Q	The quality was good. Once I had familiarized myself with the feedback you gave... it took some time... I thought it was effective. I liked the short statements. Sometimes when you try to overcorrect coaches tend to provide too much feedback. Then the learner might be "Wait! What? What did you want me to change?" What we did worked well. Addressing one part instead of all four helped me figure out the stroke. One at the time was certainly good.
	O	Not really. This is an experimental setting and not exactly a real world setting.

Table 16. *Continued.*

ID	Item	Response
608	S	I used your feedback and I also looked at the pictures on the wall a lot to make sure my form was good. While I was rowing I kept looking at my arms and legs... I thought about whether my form was good and if I did things the right way. I feel that sometimes during the 30-s trials I was thinking too much. All the thinking caused me to mess things up. Other times I thought less about my form and performed better. I think I had the same approach for all the trials.
	G	The goal was to get my rowing form right. I wanted to learn so I set out to do things right. That way if I want to row in the future I will know how. I guess this goal was not strong during the first few trials but developed over time
	Q	I think the feedback was good. You gave it at the right time and told me which phase you were looking at. The feedback helped me correct my form. You also gave me no feedback which allowed me to figure things out on my own. Sometimes receiving no feedback made me think even more on the next trial. You know, I was not always sure if I did the last trial correct or incorrect.
	O	I cannot think of anything.
609	S	My strategies did change. That's for sure. I took on the task of rowing in three stages. It was the form, which I really focused on, and then the rowing speed (pace), and then the actual flow of everything. Those were the three things I chose to focus on. And you could tell which one I chose to focus on. If my rate shot up my rowing form might have gotten a little better... If my flow got a little better something else might have changed. Yesterday (Day 1) I focused on this or on this or on this. Now (Day 2) I am trying to combined them.
	G	18 strokes per minutes was my goal and will always be on this machine (laughs). I mean, my main goal was to learn how to row and do it correctly. I wanted to achieve the best form scores among your research participants. I am competitive. I guess the more I learned about the different phases the more form related goals I developed.
	Q	Personally I need more feedback than the small statements that you provided. To really learn I would need you to sit over there and tell me constantly what I am doing in my face. That's the kind of person I am. More feedback and more detail would have been better.
	O	Nope. I cannot think of anything.

Table 16. *Continued.*

ID	Item	Response
612	S	I mainly really focused on trying to fix one thing at the time. In high school, when practicing softball and taking batting lessons, that was the only way I could fix my swing. I focused on one thing at the time. That way I did not get overwhelmed. I kept this step-be-step approach for all practice trials.
	G	My goal was to get my form as accurate as possible. That was pretty much it. At first I started off understanding everything that I could and later I tried to improve my rowing form.
	Q	I think it was very productive. I think having constant and to the point feedback about what's wrong helped a lot.
	O	Not that I can think of.
604	S	I would say that the first strategy that I developed was to get my chins perpendicular at the catch. I would squeeze and almost pause at the catch to really emphasize that position. I wanted to recognize that I had gotten all the way to that position. And then my second strategy was that I extended my legs all the way and then pull with my back with straight arms. I pretty much locked my knees and arms so that they stayed straight during the back movement in the power phase and the recovery phase. I think that's pretty much it. I think realizing the sequence and step-by-step approach helped. Yesterday (Day 1) I might have been a little robotic and today (Day 2) I tried to smoothen the edges and get some flow.
	G	My goal was to learn the proper technique and to improve over time. Once I have learned the initial steps my goal was to - by the end of this - be able to do it. I started out kind of rough. But as long as I was getting better I felt good about it.
	Q	It was really good. I appreciated the fact that it was usually one thing at the time instead of multiple things. You started with the legs and you moved to the back, then you went to as the bar moved over my knees... I realized that the first time I rowed I did it all wrong. But you started with one particular thing and let me master that before you moved on. That was good. Instead of saying "you did that completely wrong" you helped me work on one thing at the time and improve little by little.
	O	Not that I can think of.

Table 16. *Continued.*

ID	Item	Response
605	S	The thing I really worked on was keeping my arms straight and my legs straight during the power phase and recovery phase. My focus on arms and legs was not always consistent but I would say that was the strategy that I used. If you told me that my shins (Catch) were too short or my finish was too high I would work on these but always try to remember straight arms and straight legs... especially in the recovery phase. I guess starting out yesterday (Day 1) I focused a lot on the number of strokes per minute but towards the end I focused more and more on my form.
	G	My goal was to get my form right and to be consistent. The goal "to be consistent" developed more and more over time. I guess my goal was to learn how to row (laughs).
	Q	I really liked the feedback. It helped to improve my form. The only thing I would like to mention is that after one trial you sometime comented on my power phase and after the next on my catch. I think I would have liked to hear how my power phase was again and if I did it better that time. When you moved on and gave feedback on a new part of the stroke did that mean I improved or not? I was not sure.
	O	Other than what I just mentioned I cannot think of anything. Overall I think the experience was good.
603	S	Today (Day 2) I made sure to stretch some before sitting down on the machine. I do not know if it helped but thought I'd give it a try (laughs). Other than that I focused on straight elbows and knees. I think that's about it. Yesterday (Day 1) I used the feedback you gave me to figure out the right rowing form and today I tried to perfect the stroke.
	G	Mostly I tried to perform the power phase and recovery phase with straight elbows and straight knees. I also focused on having a 30 degree backlean at the Finish. Mainly my focus for both days was to achieve correct rowing form.
	Q	I think it was relatively good. It helped me to be better. The feedback you provided reminded me what to do and to improve my form. The feedback was short and to the point... Very easy to understand. I liked it.
	O	Hmm. Maybe it would be an idea to have participants warm up and stretch beforehand. I mean, I think I would have performed better had I jogged in place and stretched some. It is just a thought.

Table 16. *Continued.*

ID	Item	Response
606	S	I just thought out the steps in my head. Almost like a small check list... "are my arms straight? Yes, I think so." "What about my knees?" I tried to stick to this check list. That's about it. At first I tried to learn the different steps and later I focused on putting everything together.
	G	My goal was always to get around 18 strokes per minute and I think I did that most of the time. Once I got the pattern down I focused more on my rowing form and to correct my form based on the feedback you gave me.
	Q	You let me know that my arms were almost always bent (laughs). I think I liked the short statements you gave. They focused on what I did wrong and helped me improve. If the task was something more difficult like building a house I would have preferred more detailed feedback.
	O	I don't believe so. I think you gave good feedback.
607	S	Yes. I did develop a few strategies. When I tried to straighten my legs and straighten arms I did this by moving fast. During the recovery phase I found it easier to maintain good form if I moved fast. You know, I would move the handle forward fast before bending my knees. Other than that I just listened to your feedback and tried to improve.
	G	My goal was to learn how to row so that I could apply the technique in a real rowboat on-water. I focused on the basics... basic skills so that I can actually practice rowing myself.
	Q	Very good. I really liked the short statements. Long statements tend to get too long and I would probably forget. Abbreviated short statements are easier to grasp... just easier to memorize and work with.
	O	No. I do not think so.

Table 16. *Continued.*

ID	Item	Response
601	S	The one strategy I used was to go “arms, chest, legs” for the recovery... “arms, chest, legs... arms, chest, legs...” When I worked on the power phase I would go “legs, chest, arms.” You know, just the reverse. For each trial, I would just be thinking the sequence out in my head while I was doing it. Other than that, I was just trying to get the hang of it I guess. My main concern was to have straight legs and arms when the handle passed over my knees.
	G	My main goal was to just keep 18 strokes per minute. Starting out yesterday (Practice Session 1) I was up in the 20’s and by the end of the day I was more 18 or 19. Today I was around 18 or 17 strokes per minute. So, I got closer to the expected number. As for my rowing form I tried to improve and not to mess up (laughs). I worked on the different phases and listened to the feedback you gave me.
	Q	It was good because it helped me correct my problems. It was good that you allowed me to work on one thing at the time... just small changes over time. If you would have asked me to change too much at one time I am afraid things would have been confusing.
	O	Just stretch before you come (laughs). I was killing my ankle before. It felt a little tight.
610	S	I used what have learned from other areas in my life to learn how to fine tune the row. I used to do fencing and that is also a very meticulous sport where you have to pay attention to every detail that you do. I think that kind of helped me to learn the form faster than I think I would have without fencing. What I gathered from rowing is that you have to learn the different steps in the stroke. This approach is kind of like learning how to do the lunge in fencing so that you don’t hurt yourself or end up hurting others. In rowing it is the same thing. If you don’t do things right, you might end up hurting yourself or mess up the rowing in a boat.
	G	I think my biggest goal was to learn how to do the different stages... I focused on the kick and the pull in the power phase and kind of the reverse order in the recovery phase. I think this session (Practice Session 2) I did better than last session with keeping my arms and legs straight. I still have a lot of room for improvement obviously, but I think I did better than last time.
	Q	I think that you did a really good job giving me feedback. It help me realize what I need to work on and what I’m doing wrong. I think that it really helped me to do the stroke better. The feedback was really useful.
	O	No. There is nothing I can think of.

Vita

Björn Anders Holmberg was born in Falkenberg, Sweden. Prior to attending his doctorate degree at the University of Tennessee, he completed a Bachelor of Arts degree in Environmental Earth Science at Boston University (Boston, MA) and a Master of Science degree in Sport Psychology at the University of Tennessee (Knoxville, TN). In August 2013, he received his Doctor of Philosophy degree in Kinesiology and Sport Studies with a specialization in Sport Psychology and Motor Behavior.