

Running head: MIXED-MODELS VS. SELF-OBSERVATION

Examining the effects of mixed-models and self-observation on motor skill acquisition within a
gymnastics environment

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Abstract

Watching oneself on video (self-observation) compared to self-observation coupled with a skilled model video (mixed-models) was examined in a gymnastics environment to determine whether combining two model types would be better than just one. Twenty-one gymnasts learned one gymnastics skill with mixed-models and a second skill with self-observation across pre-test, three learning sessions, and post-test. Physical performance, scored by two evaluators, revealed a significant condition by session interaction ($F(3,51) = 3.329, p = .027$). At session 3 and post-test, scores obtained with mixed-models were significantly higher than those with self-observation. Cognitive representation of the skills was measured at pre-test and post-test via error detection and recognition tests, analyzed using signal detection. Participants had significantly higher response sensitivity scores with mixed-models ($F(1,14) = 10.810, p = .005$) compared to self-observation. The conclusion drawn is that it is better to incorporate self and skilled models in a gymnastics setting than self-observation alone.

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Chapter 1: Introduction

Sport participation results in the acquisition and continued development of specific motor skills. Athletes engage in practice in order to establish new skills, improve performance, and increase overall levels of success. Coaches play a critical role by, among other things, providing athletes with important information through augmented feedback. Augmented feedback is information in regards to the athlete's performance that can be provided before, during, or after skill execution (Schmidt & Lee, 1999; Magill, 2001). On the other hand, intrinsic feedback is information acquired naturally by an athlete through sensory mechanisms such as vision, touch, and proprioception (Schmidt & Lee, 1999) that occur during movement execution.

Augmented feedback about an athlete's performance can only be provided from an outside source, like a coach (Magill, 2001). Two important types of augmented feedback that coaches can provide are knowledge of results (KR) and knowledge of performance (KP). KR is information about the outcome of the action, for example, a score for a gymnastics routine (Schmidt & Wrisberg, 2008). KP is information about the quality of the performance; for example, the coach informs a gymnast that her legs were bent during skill execution (Schmidt & Wrisberg, 2008). Typically, KR and KP are provided to athletes verbally; however, augmented feedback can also be delivered visually, such as through the use of video feedback. This use of video feedback falls within self-as-a-model observational learning techniques, specifically that of self-observation, which practitioners can use to enhance motor learning.

Before continuing with an overview of relevant findings within this body of motor learning literature, it is important to first define the distinction between motor performance and motor learning. The standard motor learning experimental paradigm includes an acquisition phase and a retention phase. The acquisition phase represents motor performance during practice. During the acquisition phase, participants practice the skill and receive the intervention (e.g.

watch a self-observation video). Results from the acquisition phase tap into certain motor learning characteristics and show how well the participant is performing during practice with the intervention, yet they do not display relative permanence of the skill (Schmidt & Bjork, 1992). Moreover, motor performance effects can be transient; therefore, a retention phase is needed to capture the relatively permanent learning effects that can occur as a result of practice (Schmidt & Bjork, 1992). Results from a retention (or transfer) phase show whether the benefits exhibited in acquisition transfer into a situation when practice and the intervention are not available. Therefore, it is the retention (or transfer) results that are used by motor learning researchers to determine whether an intervention contributes benefits for motor learning (Schmidt & Bjork, 1992). For the present experiment, only retention tests were used to capture the relatively permanent learning effects.

To return to the main interest of this research, while video feedback in the form of self-observation can be used as an observational learning technique, there is also the use of other models beyond that of the self that can contribute to motor skill acquisition. To expand, observational learning is the process by which learners acquire the capability for action by observing the self, or others, in attempt to perform novel behaviours and improve actions (Schmidt & Wrisberg, 2008; Starek & McCullagh, 1999). Researchers have shown the use of observational learning to be superior to motor learning situations in which no model demonstration is provided (Al-Abood, Davids, & Bennett, 2001; Ram, Riggs, Skaling, Landers, & McCullagh, 2007; Rohbanfard & Proteau, 2011). Observed models can be those surrounding the individual, such as peers, parents or coaches, but it can also be the self. Self-as-a-model techniques typically involve capturing the learner on videotape for later playback in unedited or edited forms.

Model characteristics, such as age, gender, and skill level have been shown to influence the effectiveness of the use of observation (Meaney, Griffin, & Hart, 2005). As an example, model skill level is a modifiable component, with model type ranging from inexperienced learners (i.e., unskilled model) to advanced experts (i.e., skilled model). Skilled models display correct behaviours, and have been shown to be effective in a variety of motor learning environments, such as dart throwing, serial reaction time tasks, and swimming (Al-Abood, Davids, & Bennett, 2001; Heyes & Foster, 2002; Weiss, McCullagh, Smith, & Berlant, 1998). A skilled model is said to be beneficial for learning because it grants learners a standard for error correction and encouragement for ideal reproduction (Bandura, 1977; Blandin, Proteau, & Alain, 1994; Sheffield 1981). In contrast, unskilled models demonstrate the to-be-learned movement with some degree of error (Ste-Marie, Law, O, Hall, & McCullagh, 2012). The use of unskilled models has also been shown to enhance motor learning (Buchanan & Dean, 2010; Lee & White, 1990). Further, it is proposed that they allow observers to discover errors in the unskilled model demonstration, which can influence varied thought processes for when they attempt a subsequent performance, and this affords the learners the chance to better detect and correct their own errors in execution (Buchanan & Dean, 2010; Lee & White, 1990).

Self-observation is a self-as-a-model technique that involves the simple playback of an unedited video for the learner to watch (Dowrick, 1999). When self-observation is provided to a learner in the beginning learning stages of the skill, one can argue that it would then act much like the observation of an unskilled model. Consequently, learners would also benefit from detecting errors in performance and building the error detection-correction mechanism that is critical for improving performance (McCullagh, Law, & Ste-Marie, 2012). Indeed, self-observation has also been shown to benefit the learning of varied motor skills (e.g., Clark & Ste-

Marie, 2007; Onate, Guskiewicz, Marshall, Giuliani, Yu, & Garrett, 2005).

Although there are varied model types available, the more common strategy used is for one model type to be employed throughout a learning intervention, such as a skilled peer, unskilled peer, or self-model (Heyes & Foster, 2002; Lee & White, 1990), with limited research on the contributions of the use of multiple model types within an intervention. Given that skilled and unskilled model types may play different roles in the benefits of observational learning, it is reasonable to propose that combining model types could elicit additive benefits. Thus, this research concerned whether a combination of model types is advantageous over the use of one specific model type. Specifically, this research concerned the use of self-observation alone versus self-observation coupled with a skilled video model and their relative effectiveness for motor skill acquisition in the applied setting of a gymnastics club. This research is significant as it may provide knowledge concerning the relative contributions of different model types, and their assumed underlying mechanisms.

This research also has practical significance. Self-observation is often used in gymnastics settings (Hars & Calmels, 2007), but these observations are typically accompanied by verbal feedback from coaches. Thus a potential outcome from this research was determining if the learner could be provided with sufficient structure for self-directed learning by inclusion of a skilled model with self-observation, thus limiting instruction and the need for verbal feedback from the coach. This would then allow the coach to be involved in other activities with the group of learners.

In the upcoming review of the observational learning literature, I first describe the theoretical framework to be adopted, that of Bandura's (1986) Social Cognitive Theory. The implications of Social Cognitive Theory for the use of varied models to gain motor learning

advantages, with an emphasis on the model types used in the research design (self-observation and skilled model) will also be presented. I continue by introducing the research to date on the use of mixed-models while highlighting important gaps within the literature. Finally, I conclude with the research question and hypotheses of the research undertaken.

Chapter 2: Review of Literature

Bandura (1986) argued that observation is one of the most powerful ways of transmitting behaviours, attitudes, and values. Most human behavior, he proposed, is learned through observation, and thus Bandura (1986) offers a strong theoretical framework in which to examine the effects of social influences on motor behaviour. Models, such as parents, coaches, and peers are important social influences that act as facilitators to convey relevant information to the viewer for subsequent motor performance (Bandura, 1986). Bandura (1977) suggested that learners symbolically code desired behaviours demonstrated by a model into a cognitive representation, which can then be used to direct future learning. As people encode these actions, they also evaluate the relationship between behaviours and their consequences. Models facilitate vicarious reinforcement, as observers view outcomes associated with the model's actions, which are then used to determine if the behaviour should continue or be modified (Bandura, 1977).

Bandura (1986) proposed that the effectiveness of observational learning depends on a multi-stage process that incorporates four sub-processes: attention, retention, motor reproduction, and motivation. First, in the attention stage, learners are said to attend to the demonstration and acquire pertinent information about the task provided by the model. Second, it is assumed that learners develop and retain a cognitive representation of the task in the retention stage. Observers can symbolically code, store, and recall information acquired from the demonstration to guide later motor skill production.

Next, in the motor reproduction stage, viewers should be physically able to translate the cognitive representation into overt movement. Participants' physical abilities may limit actual motor performance and provide an inaccurate assessment of learning; therefore, alternative assessments have been developed. As examples, cognitive evaluations, such as comprehension, recognition, and verbal production tests have been used to supplement physical performance

measures. Comprehension tests allow the observer to display their understanding of an underlying rule (Rosenthal & Zimmerman, 1978), recognition tests involve the identification of correct movement patterns (Carroll & Bandura, 1985; McCullagh & Weiss, 2001), and verbal production tests require a verbal explanation of the learned task (Bandura, Jeffery, & Bachicha, 1974). This research included cognitive representation measures to assess the participants' abilities to detect, identify, and recognize errors. Finally, the motivation sub-process assumes that observers are motivated to attempt the desired behaviours and to learn from the model demonstration. Overall, Bandura (1986) suggests that people learn through observation by a multi-stage process that relies on cognitive and motoric processes (Bandura, 1986).

Observational learning and models can also be used as a method to intentionally improve motor behaviours. For example, video interventions are commonly used in a sport environment for athletes to learn new motor skills and enhance their performance. In support of Bandura's (1986) propositions, numerous researchers have shown that video model demonstrations are superior to no model demonstrations in the learning of varied motor skills (Al-Abood, Davids, & Bennett, 2001; Ram, Riggs, Skaling, Landers, & McCullagh, 2007; Rohbanfard & Proteau, 2011). That research has also identified that mere observation does not lead to benefits and that there are a variety of features that are relevant for observation to enhance motor learning (see Ste-Marie et al., 2012 for a review). Of relevance to this research are characteristics associated with model type and model-observer similarity in regards to video interventions used with the intent to develop motor skills. These two features are expanded upon next.

Model Type

Observational learning research has revealed that there are a number of model characteristics that impact the effectiveness of model observation. Every model can have

different model characteristics, such as age, gender, and skill level. These characteristics may influence the observational learning sub-processes by affecting the amount of attention paid to the demonstration, the learner's cognitive and behavioral strategies, and/or motivation to learn the skill, which can impact subsequent performance and overall success (Bandura, 1977). Model skill level is a frequently researched characteristic and is an important factor to consider when designing an observational learning intervention, especially due to the vast range of model abilities. Models' skill levels can range along a continuum from inexperienced learners to advanced experts. Two commonly used model skill levels in sport include skilled and unskilled. Briefly, skilled models display the correct execution of the skill (Ste-Marie et al., 2012) and can be considered experts at the task they are demonstrating. Within the research, this type of model has also been referred to as an expert model or a correct model. For the remainder of this literature review, the term 'skilled model' will be consistently used, but also captures the research in which these various terms are used.

In contrast, an unskilled model provides a demonstration of the desired behaviour, but executes it with some degree of error (Ste-Marie, et al., 2012). The unskilled model usually has no previous experience with the task, classifying them as novices. It should be noted that various terms are also used to describe unskilled model types, such as a novice model, or an incorrect model. Similar to the point about skilled models, in this literature review the term unskilled will be used throughout, but also represents research done with novice and incorrect models.

Another model type that has been used is a learning model. This model type starts as an unskilled model and can transition into a skilled model. That is, the model begins by executing the desired behaviour with errors, but over time, the model improved in performance, and can eventually demonstrate the task with no errors (Lee & White, 1990; McCullagh & Meyer, 1997).

Researchers typically incorporate learning models in one of two ways. First, learning models can be participants in a separate experimental group that are observed while they are learning the task themselves (Pollock & Lee, 1992; Rohbanfard & Proteau, 2011). Second, researchers have used a skilled model to ‘artificially’ demonstrate a learning effect. That is, the skilled model is asked to perform the skill with multiple errors in the execution of the skill, and to gradually perform the movement with fewer errors, until they were displaying the correct skill performance (Meaney, et al., 2005). In the context of this research, skilled and unskilled model demonstrations are more relevant and are thus developed more next.

Skilled models. The literature supports the use of skilled models and has shown they are advantageous for learning when compared to control groups that do not view a model (Adams, 1986; Al-Abood, Davids, & Bennett, 2001; Heyes & Foster, 2002). For example, Al-Abood, Davids, and Bennett (2001) investigated the value of visual demonstrations using a dart-throwing task. Participants in the modeling group watched six trials performed by the skilled model at the beginning of the acquisition period and after every 10 successive trials. After 100 acquisition trials, and 20 retention trials, results indicated the modeling group estimated the model’s movement coordination patterns faster and with more precision than participants who were provided only verbal instruction or no added information. This shows that participants in the modeling group adopted the same dart-throwing movement strategy as the skilled model much faster and more accurately than the other two groups. Next, Heyes and Foster (2002) examined the effects of observational learning using a serial reaction time task. Results from this study showed that observation of a skilled model with physical practice enhanced the acquisition of sequence information when compared to a physical practice only group.

A skilled model is said to be beneficial for learning because it grants learners a standard

for error correction and encouragement for ideal reproduction (Bandura, 1977; Blandin, Proteau, & Alain, 1994; Sheffield 1981). The skilled model shows accurate behaviours, and thus a strong reference of correctness is presented that observers can compare to their own personal performance. Through the use of error estimation, Blandin and Proteau (2000) found that the effectiveness of the error-detection and correction mechanism was significantly better after observing a skilled model as compared to an unskilled model. The error-detection mechanism was examined using participant's estimation of errors and actual errors committed, while the error-correction mechanism was computed using bias in estimation and actual corrections (size and direction) made by the participant. Blandin and Proteau (2000) also argued that the skilled model video might motivate learners to perform the same correct actions as the model, thereby assisting in the correction of previous errors.

Unskilled models. While skilled models have produced learning benefits, unskilled models have also impacted learning. It is common for an unskilled model to be a participant within the experiment, such as in a model-observer pairing. Lee and White (1990) examined the effects of observational learning using a computer long jump task. Participants were split into model-observer pairs; the first participant (model) performed all trials without having watched a model in advance, but served as the unskilled model for the paired observer who watched the participant do the task and recorded the performance scores of the model. Afterward, the observer was then provided the same physical practice as the first participant on the task as well. Results showed significant performance effects for the observer group as compared to the no model group, suggesting the use of an unskilled model is beneficial.

Other research has also revealed that unskilled model groups outperform control groups who are simply given physical practice of the task (Black & Wright, 2000; Buchanan & Dean,

2010; Lee & White, 1990). Varied reasons have been provided for the advantages that an unskilled model provides for learning. Adams (1986) suggested, for example, that associations observed between successful and unsuccessful trials of the performer increase error detection and correction processes, thereby increasing observers' cognitive effort, which can lead to enhanced learning. Observers, he argued, can discover errors in the unskilled model demonstration and engage in thought processes as they attempt to correct subsequent performance. Additionally, in consideration of Bandura's (1986) propositions about the importance of similarity between model and learner, learners may relate more to the model, as they are presumably at similar stages of learning, which can increase the effectiveness of a visual demonstration (Bandura, 1986). Furthermore, unskilled models offer a wider range of movement strategies and can broaden the cognitive representation observers create via the interaction of observation and action of the skill (Blandin & Proteau, 2000; Buchanan & Dean 2010).

While the effectiveness of specific model types has been demonstrated in comparison to control groups; research comparing these two model types directly has generated mixed findings. For example, Schunk, Hanson, and Cox (1987) indicated skilled models led to higher performance scores and motor learning than unskilled models, while Weir and Leavitt (1990) revealed unskilled models were superior. Weir and Leavitt (1990) examined model skill level and knowledge of results (KR) using a dart-throwing task. Results showed the unskilled model groups had more consistent performance, while the skilled model groups required KR to perform with the same accuracy as the unskilled model groups. Furthermore, several researchers observed no differences in observational learning effects between model skill levels (Martens, Burwitz, & Zuckerman, 1976; McCullagh & Meyer, 1997; Pollock & Lee, 1992). Female participants were tasked with learning the free-weight squat lift, and results showed that both a skilled and learning

model were equally beneficial for learning the correct form of the task (McCullagh & Meyer, 1997). Also, Martens, Burwitz, and Zuckerman (1976) compared skilled, learning, unskilled, and no model groups. Results displayed skilled and learning model groups were superior to the unskilled model and control groups. These findings suggest that different strategies used from viewing different model skill levels may have comparable effects on motor learning.

Despite the lack of clarity as to which of these two model skill levels is most effective for motor learning, evidence does show each one contributes to skill acquisition. Overall, both skilled and unskilled models can improve performance when compared to a control group that does not receive observation, thus validating the use of observational learning techniques. In addition, the benefits obtained from observation, whether the model is providing a demonstration with or without errors, appear to derive from the enhanced development of a cognitive representation of the motor skill that is used as a reference of correctness for skill execution. This enhanced cognitive representation serves as an error detection and correction mechanism that enables self-evaluation for acquiring the skill to be learned (Bandura, 1986; Blandin & Proteau, 2000; Blandin, et al., 1994). Given this, it is logical to consider that combining more than one model type could generate additive benefits to the learners. This research centers on this notion. Before proceeding further on this, is also important to consider other model characteristics that have an impact on observational learning benefits.

Model-Observer Similarity

Another factor to consider when deciding which model type to use is model-observer similarity. A variety of model characteristics such as age, gender, race, body type, and skill level could influence the perceived similarity between the observer and the model (Gould & Weiss, 1981). Bandura (1977) suggests similarity in all attributes, is best for learning. Increased model-

observer similarity has been shown to be more effective than dissimilar models (McCullagh & Weiss, 2001; Meaney, et al., 2005; Gould & Weiss, 1981). Peer models are matched by gender and age to the observer, increasing model-observer similarity in comparison to a non-peer model. Many researchers have incorporated the use of peer models, for example, Meaney, Griffin, and Hart (2005) demonstrated that gender of the model might impact the learner's perception of the task and influence skill acquisition. These researchers used a juggling task to examine the influences model skill level (skilled and learning) and model sex (male and female) on female participants. Results indicated participants transferred significantly more learning strategies after viewing a female model, implying an increase in model-observer similarity is favourable for learning. Furthermore, Gould and Weiss (1981) compared the effects of peer and non-peer models on muscle endurance performance. Participants were unskilled female university students; therefore, the similar model was a 24 year-old non-athlete female and the dissimilar model was a 27 year-old varsity track male. Findings showed participants in the peer model group performed a leg extension exercise significantly longer than the non-peer model and control groups.

Overall, the literature supports the use of models with increased similarity to the observer, such as peer models. Bandura (1977) suggests learners who perceive more similarities may relate more to the model, thereby increasing attention and improving subsequent performance. Many factors can affect the strength of model-observer similarity, and consequently, watching yourself is considered the greatest association to the model (Bandura, 1977). Given this model similarity factor, a number of researchers have proposed that observing the self may provide the greatest model similarity (Bandura, 1977; Clark & Ste-Marie, 2007; Dorrack, 1999), thus self-as-a-model types are presented next.

Self-as-a-model

Self-as-a-model interventions have benefitted learning when compared to a control group (Clark & Ste-Marie, 2007; Hodges, Chua, & Franks, 2003). Various self-as-a-model techniques exist within observational learning, such as feedforward self-modeling, positive self-review, and self-observation. Feedforward self-modeling is modifying videos to show behaviours the learner has not yet accomplished, or the execution of the task in a more challenging environment (Dowrick, 1999). Positive self-review involves video editing to include only correct actions or best attempts by removing errors and distracting footage (Dowrick, 1999). Self-observation is simply the playback of the unedited video for the learner (Dowrick, 1999). In using a sport situation from track and field, all three possible self-as-a-model techniques can be illustrated. First, consider that an athlete is videotaped running over a series of three hurdles, and in the process the athlete successfully clears one hurdle, but knocks over two. Feedforward self-modeling would reconstruct the video to show all three hurdles being performed successfully in a consecutive manner despite the runner not yet attaining that level of performance. The positive self-review video would be structured to show only the one successful hurdle clearance, and if we wanted to equate the number of observations, that would be viewed three times. Finally, the self-observation video would simply show the entire run, including both the successful and unsuccessful hurdling behaviours.

Franks and Maile (1991) reported that self-observation is effective because it provides quick, precise, and complete details of the just executed task. The unedited videos are argued to be informative, and to encourage the use of error detection and correction processes (Franks & Maile, 1991). Learners are said to identify errors they are making, as well as qualities of correct performances. This access to both KR and KP was proposed to enhance these processes, because

learners can associate different behaviours and actions with successful and unsuccessful trials (Adams, 1986; Blandin & Proteau, 2000). Hodges, Chua, and Franks (2003) studied the effects of self-observation on a bimanual coordination task. The modeling group showed better performance in both acquisition and retention trials than the non-modeling group, and were able to better distinguish between correct and incorrect movement patterns. To note, is that the propositions for why self-observation is effective are the same as for those presented in reference to the benefits of observing an unskilled model. When one engages in self-observation in the beginning stages of learning, the self is acting as an unskilled model and thus comparable strategies are argued to be employed. Therefore, self-observation, like unskilled models, may allow the participant to benefit from detecting their own errors and reinforce correct movement patterning. Subsequently, having the learner develop a stronger cognitive representation that strengthens the development of one's error detection-correction mechanism.

Mixed-Models

Thus far, self-observation has been presented as a valuable tool for motor learning as it engages the learner in cognitive and behavioral strategies that arise from watching one's own performance. On the other hand, self-observation does not provide the optimal reference of correctness for observers in those initial stages of learning. Skilled models, however, are argued to provide such a reference of correctness, but may not provide learners with the same cognitive and behavioral strategy benefits that are claimed to be provided by self-observation. This leads to the supposition that the combination of a skilled model type with self-observation would lead to learning strategies that would optimize motor skill acquisition. Certain authors have examined this supposition, however that literature, to be presented next, is limited.

Rohbanfard and Proteau (2011) used a sequential timing laboratory task to compare

individual model types and mixed-models. The task was to knock down three barriers and finally hit a target with their hand, in a clockwise motion. Each segment was to be completed in 300ms, for a total movement time of 1200ms. Participants were randomly divided into five groups: physical practice, unskilled model, skilled model, mixed-models (combination of an unskilled and a skilled model), and control. During the first session, the physical practice group executed 60 trials of the task with KR, all three of the observation groups watched 60 trials of the task on video and received KR in regards to the video trial, and the control group simply read a magazine. The unskilled and skilled model groups observed 60 trials of their respective individual model, and the mixed-models group alternated model types every five trials, to watch a total of 30 unskilled and 30 skilled trials. Next, all participants completed an immediate retention and transfer test. The retention test consisted of 20 trials of the task, without any feedback or video. For the transfer test, participants were asked to complete 20 trials of the same movement pattern, but this time in 1500ms (increased total movement time). The second acquisition session included 60 practice trials with KR for all groups except for the control group, who again read a magazine. This was followed by a 10-minute and a 24-hour retention and transfer test, following the same procedures as the immediate retention and transfer tests.

Results of Rohbanfard and Proteau (2011) showed that observation, regardless of the model, produced immediate performance benefits. Findings from the retention tests revealed that the mixed-models and the skilled model groups outperformed the unskilled model group. Interestingly, the transfer tests showed that the skilled and unskilled model groups had comparable performance, but the mixed-models group demonstrated better total movement time and intermediate times. This suggests that the learners profited from an accurate reference of correctness, but were still better able to transfer the learned task when the learner was able to

contrast the skilled model performance with that of an unskilled model (i.e., to use the mixed-models).

This mixed-models experimental design compared the use of one model (e.g. skilled model) to the use of two models (e.g. skilled and unskilled models). It could be argued that the advantages from observing mixed-models were derived from watching more than just one person, regardless of the different skill levels, as it provides another movement pattern to observe. For example, watching two different skilled models would offer additional information, compared to viewing only one skilled model, and this increase in information could enhance the learner's reference of correctness, and in turn enhance learning. Andrieux and Proteau (2013) eliminated this possible alternative explanation by investigating differences between observing two models as compared to watching just one model. The same sequential timing task used by Rohbanfard and Proteau (2011) was used in this experiment; i.e., the goal of knocking over three barriers and hitting a target in 1200ms. Participants were randomly assigned to one of the following groups: mixed-models, skilled models, unskilled models, physical practice, and control. The mixed-models group watched a skilled model execute 30 trials and an unskilled model execute 30 trials. The skilled models group observed one skilled model perform 30 trials and a different skilled model perform 30 trials. The unskilled models group viewed two different unskilled models, each completing 30 trials. The physical practice group executed 60 trials, and the control group simply read a magazine. Results demonstrated that the mixed-models and physical practice groups produced similar retention scores, which were both significantly higher than observation of two skilled or two unskilled models. The implication then is that the use of mixed-models was still the better observational learning approach, suggesting that the information afforded by the different model skill levels provided learning benefits above and

beyond that provided by viewing more than one model of the same model type.

Although Proteau and Rohbanfard (2011) have explored the differences between mixed-models and individual model types employing laboratory tasks, Ste-Marie et al. (2012) have noted that a gap in the observational learning literature is the lack of research in applied settings. Investigation into the effectiveness of mixed-models using applied tasks is beneficial for sport and rehabilitation communities. On the current research topic, Baudry, LeRoy, and Chollet (2006), studied the effects of mixed-models on a men's gymnastics skill. To maintain ecological validity, measures were taken to preserve traditional gymnastics training conditions. Experienced national level gymnasts were randomly assigned to either the mixed-models or the control group. The mixed-models video displayed both a skilled model and self-observation executing the skill using a split screen technique. This split screen technique displayed the self-observation video on one side of the screen (e.g. right half), and displayed the skilled model video on the other side of the screen (e.g. left half). These two videos played simultaneously for the observer to view both videos side by side.

While the video was playing, a coach compared the two performances and directed athlete's attention to important aspects of the skill. Participants in the mixed-models group sequentially completed a pre-test, five acquisition practice sessions with the mixed-models video intervention, and a post-test. Participant in the control group completed a pre-test, five acquisition practice sessions without video or verbal feedback, and a post-test. All participants were judged on body segment alignment, specifically the trunk-leg angle, to measure performance. The results from post-test showed the mixed-models group significantly improved performance of the circle as compared to the control group.

These findings are favourable, and are in line with the observational learning literature.

Moreover, the researchers demonstrated successful use of mixed-models in an applied setting, thus maintaining some ecological validity within a gymnastics club. However, a major limitation is that performance was only compared between mixed-models and a control group. As observational learning has been previously shown to be beneficial, it is important to determine if a mixed-models strategy is more effective than a single model, in order to promote the use of mixed-models. Another limitation was that the video feedback was augmented with verbal feedback from the coach. In sport situations, a coach may not always be available to provide verbal feedback associated with the visual feedback. Furthermore, the addition of verbal cues or feedback to video observation obscures the independent effects of a video intervention. Favourable results may have been due to the video feedback, verbal feedback, or a combination. The purpose of the current research is to investigate mixed-models techniques without accompanying verbal feedback to examine possible benefits of self-directed observational learning.

An example of mixed-models research with applications to rehabilitation is that by Onate, et al. (2005). They utilized mixed-models to examine jump-landings for rehabilitation purposes. Fifty-one healthy recreational athletes, between the ages of 18 and 25 years, were divided into four groups. The groups included: skilled model, self-observation, mixed-models, and control. Participants in the mixed-models group observed two trials performed by the skilled model, followed by watching three of their own trials. Results revealed all video feedback groups outperformed the control group, with the mixed-models and self-observation group performing better than the skilled model group. Onate and colleagues (2005) suggested that it is better to incorporate one's own performance to individualize the observation experience and allowing participants to be more actively involved in the learning process.

Onate et al.'s (2005) research has practical implications, supporting the use of mixed-models and self-observation video feedback in rehabilitation settings. However, similar to Baudry et al. (2006), participants were provided with verbal feedback throughout the learning phase. Again, the independent effects of the modeling video conditions are not known, and additive benefits may have influenced learning results. In the context of this research, one of the aims is to determine whether effective observational learning can occur without the provision of verbal feedback/instruction from the coach. As such, verbal feedback was not included in the current experimental design. The purpose of this research was to determine if a mixed-models approach is more effective for learning than self-observation. The research question was: will a mixed-models (the combination of self-observation with a skilled model) observation intervention, generate better skill performance and a better cognitive representation of a gymnastics skill in comparison to self-observation alone?

A gymnastics club was chosen as an applied setting in which to examine this research question as it is seen as an appropriate venue for the research. More specifically, gymnastics is a complex, high-risk, and aesthetic sport and self-observation techniques are often employed in this sport setting (Hars & Calmels, 2007). To this end, using a within-subjects design, gymnasts were tasked with learning two different gymnastics skills. During their regular gymnastics practices, over a 2-week period, they learned one skill using the mixed-models video intermixed with physical practice, and the other skill using self-observation intermixed with physical practice. The mixed-models video displayed a skilled model performing the skill coupled with self-observation. Based on results that have favored mixed-models over singular model types for motor skill acquisition (Onate et al., 2005; Rohbanfard & Proteau, 2011), it was hypothesized that use of mixed-models would produce higher physical performance scores than that of the

self-observation alone. It was also hypothesized that the use of mixed-models would better develop the learner's cognitive representation of the skill than the use of self-observation alone. These advantages generated by exposure to a mixed-models intervention compared to self-observation alone would be evidenced through superior performance on error recall and error recognition tests, as well as through superior physical performance of the gymnastics skills.

Chapter 3: Method

Experimental Design

The within-subjects design has been reported to reduce the variance of error associated with individual differences, as well as enabling one to obtain increased power with smaller sample sizes (Berg & Latin, 2008; Keren & Lewis, 2009). Knowing this, and due to the limited population to recruit from for the research, a within-subjects design was used. More specifically, each participant was tasked with learning two gymnastics skills. One gymnastics skill was learned by intermixing physical practice with self-observation on video, whereas the other gymnastics skill underwent the same physical practice, but with a mixed-models (self-observation and skilled model) video provided.

Participants

Twenty-one female artistic gymnasts, between the ages of 8 and 14 years (M age = 10.75, $SD = 2.07$) participated in the experiment. Gymnasts were recruited from the Ottawa Gymnastics Centre in Ottawa and Apollo Gymnastics in North Bay. All participants were registered in the Invitational Program and consistently practiced four hours a day, two days a week. Gymnasts had an average of 5.86 years of general gymnastics experience and 1.81 years of Invitational gymnastics experience. Sixteen participants indicated they had previously used video feedback in a gymnastics setting; 11 participants specified they used video feedback on a weekly basis, while the other 5 participants specified a monthly basis. All 16 participants who had previously used video feedback revealed that their coach provided verbal feedback to supplement the video. Moreover, 12 participants indicated that they found previous video feedback to be helpful, while 4 participants said that it was sometimes helpful. The experimental design received approval by the Research Ethics Board at the University of Ottawa (see Appendix A).

Gymnastics Skill Selection

The gymnastics skills selected for each participant were dependent on the level in which they competed within the Gymnastics Ontario's Invitational program. Two specific skills (one for the uneven parallel bars and one for the floor) were chosen per gymnast. The selection of the skills was done in consultation with coaches from Ottawa Gymnastics Centre and Apollo Gymnastics to ensure that appropriate and novel skills were chosen. A total of nine gymnastics skills were used in the experiment: five bars skills, and four floor skills (see list and description of the gymnastics skills in Appendix B). Every skill had a corresponding checklist comprising six key elements for correct skill execution (see Appendix C). These requirements were derived from the Gymnastics Ontario's Women's Artistic Rules and Regulations and in consultation with coaches from the Ottawa Gymnastics Centre. This checklist was used to provide skill instruction to the participants, and for the evaluators to assess physical performance. A specific skill instructions script was created from the checklist; to ensure the same information was verbalized for every participant (see Appendix D). Furthermore, the researchers had an attendance checklist for each participant to track their progress and for reference as needed (see Appendix E).

Gymnastics Environment

Data collection occurred in the natural environment of a gymnastics club; therefore, we had to work within the constraints of this environment. All participants attended their regularly scheduled practices, and the order of the skills was determined by the club's event rotation schedule. For example, if one participant's rotation schedule was Bars-Beam-Floor-Vault, then she completed all of the procedures for her bars skill during her first rotation, resumed regular practice until she arrived at floor, and then completed all of the procedures for her floor skill. Furthermore, coaches and athletes were asked to cooperate with the protocols of the study in two

important ways. First, it was asked that no verbal feedback be provided in regards to the assigned skills. Second coaches and gymnasts were asked to not engage in additional practice of the skills for the duration of the entire experiment.

Materials

Equipment. The required gymnastics equipment was setup at both sites: Ottawa Gymnastics Centre and Apollo Gymnastics. Participants used one set of uneven parallel bars, as well as the floor apparatus. All events were accompanied by the appropriate safety landing mats. For the videoing on site, a Sony video camera was mounted on a tripod, and setup at a 90-degree viewing angle to the apparatus in order to record the side view of all trials. These recordings were used as the self-observation video component, and for later performance analysis for the physical performance scores. The video camera was connected to a Toshiba laptop, which had Dartfish TeamPro 8 Software installed. This program was able to save and display the videos of all of the trials.

Questionnaires. Each participant completed a demographics questionnaire to gather information about the gymnasts' age, gymnastics level, years of gymnastics experience, and previous use of observational learning (see Appendix F). Also, every participant completed a Perceived Skill Difficulty Questionnaire in order to assess subjective difficulty of her skills (see Appendix G).

Modeling videos. Two modeling videos were used throughout this experiment, including a self-observation video and a mixed-models video (combination of self-observation and a skilled model). Self-observation was necessary for both video conditions, which involved displaying the unedited video replay of the participant's most recent block of trials. The skilled model was a female Provincial level gymnast, performing the specific skills without error. For

consistency purposes, the same model gymnast was used for all of the skilled model videos generated. This model was chosen, as she was the model that was used by Gymnastics Ontario in their videos that are used to demonstrate the correct execution of the compulsory Levels 3 to 5 gymnastics routines. Also, this model was considered a peer model with a high level of model-observer similarity because she was the same gender, within the same age range, and participating in the same sport as those observing the video. This was important, as it has been shown that the use of peer models and an increase in model-observer similarity are favourable for motor learning (Gould & Weiss, 1981; Meaney, et al., 2005).

Physical Performance

Evaluators' physical performance videos. The evaluators watched the videos that had been recorded of the participants executing the skills to generate performance scores using the checklist of six key elements. The individual video trials of the gymnasts were assembled such that the evaluators received one overall video with all of the participants' trials. Skills were shown in blocks of two trials, and all participants' blocks were randomized to conceal the timeline of the experimental protocol. In addition, all evaluators were required to sign a confidentiality agreement (see Appendix H), because they watched videos of the participants.

Evaluators' physical performance sheets. To compliment the video, evaluators were provided with a marking sheet (see Appendix I). This sheet had each skill listed in order of appearance on the video and included the six key elements that had been provided in the checklist for their reference. Evaluators were asked to score each skill component, and mark their score down in the appropriate box. Detailed information about the scoring system can be found in the 'dependent measures' section.

Physical performance was measured based on the execution of each skill. Two evaluators who were blind to the conditions, with at least 10 years of combined gymnastics and coaching experience, independently evaluated each video to generate the participants' performance scores. The evaluators watched every trial and indicated if the athlete demonstrated each skill requirement on the checklist of the six key elements provided.

Cognitive Representation

Each participant individually completed an error recall test and then an error recognition test for each skill during the pre-test and the post-test. For both error tests, participants were required to watch the error test videos specific to their assigned skills.

Error test videos. Videos were constructed for each of the gymnastics skills used in the experiment (i.e. 10 videos were made). Each of these 'error test videos' consisted of six performances of the same skill, executed by the same gymnast. The error test models were two National level gymnasts from OGC, who granted permission for their videos to be used in the experiment (see Appendix J). For the purposes of the error tests, three of the skill demonstrations were performed with error, whereas the other three were performed correctly. For the three video trials in which errors were present, either one, two, or three errors were shown.

Error recall test. Participants were first asked if the first video trial of six was correct (i.e. no errors) or incorrect (i.e. demonstrated error(s)). Their answers to this decision comprised the error detection component. Next, participants were asked to write down on a sheet provided the specific errors they saw in the video trials. This component of the task was classified as the error identification component. The 'error recall sheet' included both error detection and identification components (see Appendix K). Participants were instructed to indicate if the skill was performed correctly or incorrectly (i.e. demonstrating error) with a checkmark in the

appropriate column. If the video was incorrect, participants were asked to list the error(s) they observed in the space provided.

Error recognition test. The second error test was an error recognition test, which was used to examine participants' abilities to recognize errors during skill execution. For this error test, participants watched the same series of six video trials of the skill; however, they were tasked with checking off errors they saw from the list of six errors provided. The 'error recognition sheet' had a list of six errors corresponding to the six key elements of the skill (see Appendix L). Participants were tasked with identifying errors they observed with a checkmark in the box associated with that specific error. Gymnasts were instructed to leave the column blank if they thought the skill execution was correct.

The separate error tests were used to distinguish between error recall and error recognition, because they evoke different strategies. Error recall requires participants to generate answers, whereas error recognition provided a list of errors for the participants to identify in the video trials. While both tests involve decision-making, the error recall test requires a higher level of processing than the error recognition test (Cabeza, et al., 1997). Recall involves encoding, storing, and retrieving information pertaining to the relevant errors, while recognition does not require that depth of processing (Craik & Lockhart, 1972). Since our participants were children, there was a possibility that an error recall test may have been too difficult; therefore, we included an error recognition test to assess their ability to identify errors in the video.

Procedures

The managers at the Ottawa Gymnastics Centre and Apollo Gymnastics were contacted and informed about the experimental procedures. The managers and the head coaches gave their permission for their Invitational athletes to participate, and for the experiment to occur at the

Ottawa Gymnastics Centre and the Apollo Gymnastics Club, respectively. The managers then distributed the information letter, consent form, and participant assent form to all of the Invitational athletes and their parents (see Appendices M and N, respectively). This was followed by a verbal information session, delivered by the primary researcher, with the manager, and the interested parents in attendance. The researcher explained the experimental procedures at the meeting and answered questions from the parents. Next, parental consent was obtained, followed by athlete assent prior to the onset of trials.

Figure 1 provides a visual overview of the experimental procedures. For every session, athletes completed all of the procedures for the first skill, and then repeated the same procedures for the second skill within the same four-hour practice session. The sessions followed the athlete’s regular practice schedule of training two days a week. For example, if one participant practiced on Tuesdays and Thursdays, Session 1 would occur on Tuesday, Session 2 on Thursday, Session 3 on the next Tuesday, and so on.

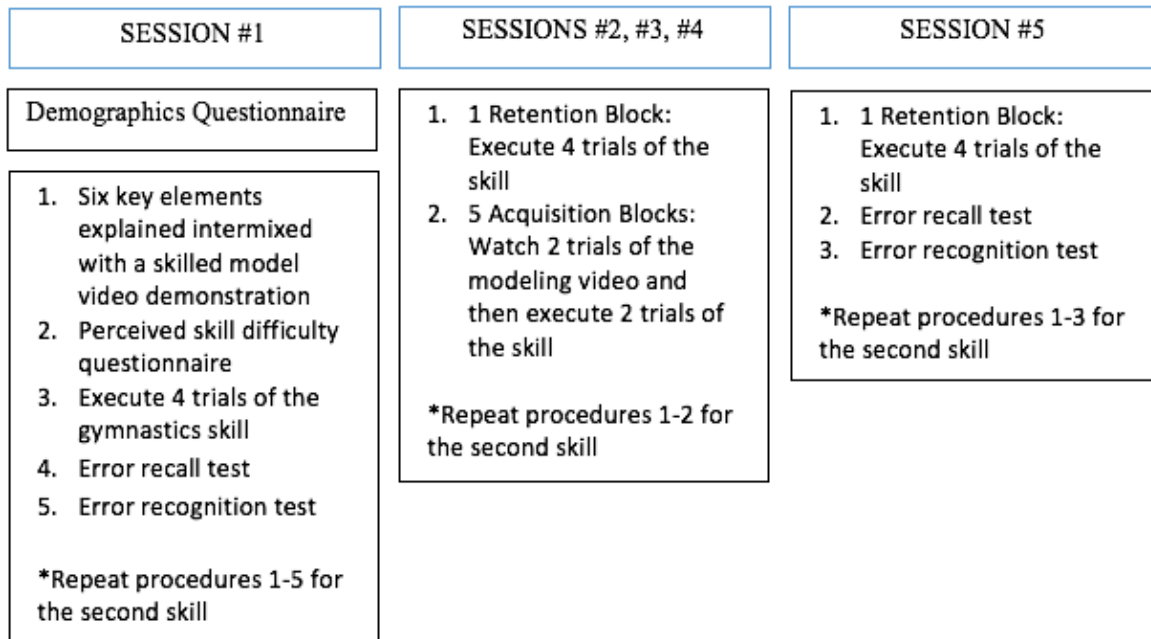


Figure 1. Visual overview of the experimental procedures for Sessions 1 through 5.

Session 1. All participants began the experiment by completing a demographics questionnaire. A researcher helped the gymnasts complete this questionnaire, making sure they understood each question. Next, participants were provided with verbal instructions in regards to their specific chosen skill. These verbal instructions were intermixed with the presentation of a video that showed a skilled model executing the skill without any errors. The skilled model video displayed in the instructional period was the same skilled model video shown throughout the mixed-models intervention. This element was incorporated to provide important safety and instructional information to the participants before they attempted a novel skill. Also, this ensured the learner was aware of the critical scoring elements of the to-be-learned.

To expand, four ‘perfect’ demonstrations of the video and the six key elements that were used to judge the skill were intermixed. For example, if the skill chosen was the back extension, the participant watched one video trial of the skill, and then the researcher shared the first two key elements: the roll back begins in a squat position with hands at the ears, and hands should be approximately shoulder width apart when they contact the floor. The instructional session continued with another video trial of the skill, followed by the next two key elements, and so on. Following the intermixed verbal instruction and video observation, participants were asked to complete the perceived skill difficulty questionnaire. This questionnaire assessed the participant’s perceptions in regards to how easy or difficult the skill would be to execute without error.

Within the first session, participants also participated in the pre-test phase. In this phase, participants were first asked to execute four trials of the specific skill to the best of their ability. Subsequent to this, gymnasts individually completed the error recall and error recognition tests. For the error recall test, participants watched the ‘error test video’ that was created for their

specific skill. For each of the six video trials shown, participants used the ‘error recall sheet’ provided to check off whether the skill was correct or incorrect. If they detected error in performance and checked off the ‘incorrect’ box, they were asked to identify the specific error(s) they observed in the space provided on the same ‘error recall sheet’. Participants had an unrestricted amount of time to write their answers, as the researcher paused the video after each skill performance.

Next, for the error recognition test, participants watched the same error test video, but this time they were given the ‘error recognition sheet’ to use. On this sheet, they checked off any of the errors they observed. Thus, rather than having to generate errors observed on their own, participants were able to use the list of errors provided to identify the errors they saw. Again, participants were afforded as much time as needed before the subsequent video trial was played.

After Session 1 was completed, the researcher assigned the skills to the two video conditions (i.e., self-observation only or mixed-models) in a counterbalanced manner. The researcher also consulted the perceived skill difficulty ratings to assist with the assignment of skills to the conditions. The purpose of this approach was to ensure that any one condition was not favoured in terms of having an ‘easier’ subset of skills assigned to that condition.

Sessions 2, 3, and 4. Each session occurred on a regular practice day, with each session taking place at least 48 hours apart. Participants followed the same procedures for Sessions 2, 3, and 4, for both of the assigned skills. At the beginning of each session, participants were told (or reminded) that any time the video showed a performance of their own attempt of the skill that it represented their recent physical attempt of the skill, whereas the peer-model presentation provided an example of a gymnast demonstrating the skill as it should be performed (i.e. without any errors). For the self-observation only condition, participants watched both trials from the just

performed block of trials. In the mixed-models condition, participants watched the first trial from their just performed block of trials using self-observation and then watched one trial of the skilled model executing the skill without error. It is important to note that both video conditions involved two observation experiences, thus the frequency of observation was the same and it was only the content that differed.

After this information was verbalized, participants executed four trials of the to-be learned specific gymnastics skill with no video demonstration provided beforehand. Since no video intervention was provided before, these trials served as a retention test¹. Following the retention test, gymnasts moved into the acquisition phase, comprised of five trial blocks. Each trial block consisted of first viewing the video of the assigned modeling condition, and then attempting two physical performance trials. For every participant, each event was associated with a different video condition; therefore, at one event they watched the mixed-models video, and at the other event they watched the self-observation video.

Session 5. Gymnasts began Session 5 on the respective events with a retention test comprised of executing four trials of the experimental skill, with no video presentation. After these physical performance trials, the gymnast completed the error recall and error recognition tests, following the same procedures as those described in Session 1; however, the order the skill performances appeared was changed.

Dependent Measures

Physical performance. For each gymnastics skill, two of the six key skill elements that had been identified as critical for movement execution were awarded either 0 (unsuccessful), 0.5

¹ The reason for the inclusion of a 'retention test' in Session 2, despite no real practice being provided, was that we wanted to make sure that even with video demonstration of skilled model in Session 1 both groups were starting at the same point. Thus, the retention test in Session 2 was used in the data analysis as the pre-test for the physical performance scores.

(somewhat successful), or 1 (successful) points. The remaining four key skill elements were awarded either 0 (unsuccessful) or 1 (successful) points for their execution. This particular marking breakdown was provided for the evaluators and included specific skill performance criteria for each score interval. For example, the marking scheme for kip cast kip on bars included “straight arms” and “straight legs”. These two key skill elements were awarded either 0, 0.5, or 1 points. The marking sheets given to the evaluators consisted of the following information: straight arms (within 10 degrees) = 1 point, slightly bent (within 30 degrees) = 0.5 points, bent (over 30 degrees) = 0 points, and straight legs (within 10 degrees) = 1 point, slightly bent (within 30 degrees) 0.5 points, bent (over 30 degrees) = 0 points. The remaining four key elements were labeled with the correct execution (e.g. continuous sequence with cast) and evaluators were informed that the successful execution of that element received 1 point and unsuccessful or incorrect execution of that element received 0 points. Parameters of this nature were provided for each of the 10 gymnastics skills that were scored by the evaluators.

Overall, a maximum score of 6 could be attained per trial. Each evaluator provided a score for every acquisition and retention trial for both skills learned by each gymnast. For acquisition, the evaluators’ scores were averaged to generate one score out of 6 points, per skill, per participant, per acquisition block. For retention tests, all four retention trials were averaged to produce one retention score out of 6 points, per skill, per participant.

Cognitive representation. The dependent measure for the error detection component from the error recall test was calculated using percentage of correct responses. Each participant watched six video trials; therefore, error detection scores could range from 0% (0/6 correct) to 100% (6/6 correct). Next, the dependent measure for the error identification component was

calculated using signal detection analysis, as it is a means for quantifying participants' abilities to discriminate between stimulus (e.g. errors) and noise (e.g. non-errors) (Macmillan, 2002).

Furthermore, the dependent measure for the error recognition test was also derived using signal detection analysis. In this analysis there are four categories of responses (hit, miss, false alarm and correct rejection). Using Macmillan's categorization (2002) for this research context, when the gymnastics skill viewed on the error recall or error recognition test contained an error, the hit and miss categories are characterized in the following manner: (1) a 'hit' occurs when the participant correctly identifies the error, (2) a 'miss' occurs when the participant does not identify the error. When an error does not occur in the video presentation, the other two categories arise: (1), a 'false alarm' occurs when the participant identifies an error, and (2) a 'correct rejection' occurs when they indicate there was no error shown. As such, each decision made by the participant allowed for the conversion of the responses into the four categories of signal detection.

Signal detection analysis generates two measures; sensitivity and response bias. Sensitivity (d' ; d') is calculated by the difference between the means of the two distributions (hit rate and false alarm rate). A higher d' reflects a better ability to discriminate stimuli (error) from noise (non-error). Specific to this research, as sensitivity scores increase, it would indicate that gymnasts are getting better at distinguishing a skill execution video with error from a skill execution video without error. In other words, participants with a higher sensitivity score would show a better hit rate (i.e. more correct answers) and a lower false alarm rate (i.e. less incorrect answers). Next, the response bias is a participant's tendency to say error (or non-error), and is represented by the location of criterion. A negative criterion is identified as a liberal bias and a positive criterion is classified as a conservative bias. In regards to the current

research, a more liberal bias would be indicated by more errors written down or checked-off, while a more conservative bias would be indicated by less errors written down or checked-off.

Data Analysis

The independent variable was the video condition, varying in the use of one (SO) or two (MM) models during the provision of video. The physical performance dependent variable was the performance scores, evaluated by two evaluators. The cognitive representation dependent variables were error detection, sensitivity (d') and response bias (C). All data are expressed as means with standard deviations, and F values are provided for the main effects. Partial eta squared (η_p^2) is reported to provide an estimate of the proportion of the variance that can be attributed to the independent variable. If Mauchly's Test of Sphericity was violated, a Greenhouse-Geisser correction was performed. Statistical significance was set at $p < .05$. When necessary, Bonferroni post-hoc analyses were performed to ascertain the location of significance.

Since we used evaluators to score the gymnast's performance, it was important to test whether the scoring measure was reliable. To do so, an intra-class correlation was employed to measure inter-rater reliability between the two evaluators. After verification of the scoring measure, a 2 Video (SO, MM) x 3 Session (S2, S3, S4) x 5 Block (B1, B2, B3, B4, B5) three-way repeated measures analysis of variance (ANOVA) was performed to explore the acquisition physical performance scores. Acquisition scores provide insight into what occurs with performance scores during practice; however, temporary performance effects may confound learning effects during the acquisition practice session. Therefore, it is important to use retention tests to examine the relatively permanent effects the different conditions might have on the performance scores (Schmidt & Bjork, 1992). The learning physical performance scores were analyzed using a 2 Video (SO, MM) x 4 Time (Pre, R1, R2, Post) two-way repeated measures

ANOVA. Furthermore, participants' answers from the error recall and error recognition tests were used to examine cognitive representation. For error detection, a 2 Video (SO, MM) x 2 Time (Pre, Post) repeated measures ANOVA was performed. For error identification for the error recall and error recognition tests, two 2 Video (SO, MM) x 2 Time (Pre, Post) repeated measures ANOVAs were conducted; one for response sensitivity (d') and one for response bias (C).

Chapter 4: Results

Preliminary Analyses

Evaluators' inter-rater reliability was assessed using a two-way random, absolute agreement, single-measures intra-class correlation (ICC) to evaluate the consistency in physical performance scores. Results indicated that the evaluators had a high degree of agreement, $ICC = .901$, suggesting that physical performance was scored similarly across evaluators.

Next, descriptive statistics were run to explore the data. Possible outliers were detected using box plots, and as a result, two participants were removed from further data analysis. Moreover, one participant was deleted from data analysis, as she did not complete all of the sessions in the study. Therefore, the data from 18 participants was used in the analysis concerning physical performance.

Moreover, during the error recall test, at least 5 participants chose not to write down errors on the paper provided, even though they had indicated that the skill execution seen on video was incorrect. This occurred despite the researcher providing unlimited time for the answers to be recorded, and encouraging participants to write down the errors they saw. For unknown reasons, however, these participants did not want to complete this part of the error recall test. Given the incomplete nature of this data set, the error identification scores from the error recall test were eliminated from the experiment due to participant noncompliance. Consequently, only error detection data from the error recall test and data from the error recognition test were analyzed. The error recognition test, however, was only added to the experimental design after five participants had completed the procedures; therefore, only 15 participants were included in the error recognition data analysis.

Finally, a t-test was performed on the scores from the perceived skill difficulty questionnaire. The ratings from this questionnaire were used to assign participants' skills to the

two conditions, as to not provide advantage to either one condition. Results showed there were no significant differences in perceived difficulty between the two video conditions, $t(20) = .367$, $p = .718$. This provides an assurance that should there be differences between the two video conditions, it would not be related to the differences in difficulty level of the gymnastics skills used in each video condition.

Acquisition Physical Performance Scores

The within ANOVA revealed a significant main effect of Session, $F(2,34) = 7.201$, $p = .002$, $\eta_p^2 = .298$. Bonferroni post-hoc tests indicated that the learners improved across the sessions; specifically, Session 2 ($M = 3.42$ (1.96) points) was significantly higher, $t(179) = 2.399$, $p = .017$, than Session 1 ($M = 3.24$ (1.27) points), and Session 3 ($M = 3.69$ (1.23) points) was significantly higher, $t(179) = 5.910$, $p < .001$, than Session 2 (Refer to Figure 2). While the mixed-models condition had higher physical performance scores ($M = 3.74$ (1.08) points) than the self-observation condition ($M = 3.16$ (1.33) points), the main effect of Video $F(1,17) = 3.594$, only approached significance at $p = .075$, $\eta_p^2 = .175$. There were no other significant main effects ($p > .05$) or significant interactions ($p > .05$) for the acquisition physical performance scores.

Retention Physical Performance Scores

The learning physical performance scores from the retention blocks were analyzed and results showed a significant main effect of Video $F(1,17) = 6.273$, $p = .023$, $\eta_p^2 = .270$, with mixed-models ($M = 3.86$ (1.00) points) producing significantly higher performance scores than self-observation ($M = 3.12$ (1.36) points). Additionally, there was a significant main effect of Time $F(3,51) = 30.876$, $p < .001$, $\eta_p^2 = .645$. Both these main effects, however, were superseded by a significant interaction between Video and Time $F(3,51) = 3.329$, $p = .027$, $\eta_p^2 = .164$. Bonferroni post-hoc tests indicated that the self-observation and mixed-models retention scores

from pre-test and Retention 1 were not significantly different ($p = .33$ and $p = .115$ respectively); however, by Retention 2 ($t(17) = 3.017, p = .008$) and again for post-test ($t(17) = 3.522, p = .003$), skills learned under the mixed-models condition were learned significantly better than the self-observation condition (refer to Figure 2).

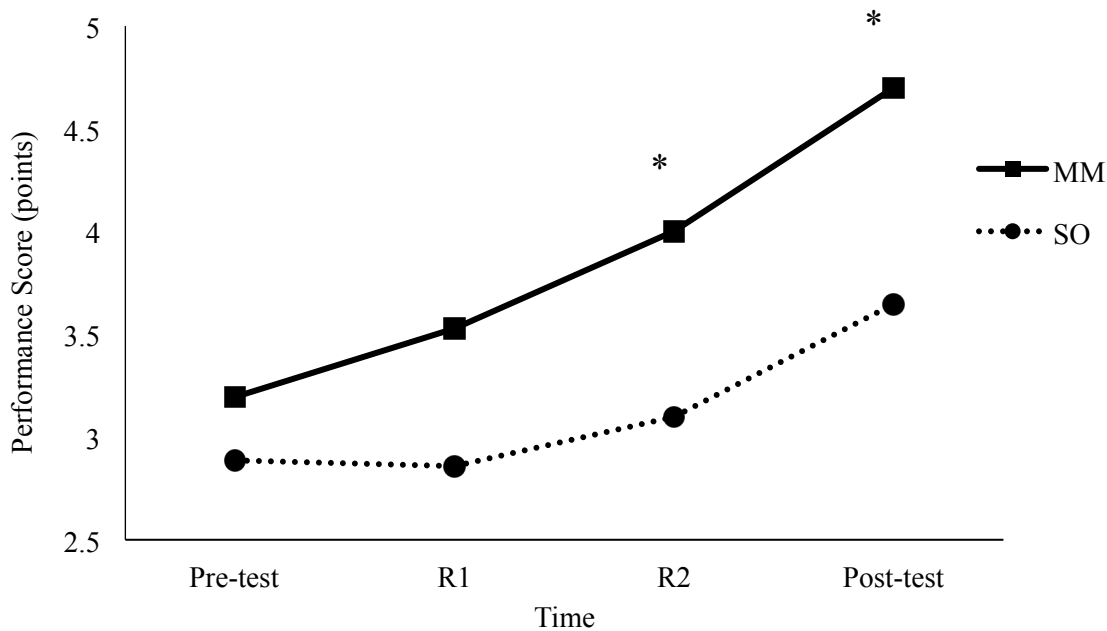


Figure 2. Mixed-models vs. self-observation physical performance retention scores from pre-test, Retention 1, Retention 2, and Post-test.

Error Test Cognitive Representation Scores

The error detection component from the error recall test was scored using percentages of correct responses. Analysis revealed no significant main effects or significant interactions ($p > .05$) for error detection.

The error recognition test was scored using signal detection; therefore, sensitivity and response bias were used in the analysis. With respect to sensitivity, a significant main effect of Time was obtained, $F(1,14) = 6.589, p = .022, \eta_p^2 = .320$, but this was superseded by a significant interaction between Video and Time, $F(1,14) = 10.810, p = .005, \eta_p^2 = .436$.

Bonferroni post-hoc tests indicated that during the pre-test there was no significant difference between the skills learned with self-observation versus mixed-models ($p = .544$); however, during the post-test, the mixed-models condition yielded significantly higher sensitivity, $t(14) = 3.197, p = .006$, than the self-observation condition (Refer to Figure 2). In relation to the response bias measure, there were no significant main effects ($p > .05$) or significant interactions ($p > .05$) for the error recognition test.

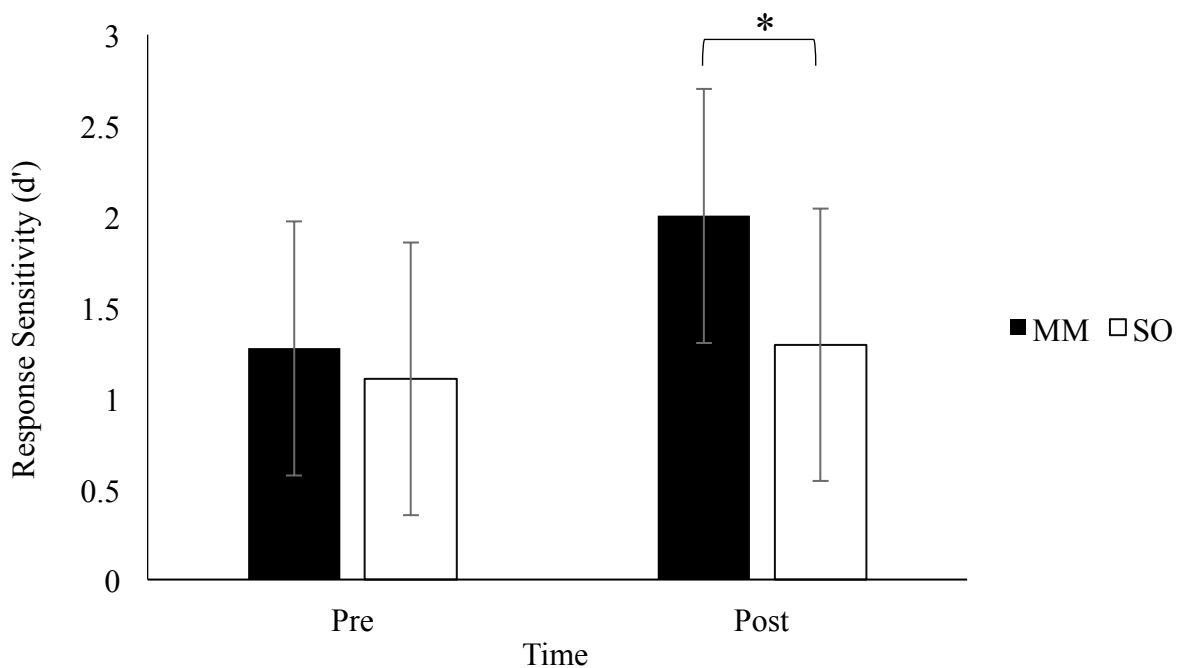


Figure 3. Mixed-models vs. self-observation cognitive representation sensitivity scores from the error recognition test at pre-test and post-test.

Chapter 5: Discussion

Optimizing learning conditions has always been of interest to motor learning researchers. One domain of importance has been the use of video observation to improve skill learning. Bandura (1986) suggested that people learn through observation by a multi-stage process that relies on both cognitive and motoric processes. Observation of different model types may influence these observational learning sub-processes, and impact subsequent performance and overall success. Previous research has shown that skilled models are an effective model type for motor learning, because they can grant learners an accurate reference for error correction (Sheffield, 1981; Blandin et al., 1994). On the other hand, past research has demonstrated that self-observation is beneficial for motor learning, and has been argued to be related to learners discovering errors and invoking problem-solving strategies (Onate, et al., 2005).

Given that these two model types provide observers with different strategies to learn and improve motor skills, it is reasonable to propose that using both model types would elicit additive benefits. Thus, the purpose of this experiment was to examine self-observation versus mixed-models (self-observation and a skilled model video) and their relative effectiveness for motor skill acquisition in the applied setting of a gymnastics club. Based on results that have favoured mixed-models (Onate et al., 2005; Rohbanfard & Proteau, 2011), it was hypothesized that the use of mixed-models would produce higher learning physical performance scores than the use of self-observation alone.

While results from previous experiments suggest mixed-models would be better than self-observation alone, none of those experiments used a multi-day acquisition period. Consequently, this aspect is exploratory, and it was further hypothesized that the mixed-models condition would show more accelerated learning than the self-observation condition; therefore, performance scores from Retention 1 and Retention 2 would be significantly higher for mixed-

models. Additionally, it was posited that the self-observation condition would still be effective for learning; therefore, by the time of post-test, performance scores would be more comparable between the two conditions. Furthermore, in regards to the cognitive representation, it was hypothesized that the error test sensitivity scores from the post-test would be significantly higher in the mixed-models condition when compared to the scores in the self-observation condition.

Cognitive Representation

Bandura (1977) suggested that learners symbolically code desired behaviours demonstrated by a model, which can then be used to direct future learning. Learners' physical abilities may restrict actual motor performance; therefore, physical performance scores may provide a limited assessment of learning (Bandura, 1977). It can be argued that participants with a better cognitive representation of a skill would exhibit a better ability to detect, identify, and/or recognize errors (Bandura, 1977). For this reason, error tests were included in the experiment to evaluate participants' cognitive representations. As noted in the results section, the credibility of the data from the error recall test was questioned because participants often did not write down any errors despite verbally indicating they detected errors. For this primary reason, the error information from the recognition test, in which the possible errors were available to the participants, will be relied upon for interpretation of the data.

Error recognition. As a reminder, participants watched a series of six videos, and were asked to identify errors observed by selecting responses from a list of six errors associated with each skill. The Video by Time interaction for the response sensitivity measure supported the hypothesis that the mixed-models condition would generate a better cognitive representation than the self-observation condition. While there were no differences at pre-test between the two conditions, at post-test, when participants observed the mixed-models video they had

significantly higher sensitivity scores than when they received self-observation only. This suggests that the mixed-models intervention helped participants improve their ability to recognize errors in a gymnastics skill performance and to distinguish them from non-error performances.

There were no significant results for response bias, which represents the decision criterion to state whether there was an error (or not); in the specific situation here, this was the participants' tendencies to check-off errors (or not) from the list provided. Upon examination of the data, 90% of the participants had a conservative approach in both conditions (i.e. $C > 0$), which implies they favoured making a decision of non-errors versus that of errors. Thus, learning with the mixed-models video condition enabled better discrimination of errors, but did not change response bias.

A possible explanation for the conservative approach is that participants only viewed the video trial once, and the skills happened quickly. Gymnasts may have noticed that the skill execution was incorrect, and may have even correctly identified one error; however, various video trials showed two or three errors. It may have been difficult for the participants to recognize multiple errors in a single video trial. Perhaps once they observed one error, they would locate it on the list and check it off, instead of watching for additional errors. Another explanation for the conservative approach is that there may have been some psychological discomfort associated with the error test. The researcher sat right beside the participant while they marked down their answers on the document provided, as the researcher was responsible for playing and pausing the video trials. Participants may have experienced an increase in stress or anxiety levels with the researcher 'looking over their shoulder'. The participants may have also

felt like the researcher was going to judge their answers; therefore, were more reluctant to check-off an error.

Overall, the findings suggest that a mixed-models intervention allowed participants to develop a better cognitive representation than a self-observation intervention. Before elaborating upon why this may occur, I will turn to the physical performance data. According to Bandura (1977), as long as the participants are physically able, this improvement in the cognitive representation should translate into better physical performance.

Physical Performance

Acquisition. The main effect obtained for Session showed that, regardless of video condition, participants significantly improved their physical performance scores across acquisition sessions. This is important to highlight because it shows that participants were learning their two gymnastics skills across the practice sessions. That is, the observation of the modeling videos and physical practice of the skills during the three practice sessions afforded learning of the gymnastics skills. Of more interest, was whether the varied modeling conditions yielded different physical performance outcomes during practice. Although mixed-models generated higher performance scores overall than self-observation, the main effect of Video only approached significance during acquisition ($p = .075$). Consequently, these results suggest that both learning conditions had a similar impact on performance during practice.

Retention. The interaction obtained for Video by Time partially supports the hypothesis, with the mixed-models condition producing superior learning benefits than self-observation alone, but only for specific time points. The interaction obtained; however, was not in the direction that was expected; in other words, the mixed-models intervention would lead to a more rapid learning curve and that the self-observation would eventually ‘catch up’. Instead, the

interaction showed that the mixed-models condition had similar learning early in acquisition, but significantly higher physical performance scores than self-observation in Retention 2 and post-test. The results, therefore suggest that both conditions promoted learning of the skill; however, the mixed-models condition was more effective, as evidenced by physical performance scores surpassing the self-observation condition in Retention 2 and post-test. While these results do not support the specific hypotheses made, it is possible that with the addition of more practice sessions the scores obtained with the self-observation intervention may have continued to improve and would eventually reach the same performance level as the mixed-models intervention.

The results from this experiment are similar to previous mixed-models studies that also showed that a mixed-models approach was more effective for motor learning (Onate et al., 2005; Rohbanfard & Proteau, 2011). Our physical performance and cognitive representation findings thus support the notion that the use of mixed-models is more beneficial than a single model type. While Rohbanfard and Proteau (2011) discovered favourable results for a skilled and unskilled mixed-models condition, the current research was novel in that it included a skilled and self-observation mixed-models condition. Self-observation is commonly used in a gymnastics setting (Hars & Calmels, 2007); therefore, it was included in the experimental design in order to compare model types that are used by coaches in real world situations. Additionally, self-observation increased model-observer similarity, which has been shown to benefit learning over dissimilar models (Gould & Weiss, 1981; Meaney et al., 2005).

The results, however, differ from those of Onate, et al. (2005), who also incorporated a skilled and self-observation pair for their mixed-models condition. Their results revealed that the self-observation only group was equally as good as the mixed-models group; however, the

current study found a significant difference between the same two conditions. The difference in results may be due to the incorporation of verbal feedback. Onate et al. (2005) provided relevant verbal feedback with all of the modeling videos. It is possible that the use of verbal feedback may have influenced the results, overpowering the effects of the specific video observations. McCullagh and Meyer (1997) investigated the use of verbal feedback with observation, and found the addition of feedback contributed to the model's effectiveness. Also, a performance ceiling effect might have influenced the results if participants could only improve so much, or both conditions allowed them to improve their performance to a maximum level. On the other hand, the current research assessed the learning of gymnastics skills, and provided no verbal feedback throughout the experiment. Perhaps the exclusion of the associated verbal feedback with the videos allowed better identification of the distinct learning effects between the two conditions.

The question remains, what does the mixed-models intervention provide over self-observation? One important factor is that the mixed-models condition provides the learner with two distinct model types, each said to benefit learning in different ways. Specific to this research, the skilled model is assumed to have provided a reference of correctness to the observer (Sheffield, 1981; Blandin et al., 1994). Sheffield (1981) posited that with a more correct video demonstration, a more accurate cognitive representation could be formed. Moreover, the skilled model may serve as an outcome goal for participants in the mixed-models condition to strive towards. Also, the identical skilled model video was shown after every block of trials, whereas the self-observation video was updated with a more recent physical performance attempt. Perhaps repetition of the same skilled model video allowed participants in the mixed-models

condition to better store this information in their memory, and retrieve it for subsequent physical performance.

At the same time, self-observation can allow participants to actively engage in the observational learning process by evaluating one's own performance, which can lead to the discovery of errors (Onate, 2005). The self-observation video updated to show recent skill execution; therefore, participants were able to compare this updated information to the consistent skilled model video. Combined, the benefits from these model types have potentially additive effects.

Another factor can be related to the benefits of increased cognitive effort for motor learning. It has been proposed that when greater cognitive demand is required during acquisition of a new task, than increased learning takes place (Lee, Swinnen, & Serrien, 1994). It can be argued that due to the inclusion of two model types instead of just one, mixed-models necessitates more information processing than self-observation alone, and therefore requires greater cognitive effort. Taken together, it is argued that the provision of a precise reference of correctness combined with the availability of self-evaluation, resulted in increased cognitive effort that lead to enhanced motor learning.

A final factor to consider arises from an unexpected finding, related to offline learning. Offline learning is improvement in performance that is seen between practice sessions, without any additional physical practice (Walker, 2005). These offline learning benefits are purported to be a result of memory consolidation processes (Stickgold & Walker, 2007) that are responsible for information storage into long-term memory (McGaugh, 2000) and can occur during the sleep cycle between practice sessions. A visual examination of the data from the last block of each practice session (Block 5) compared to the retention test that occurred in the subsequent session

days later, suggests that offline learning may have occurred for the mixed-models condition, but not for the self-observation condition. As can be seen in Figure 4, when participants learned a gymnastics skill under the mixed-models condition, the change from Block 5 to the retention test (including post-test) showed an improvement in physical performance scores, even though they received no additional practice. In contrast, the skills learned with the self-observation intervention showed a decline in physical performance from Block 5 to retention (including post-test) each time. This different pattern of results suggests that the mixed-models condition enabled better storage and later retrieval of skill information from their long-term memory assumedly due to the enhanced motor memory consolidation processes (Trempe & Proteau, 2012).

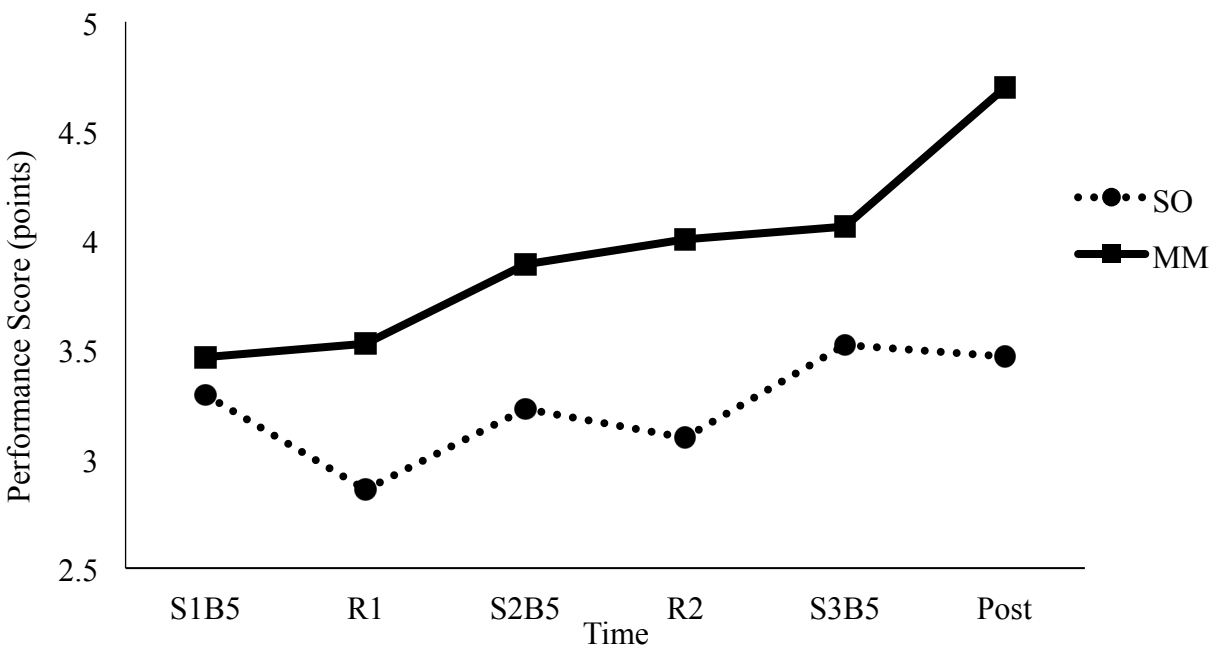


Figure 4. Self-observation and mixed-models physical performance scores from Session 1 Block 5, Retention 1, Session 2 Block 5, Retention 2, Session 3 Block 5, and post-test.

This experiment is the first to have multiple acquisition and retention sessions separated by time intervals of 48 hours or more, with both mixed-models and self-observation alone

conditions, and thus there is no previous research to draw upon for interpretation of this specific data. The findings do reinforce the abovementioned notions concerning the unique benefits that may arise when learners are provided two different model types in a learning situation and allow us to speak more directly to the mechanism of the advantages possibly lying within the consolidation processes that can occur in between practice. Further research on the effects of mixed-models on motor memory consolidation is recommended.

A possible explanation for these findings is related to past research that suggests some consolidation processes are only activated when the learner experiences some degree of success during practice (Lewthwaite & Wulf, 2010; Trempe, Sabourin & Proteau, 2012). Specifically, Trempe et al. (2012) revealed that all groups improved performance during the first session; however, after 24 hours, retention results showed participants who had initially experienced success performed significantly better than those who did not feel successful. The comparison of videos could have informed participants in regards to their success. In the current study, participants were not given performance scores to acknowledge their success; however, the evaluation process that was available through the comparison of their performance with that of the skilled model may have allowed participants under the mixed-models condition to subjectively estimate their success better than under self-observation alone. Further research of the effects of mixed-models on motor memory consolidation is recommended.

Limitations

Recognition must always be given to the limitations of one's experimental design. Certainly, in the case of this research in which data collection occurred in the applied setting of a gymnastics club, there were limitations imposed by the constraints of this environment. To begin, coaches, athletes, and participants were all asked to not provide verbal feedback or allow

additional practice of the assigned skills; however, we were unable to control this factor, and there was the occasional occurrence of instruction being provided. For example, an athlete from another group provided a correction “keep your legs straight” to a participant during her back handspring procedures. As well, a coach from another group told a participant to “drop faster” while she was performing her stride circle. Overall, these were rare occurrences, and it is anticipated that it did not have a big impact on the data.

Other variables that could not be controlled for were differences that may have occurred for the same gymnast as they experienced the two experimental conditions; such as differences in fatigue, sore muscles, weather conditions controlling the temperature in the gymnastics club, observation of a peer model (e.g. another gymnast) during practice, and possible distractions around the gymnastics club. It is again argued, however, that these variables happened similarly between the two video conditions and thus should not be a confounding variable.

Also, a limitation of the experimental design was the use of multiple gymnastics skills across participants and conditions. Due to a limited gymnastics population to draw from, and drastic individual differences, the use of a variety of skills was necessary. For this reason, a within-subjects design was incorporated to minimize the effects of individual differences, and to increase power with a smaller sample size. Furthermore, skills were counterbalanced between the two conditions, and perceived skill difficulty scores were balanced between conditions to ensure that one condition did not have a subset of skills that were in fact more difficult than the other condition (refer to Table 1).

SO Event	SO Skill	SO PSD	MM Event	MM Skill	MM PSD
Bars	FC	4	Bars	FC	5
Bars	FC	6	Bars	FC	5
Bars	FHC	5	Bars	FHC	5
Bars	FHC	6	Bars	FHC	7
Bars	K	5	Bars	K	4
Bars	K	6	Bars	K	4
Bars	KK	4	Bars	KK	5
Bars	SC	5	Bars	SC	6
Bars	SC	5	Bars	SC	7
Bars	SC	6	Bars	SC	7
Floor	BH	4	Floor	BH	2
Floor	BH	5	Floor	BH	3
Floor	BH	6	Floor	BH	3
Floor	BH	7	Floor	BH	6
Floor	BX	3	Floor	BX	4
Floor	BX	4	Floor	BX	5
Floor	FH	4	Floor	FH	3
Floor	FH	4	Floor	FH	5
Floor	FH	6	Floor	FH	5.5
Floor	FT	4	Floor	FT	6
Average PSD		4.95	Average PSD		4.875

Table 1. Self-observation and mixed-models conditions by event, skill, and perceived skill difficulty (PSD) ratings. *Note.* SC = stride circle, BH = back handspring, BX = back extension, KK = kip cast kip, FH = front handsprings, K = kip, FC = free hip circle, FT = front tuck, FHC = front hip circle, BC = back hip circle

Another limitation was that subjective evaluations of physical performance were needed, rather than an objective outcome score. To control for this factor, we chose to have two independent evaluators that were blind to the conditions, and to use the average scores from both evaluators. It was also ensured that these independent evaluators had an excellent degree of agreement. An additional limitation was that the marking criteria consisted of six different key elements for each skill. These criteria were developed from the Women's Artistic Gymnastics Rules and Regulations, and in consultation with coaches at the Ottawa Gymnastics Center;

however, they could not be consistent across all skills as each skill had unique elements to its performance.

Furthermore, due to the context of the research, it was realized that the scoring system did not capture aspects that made one skill performance quantitatively different from another. For example, the stride circle required three specific skill components, including the shoot through of the leg at the beginning of the skill. Six participants learned the stride circle: 2 participants skipped the leg shoot through component at least once, and 2 participants rarely attempted it. In turn, participants who attempted this leg shoot through and were unsuccessful received the same score on that skill element as a participant who did not try and just skipped the skill element. Additionally, due to the use of novel skills, assistive aids were sometimes necessary for the safety of the participant. Specifically, the back handspring and front tuck skills on floor sometimes required the use of a safety mat due to the inverted nature of the skills novel to participants. Five participants requested a floor safety mat, which was allowed in order to maintain a safe environment. The use of safety mats was not reflected in the physical performance scores provided by the judges, even though it could have influenced performance through increased confidence, or decreased impact forces.

A final limitation of the experiment was that only two conditions were examined. The mixed-models condition was compared to the self-observation condition; however, there was no physical practice only condition or skilled model only condition. Due to the limited population to draw from, only two conditions were included.

Future Research

While the research conducted allowed us to make a statement about the benefit of mixed-models over self-observation alone, it does not allow us to separate out the unique contributions

of the model types used. Future research could include other experimental groups; ideally, a skilled model only condition, as well as a physical practice only control condition. This would provide more insight into the specific contributions of self-observation, a skilled model, and mixed-models (combination of self-observation and skilled model).

Furthermore, future research that examines the effectiveness of different mixed-models conditions is recommended. For example, comparing a mixed-models condition, consisting of self-observation and a skilled model, to another mixed-models condition, comprising a novice model and a skilled model. There are many combinations of model types that could be used within mixed-models, and perhaps one combination would be more effective than another. Another factor to consider for future research concerns is the order the model types were displayed within the mixed-models condition. In the present experiment, the learners first observed the self, which was followed by the skilled model. It would be beneficial to examine the order effects, as they may potentially influence the efficiency of the intervention.

An alternative theme follows from the differences in results of this research with that of Onate, et al. (2005). Future directions should focus on examining the effects of a mixed-models condition without verbal feedback, in comparison to single model conditions with verbal feedback. This research would provide insight into effective coaching strategies. The question remains, should coaches be focusing their time and efforts on providing relevant verbal feedback coupled with observation of a model, or it is sufficient to provide a skilled model to watch in addition to self-observation?

A final note, the offline learning explanation is purely speculative and was not a focus of the research design. Continued research on the possible differences in consolidation processes that are derived from a mixed-models observation intervention is merited. In this design, for

example, there were sleep intervals between the acquisition sessions. Trempe et al. (2010) has highlighted in their research that observational practice and physical practice yield different behavioural outcomes from offline learning processes. Research that examines the importance of the sleep cycle or the combined observational and physical practice techniques would advance our understanding of the advantages noted for the mixed-models intervention used in this research.

Conclusions and Implications

The results suggest that the mixed-models condition was better for the development of the cognitive representation, and this translated into improved physical performance. Although the differences in scores may seem small between the conditions, the error recognition effect size is strong (.436) and the retention effect size is moderate (.270). A practical application of the experiment is performance at a gymnastics competition, where the difference between first and second place can be 0.01 points. For example, at the 2015 World Gymnastics Championships, there was a four-way tie for first place on the uneven parallel bars with a score of 15.366, and the gymnast in last place was only 0.766 points behind first with a score of 14.600. Also, on the floor exercise, one gymnast missed out on a medal by 0.067 points (“World Gymnastics Championship Results”, 2015). This shows that the intervention could have an impact on the results of a gymnastics competition, as small fractions of points can make a big difference in the sport of gymnastics.

It is obvious that something more happens when a learner is able to access a correct reference model and their own performance. A number of possible reasons were provided that relate to the advantages gained from the unique contributions of a skilled model, the increased effort of both models being available, and the ability to compare both videos. Additionally, there

was preliminary evidence of consolidation playing an important role shown; however, more research is needed to understand the mechanisms involved.

Practical implications, in regards to the sport of gymnastics, are also evident. First, when participants were in the mixed-models condition they demonstrated superior error recognition than when they were in the self-observation condition. This suggests that even under practice conditions in which physical performance is not improving, a mixed-models intervention may still be beneficial over self-observation alone because it develops a better cognitive representation of the skill. That is, it may be that physical performance benefits were not occurring because the gymnasts did not yet have certain prerequisite physical abilities. When the gymnasts eventually improve those prerequisite physical abilities (e.g. strength, flexibility), then this more accurate cognitive representation could translate into better skill performance.

In this experiment, however, there was the occurrence of the mixed-models condition leading to superior physical performance. Given that athletes continually aim to improve their physical performance in competition, it can be recommended as the better video intervention to use. The retention test results are critical, because not only do the scores represent the relatively permanent learning effects, but it can also be argued that the retention tests also recreate a typical gymnastics competition scenario. That is, after days of practice, gymnasts are required to execute their routines in competition with limited time to warm-up their skills and with the goal of achieving the highest physical performance score. In this experiment, it was shown that performance levels attained in practice under intermixed mixed-models and physical practice conditions did not deteriorate across two days (or more) of rest. Having an intervention that enables such retention and continued improvement is significant.

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Appendix A

Ethics Approval

File Number: H 03-15-02



Date (mm/dd/yyyy): 06/03/2015

Université d'Ottawa **University of Ottawa**
 Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

Certificate of Ethics Approval

Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

<u>First Name</u>	<u>Last Name</u>	<u>Affiliation</u>	<u>Role</u>
Diane	Ste-Marie	Health Sciences / Human Kinetics	Supervisor
Margot	Dods	Health Sciences / Human Kinetics	Student Researcher
Rebecca	Robertson	Health Sciences / Human Kinetics	Student Researcher
Laura	St. Germain	Health Sciences / Human Kinetics	Student Researcher
Kaitlin	Proksch	Health Sciences / Human Kinetics	Research Assistant

File Number: H 03-15-02

Type of Project: Master's Thesis and 4th year project

Title: Examining the effects of mixed-models and self-observation on motor skill acquisition within a gymnastics environment

Approval Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
06/03/2015	06/02/2016	Ia

(Ia: Approval, Ib: Approval for initial stage only)

Special Conditions / Comments:

N/A

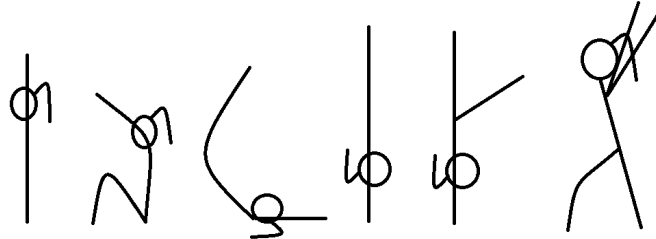
Appendix B

List of Gymnastics Skills

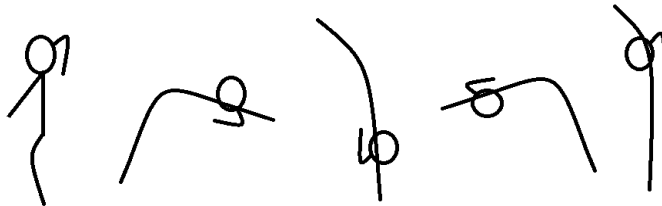
Bars Skill	Description	Picture
Stride Circle	Start in front support, then cast and shoot one leg through to a stride support. Switch hands to an under-grip position, then push upward, and fall forward, pressing the back leg on the bar. Complete the circle and return to stride support. Switch hands back to over-grip position. Cut the leg backwards to return to front support.	
Front Hip Circle	Start in front support, with the bar at mid-thigh. In a straight position, fall forward. Maintain pressure between the bar and the legs, and at the bottom of the circling motion, the body is forced into a hollow body position, accelerating the body back to front support. Arms should remain straight and head neutral throughout the skill.	
Kip	Jump from both feet, lifting the hips upward to grasp the low bar with an over grip. Swing the body forward with the legs together. Quickly lift the feet to the bar and pull the bar up the legs to the hips to arrive in a front support.	
Kip Cast Kip	Kip followed by an immediate cast to a drop into a second kip (refer to kip above).	
Free Hip Circle	Complete rotation backwards around the horizontal axis, keeping the body away from the bar.	

Floor Skill	Description and Picture
-------------	-------------------------

Back Extension	From a standing position bend the knees to arrive in a tuck sit. Begin rolling backward with the head tucked and arms by ears. With the arms straight and hands turned inward, reach back to place heel of the hands on the floor behind the head to execute a backward roll to handstand with the legs together. Step down at the end.
----------------	---



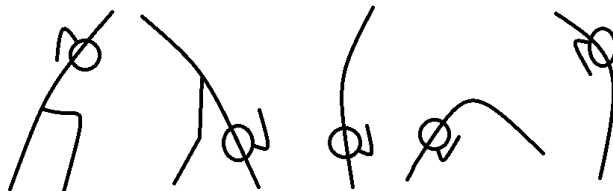
Back Handspring	Push off on the floor jumping a half turn backwards around the horizontal axis to handstand, followed by a push off from handstand with a half turn backwards around the horizontal axis to standing position.
-----------------	--



Front Tuck	Jump with forward tucked rotation around the horizontal axis.
------------	---



Front Handsprings	Take a few steps and hurdle into a deep lunge on the front leg. Kick the rear leg backward-upward overhead, and reach for the floor. Forcefully extend through the shoulders and simultaneously extend the front leg by pushing down against the floor. Rotate the body in a tight stretched position to step out one foot at a time. Continue with a smooth transition to repeat the same action, this time joining the legs past vertical to land with legs together with an immediate rebound.
-------------------	---



Appendix C

Checklist of Key Skill Elements

Bars

1. Stride Circle
 - i. Clear the foot on squat through
 - ii. Stride support shown after squat through
 - iii. Legs straight (no hooking)
 - iv. Big split maintained throughout the circle
 - v. Complete the circle (all the way around)
 - vi. Clear the foot on the cut backwards

2. Front Hip Circle
 - i. Start in a hollow body position with thighs on bar
 - ii. Tight body on downswing
 - iii. Pike position on upswing
 - iv. Straight arms all the way to front support
 - v. Complete the circle (all the way around)
 - vi. Small cast connected to the circle

3. Kip
 - i. Jump to takeoff with feet together
 - ii. Hollow body position in glide swing
 - iii. Fully extend glide swing
 - iv. Straight arms all the way to front support
 - v. Legs straight
 - vi. Head remains neutral

4. Kip Cast Kip
 - i. Arms and legs straight throughout the sequence
 - ii. Fully extend first glide swing in tight hollow position
 - iii. Successfully complete both kips
 - iv. Continuous sequence with a cast connecting kips
 - v. Control into second kip
 - vi. Fully extend second glide swing in tight hollow position

5. Free Hip Circle
 - i. Cast to horizontal
 - ii. Tight hollow body position on downswing
 - iii. Straight arms throughout the skill
 - iv. Tight hollow body on the upswing
 - v. Hips clear the bar
 - vi. Shoot out to horizontal or above

Floor

1. Back Extension
 - i. Roll back into squat position with arms straight and at ears
 - ii. Straight arms during the entire skill
 - iii. Legs straight during the entire skill
 - iv. Hands shoulder width apart on the ground
 - v. Pass through horizontal and hit handstand without arching
 - vi. Step down after handstand
2. Back Handspring
 - i. Bend knees and swing arms to jump backwards
 - ii. Extend legs to a tight arch position
 - iii. Arms stay by ears and straight after the swing
 - iv. Straight legs after jump backwards
 - v. Push-off hands to create flight in a tight hollow body position
 - vi. Immediate rebound at the end
3. Front Tuck
 - i. Keep arms by ears during takeoff
 - ii. Takeoff with feet together
 - iii. Good tuck position in the air (bend at hips and knees)
 - iv. Minimal traveling (half of a mat at most)
 - v. Land with feet together
 - vi. Chest up during landing
4. Front Handsprings
 - i. Keep arms up at ears
 - ii. Arms straight when hands contact the ground
 - iii. Flight in first handspring
 - iv. Good continuous transition
 - v. Flight in second handspring
 - vi. Controlled landing with feet together

Appendix D

Skill Instructions

Bars Skills:

1. STRIDE CIRCLE:

- [Video] You want your foot to clear the bar on your squat through and make sure you show your stride support after the squat through and before the circle
- [Video] Keep your legs straight with a big split during stride circle and do not hook your leg on the bar
- [Video] Try to get all the way around and back to the stride support and then you want your foot to clear the bar on your cut backwards
- [Video]

2. FRONT HIP CIRCLE:

- [Video] You want to start in a hollow body with the bar on your thighs and then you want to keep a tight straight body on the way down
- [Video] Next you want to have a pike position for the way up and you want to make sure to keep straight arms all the way to front support
- [Video] Try to make it around without falling and connect a small cast after your circle
- [Video]

3. KIP:

- [Video] You want to jump and takeoff with your feet together and maintain a hollow body position in the glide swing
- [Video] You want to make sure you extend your glide swing all the way and keep your arms straight all the way up to your front support
- [Video] Be sure to keep your legs straight and keep your head neutral throughout the kip
- [Video]

4. KIP CAST KIP:

- [Video] Make sure you keep your arms and legs straight throughout the sequence, and extend your first glide swing all the way in a tight hollow body position
- [Video] You want to successfully complete both kips, with a cast in between to complete the continuous sequence
- [Video] Keep control into the second kip, and make sure to full extend your second glide swing in a tight hollow body position
- [Video]

5. FREE HIP CIRCLE:

- [Video] You want to start by casting to horizontal or above and then you want to have a tight hollow body position on the downswing
- [Video] Make sure to keep your arms straight throughout the skill and have a tight hollow body on the upswing
- [Video] Keep your hips clear of the bar and shoot to horizontal or above at the end of the circle
- [Video]

Floor Skills:

1. BACK EXTENSION:

- [Video] You want to start by rolling into a squat position keeping your arms straight and up at your ears, you also want to keep your arms straight the whole time
- [Video] Keep your legs straight in the skill and you want your hands about shoulder width apart on the ground
- [Video] Make sure to pass through and hit handstand without arching, and then step down after the handstand
- [Video]

2. BACK HANDSPRING

- [Video] You want to start by bending your knees and swinging your arms, then you want to jump back and extend your legs and your body into a tight arch positions
- [Video] Make sure to have your arms up by your ears and don't forget to keep your arms straight when your hands hit the ground, you also want to keep your legs together and straight during the skill
- [Video] After your hands hit the floor you want to push off with your hands to create flight and keep a tight hollow body position at the end
- [Video]

3. FRONT TUCK:

- [Video] You want to keep your arms up by your ears during takeoff and takeoff with your two feet together
- [Video] In the air you want to have a good tuck position with a bend at the hips and at the knees, also you do not want to travel too much
- [Video] Land with your two feet together and keep your chest up at the end
- [Video]

4. FRONT HANDSPRINGS:

- [Video] You want to keep your arms up and at your ears, keeping your arms straight when your hands hit the ground
- [Video] After your hands hit the ground you want to pop to have flight in your first front handspring, and then you want to make sure you have a smooth and continuous transition
- [Video] After your hands hit the ground a second time, you again want to pop to have flight in your second front handspring, and then land with control and your feet together
- [Video]

Appendix E

Attendance and Progress Checklist for the Researchers

NAME: _____ NUMBER: _____

SESSION: 1: _____ 2: _____ 3: _____ 4: _____ 5: _____

CONSENT FORMS:

- Parent
- Participant/Assent

BARS: CONDITION _____ SKILL _____
FLOOR: CONDITION _____ SKILL _____

- Demographics questionnaire

BARS:

SESSION 1: <input type="checkbox"/> Perceived skill difficulty questionnaire <input type="checkbox"/> Key elements and expert model video <input type="checkbox"/> Error test (Identification) <input type="checkbox"/> Error test (Recognition) <input type="checkbox"/> Pre-test (2 blocks)

SESSION 2: <input type="checkbox"/> Block 1 <input type="checkbox"/> Block 2 <input type="checkbox"/> Video 1 <input type="checkbox"/> Block 3 <input type="checkbox"/> Video 2 <input type="checkbox"/> Block 4 <input type="checkbox"/> Video 3 <input type="checkbox"/> Block 5 <input type="checkbox"/> Video 4 <input type="checkbox"/> Block 6 <input type="checkbox"/> Video 5 <input type="checkbox"/> Block 7	SESSION 3: <input type="checkbox"/> Block 1 <input type="checkbox"/> Block 2 <input type="checkbox"/> Video 1 <input type="checkbox"/> Block 3 <input type="checkbox"/> Video 2 <input type="checkbox"/> Block 4 <input type="checkbox"/> Video 3 <input type="checkbox"/> Block 5 <input type="checkbox"/> Video 4 <input type="checkbox"/> Block 6 <input type="checkbox"/> Video 5 <input type="checkbox"/> Block 7	SESSION 4: <input type="checkbox"/> Block 1 <input type="checkbox"/> Block 2 <input type="checkbox"/> Video 1 <input type="checkbox"/> Block 3 <input type="checkbox"/> Video 2 <input type="checkbox"/> Block 4 <input type="checkbox"/> Video 3 <input type="checkbox"/> Block 5 <input type="checkbox"/> Video 4 <input type="checkbox"/> Block 6 <input type="checkbox"/> Video 5 <input type="checkbox"/> Block 7
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SESSION 5: <input type="checkbox"/> Post-test (2 blocks) <input type="checkbox"/> Error test (Identification) <input type="checkbox"/> Error test (Recognition)

FLOOR:

SESSION 1: <input type="checkbox"/> Perceived skill difficulty questionnaire <input type="checkbox"/> Key elements and expert model video <input type="checkbox"/> Error test (Identification) <input type="checkbox"/> Error test (Recognition) <input type="checkbox"/> Pre-test (2 blocks)

SESSION 2: <input type="checkbox"/> Block 1 <input type="checkbox"/> Block 2 <input type="checkbox"/> Video 1 <input type="checkbox"/> Block 3 <input type="checkbox"/> Video 2 <input type="checkbox"/> Block 4 <input type="checkbox"/> Video 3 <input type="checkbox"/> Block 5 <input type="checkbox"/> Video 4 <input type="checkbox"/> Block 6 <input type="checkbox"/> Video 5 <input type="checkbox"/> Block 7	SESSION 3: <input type="checkbox"/> Block 1 <input type="checkbox"/> Block 2 <input type="checkbox"/> Video 1 <input type="checkbox"/> Block 3 <input type="checkbox"/> Video 2 <input type="checkbox"/> Block 4 <input type="checkbox"/> Video 3 <input type="checkbox"/> Block 5 <input type="checkbox"/> Video 4 <input type="checkbox"/> Block 6 <input type="checkbox"/> Video 5 <input type="checkbox"/> Block 7	SESSION 4: <input type="checkbox"/> Block 1 <input type="checkbox"/> Block 2 <input type="checkbox"/> Video 1 <input type="checkbox"/> Block 3 <input type="checkbox"/> Video 2 <input type="checkbox"/> Block 4 <input type="checkbox"/> Video 3 <input type="checkbox"/> Block 5 <input type="checkbox"/> Video 4 <input type="checkbox"/> Block 6 <input type="checkbox"/> Video 5 <input type="checkbox"/> Block 7
---	---	---

SESSION 5: <input type="checkbox"/> Post-test (2 blocks) <input type="checkbox"/> Error test (Identification) <input type="checkbox"/> Error test (Recognition)

Appendix F

Demographics Questionnaire

Name: _____

Date of birth (e.g. January 1, 2000): _____ Age: _____

1. What level are you currently competing? _____

2. How many years have you been participating in gymnastics? _____

3. How many years have you been in the Invitational program? _____

4. Do you have any injuries or related health concerns that may limit your full participation?

Yes No

5. What is your preferred style of learning?

Visual (i.e. see it) Auditory (i.e. hear it) Kinesthetic (i.e. do it)?

6. Have you ever used video feedback before? Yes No (if no, skip to #7)

A) How often? Daily Weekly Monthly Yearly

B) Who do you watch? (Check all that apply)

Yourself Someone doing the skill correctly Someone learning the skill

C) Does your coach assist you? Yes No Sometimes

D) Does your coach provide verbal feedback? Yes No Sometimes

E) Do you find it helpful? Yes No Sometimes

7. Have you ever used imagery before? Yes No (if no, skip to end)

A) How often? Daily Weekly Monthly Yearly

B) Do you find it to be helpful? Yes No Sometimes

Appendix G

Perceived Skill Difficulty Questionnaire

Participant Number: _____

How easy or difficult would it be for you to perform _____
without any error? (Circle one answer)

Very easy	Easy	Somewhat easy	Neither easy or hard	Somewhat hard	Hard	Very hard
1	2	3	4	5	6	7

How easy or difficult would it be for you to perform _____
without any error? (Circle one answer)

Very easy	Easy	Somewhat easy	Neither easy or hard	Somewhat hard	Hard	Very hard
1	2	3	4	5	6	7

Appendix H

Confidentiality Agreement

**Université d'Ottawa · University of Ottawa**Faculté des sciences de la santé
École des sciences de l'activité physiqueFaculty of Health Sciences
School of Human Kinetics**Confidentiality Agreement**

I, _____ (name printed), agree that I will keep confidential any personal information about the participants that comes to me as a result of carrying out my responsibilities with respect to research at the University of Ottawa, titled “Examining the effects of mixed-models and self-observation on motor skill acquisition within a gymnastics environment”. I will not discuss with anyone, with the exception of the Principal Investigator, Co-Investigator, and Thesis Supervisor, any personal information relating to the participants or their performances.

Signature_____
Date

Appendix I

Example of Evaluators' Marking Sheet

VIDEO 68: BACK HANDSPRING	Trial 1	Trial 2
Bends knees and swings arms to jump back		
Legs straight (0.5 slightly bent)		
Straight arms (0.5 slightly bent)		
Good position (tight arch) in handstand		
Second flight phase in a tight hollow body		
Rebound immediately (lands two feet together)		
TOTAL		

VIDEO 71: STRIDE CIRCLE	Trial 1	Trial 2
Foot clears the bar on squat through		
Stride support is shown after squat through		
Stride support before circle and big split		
Legs straight (0.5 slightly bent)		
Completes circle to stride (0.5 uncontrolled)		
Foot clears the bar on cut backwards		
TOTAL		

VIDEO 69: BACK HANDSPRING	Trial 1	Trial 2
Bends knees and swings arms to jump back		
Legs straight (0.5 slightly bent)		
Straight arms (0.5 slightly bent)		
Good position (tight arch) in handstand		
Second flight phase in a tight hollow body		
Rebound immediately (lands two feet together)		
TOTAL		

VIDEO 72: BACK HANDSPRING	Trial 1	Trial 2
Bends knees and swings arms to jump back		
Legs straight (0.5 slightly bent)		
Straight arms (0.5 slightly bent)		
Good position (tight arch) in handstand		
Second flight phase in a tight hollow body		
Rebound immediately (lands two feet together)		
TOTAL		

VIDEO 70: FREE HIP CIRCLE	Trial 1	Trial 2
Cast to horizontal at the start		
Hollow body position on the downswing		
Straight arms (0.5 slightly bent)		
Hollow body position on the upswing		
Hips stay clear of the bar (0.5 slight brush)		
45 degrees above horizontal at the end		
TOTAL		

VIDEO 73: STRIDE CIRCLE	Trial 1	Trial 2
Foot clears the bar on squat through		
Stride support is shown after squat through		
Stride support before circle and big split		
Legs straight (0.5 slightly bent)		
Completes circle to stride (0.5 uncontrolled)		
Foot clears the bar on cut backwards		
TOTAL		

Note: slightly bent = within 30 degrees, slight brush = hips brush bar momentarily on downswing only, uncontrolled = extra unnecessary moment (e.g. side to side)

Appendix J

Personal Statement

Title of Study: Examining the effects of mixed-models and self-observation on motor skill acquisition within a gymnastics environment

Dr. Diane Ste-Marie, Professor, School of Human Kinetics, University of Ottawa,

Rebecca Robertson, MSc Candidate in Human Kinetics, School of Human Kinetics, University of Ottawa

Laura St. Germain, Margot Dods, and Kaitlin Proksch, undergraduate students

Personal Statement

I _____ understand that videos of my gymnastics skills will be used for research purposes, and will be watched by participants, researchers, and evaluators involved in the research project. I give my permission for my videos to be used by the abovementioned researchers from the School of Human Kinetics at the University of Ottawa.

Signature of Parent/Guardian: _____

Signature: _____

Date: _____

Appendix K

Example of Error Recall Test Sheet

Participant Number: _____

Pre-test Post-test

Skill: _____

For each video please indicate if the skill is performed correctly or incorrectly (i.e. demonstrating error) with a checkmark in the appropriate column. If the video is incorrect, please list the error(s) in the space provided. Recall that every skill is evaluated based on six key elements that were previously communicated.

Trial	Correct?	Incorrect?	Specific Error(s)
1			
2			
3			
4			
5			
6			

Appendix L

Example of Error Recognition Test Sheet

Participant Number: _____

Pre-test Post-test

Skill: Free Hip Circle

ERRORS	1	2	3	4	5	6
Cast was below horizontal						
Arched on the downswing						
Bent arms						
Pike don the upswing						
Hips were too close to the bar or hit the bar						
Shoot out was below horizontal						

Pre-test Post-test

Skill: Front Handspring (2x)

ERRORS	1	2	3	4	5	6
Bent legs						
No flight in first handspring						
Bad transition						
No flight in second handspring						
Arms were out to the side not by ears						
Uncontrolled landing						



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Appendix M

Information Letter and Parent Consent Form (OGC)

Title of Study: Examining the effects of mixed-models and self-observation on motor skill acquisition within a gymnastics environment

The following people are conducting this research. The data collected will be used in partial fulfillment of Rebecca Robertson's Master's Thesis, as well as Laura St. Germain and Margot Dods' 4th year undergraduate research project. If for any reason you would like to contact us, the following information should provide you with the means to do so:

Dr. Diane Ste-Marie, Professor, University of Ottawa

Rebecca Robertson, MSc Candidate in Human Kinetics, School of Human Kinetics, University of Ottawa

Laura St. Germain, undergraduate student

Margot Dods, undergraduate student

Kaitlin Proksch, undergraduate student

Invitation to Participate: Your child is invited to participate in the abovementioned research study conducted by the above researchers.

Purpose of the Study: This research is concerned with understanding how different video feedback conditions affect learning new gymnastics skills. During the experiment, feedback regarding your child's movements will be provided visually using videotape replay.

Participation: If your permission is granted, your child will be required to learn two new gymnastics skills. The skills chosen for your child will be based on her current level of training, and will be selected in consultation with her coach. Data collection will take place at the Ottawa Gymnastics Centre, during your child's regularly scheduled practices. This research will consist of five **consecutive** sessions. It is important that your child attends five practices in a row; however, if she does miss a session she will not be excluded from the study. She will continue at the next practice, and will still complete five full sessions. The first session will be a pre-test in which your child will be informed of the two skills to be learned and will attempt to do each skill four times. These performances will be captured on video. She will also answer questions about how hard she thinks it will be to learn the skills and will watch a video of someone else performing the skills to see if she can see what is

being done wrong in the execution of those skills. This session will take approximately 20 to 25 minutes. During the next three practice sessions your child will alternate between performing the skill four times, with these performances being captured on video, and observing video replay and demonstration of the skill. Sessions 2 to 4 will take approximately 30 to 40 minutes. The final session will be the post-test and will be the same as the pretest. The final session will take approximately 15 to 20 minutes.

Risks: Participants may experience minor muscle fatigue or strain, and in rare cases may experience injury from participation; but this risk is not above and beyond the risk the participant typically encounters in their regular gymnastics practice. Participation in this experiment will not exceed the normal volume of practice, and the skills are within the average physical demands and risks of their training and current skill level. Participants will also have a chance to physically rest when observing the modeling videos, and will be reminded that they can take breaks as needed. Muscle soreness and injuries will be treated as if they occurred during a regular practice. All of the coaches are trained with First Aid and CPR, there are first aid kits throughout the gym, and ice packs are available. Participants may also feel anxious about being videotaped and knowing that later their performance will be evaluated. Again, this anxiousness is not above and beyond the typical competition scenario in gymnastics. We will remind the participants that the data and videos are confidential, in order to aid in reducing any stress and anxiety they may feel regarding their performances. Every effort will be made to ensure that any chance of discomfort or distress is minimized.

Potential benefits: The benefit to your child's participation in this research project is that she will receive video feedback techniques that may help her to learn two new gymnastics skills required for level advancement. Furthermore, the results will provide more insight into how video feedback improves the learning of a gymnastics skill.

Anonymity and Confidentiality: All information and data collected will be coded to maintain confidentiality. Specifically, raw data will be stored using an alphanumeric coding system and stored on password protected USB storage devices. The videotape data that is collected during this study will be used to provide video feedback during the study, as well as skill assessment. The videotape data of your child's performances will only be available to the identified researchers on this consent form, as well as the two judges who will be assessing the videotaped skills to provide performance scores. Please be aware there are limitations to anonymity due to the video data and therefore, you will be asked to sign a video release form should you decide to participate. The information on the videotapes will remain strictly confidential as the videotapes will not indicate your child's name and no one except the identified researchers and judges will have access to these videotapes.

The data will be analyzed on password protected computers to which only the researchers directly involved in the study will have access. Once analyzed, the data will be kept in a locked room at the University of Ottawa, in a locked filing cabinet, on password protected devices, and only the researchers and judges directly involved in this study will have access to the data. No records bearing your child's name will leave the institution.

We hope that the data collected for this study will be published in scientific journals. Participant names will not be published in papers or revealed in presentations, protecting the anonymity of the participants. The data will be kept for a period of 10 years following collection. This 10 year period will allow for publication of the data and a period of time post publication. Specifically, it is expected that if the data is published, publication would occur within 5 years of collection. By conserving the data for 10 years post collection, this will ensure that under conditions in which the data is published, the data would still be available for at least 5 years post publication. After this 10 year period, all the data will be destroyed by the physical resources service of the University of Ottawa. In particular, electronic records will undergo secure deletion and all paper data will be shredded.

I am aware that my child is not obligated to participate in this experiment. Should I want to withdraw my permission for my child to participate or should my child want to withdraw from the study, this can be done at any time for any reason, without question or penalty, and any data collected will be destroyed. In addition my child and I are free to ask any questions about the research being conducted.

If I have any questions, I may contact the principal investigator, Rebecca Robertson.

If I have any questions regarding the ethical conduct of this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5

Tel.: (613) 562-5387

Email: ethics@uottawa.ca

There are two copies of the consent form, one of which is yours to keep.

Acceptance: I, _____ (parent or guardian's name, please print) have read and understood the request for my daughter to participate in this study and I give permission for my daughter to participate in the above research study conducted by the abovementioned researchers of the School of Human Kinetics at the University of Ottawa.

Name of child (please print): _____

Signature of Parent/Guardian: _____ Date: _____

Signature of the Researcher: _____ Date: _____



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Appendix N

Information Letter and Participant Assent Form (OGC)

Title of Study: Examining the effects of mixed-models and self-observation on motor skill acquisition within a gymnastics environment

The following people are conducting this research. The data collected will be used in partial fulfillment of Rebecca Robertson's Master's Thesis, as well as Laura St. Germain and Margot Dods' 4th year undergraduate research project. If for any reason you would like to contact us, the following information should provide you with the means to do so:

Dr. Diane Ste-Marie, Professor, University of Ottawa

Rebecca Robertson, MSc Candidate in Human Kinetics, School of Human Kinetics, University of Ottawa

Laura St. Germain, undergraduate student

Margot Dods, undergraduate student

Kaitlin Proksch, undergraduate

We are asking you to take part in a research project that is interested in learning about how watching videos could help with learning new gymnastics skills. If you agree to take part in this study, you will be asked to learn two new gymnastics skills, one on the floor exercise and one on the uneven parallel bars. The skills will be chosen with help from your coaches. These skills may help you move up to a higher level.

The study will take place at your current gymnastics club (Ottawa Gymnastics Centre) during your regular practices. We are asking that you attend **five practices in a row**, and the study may take from 15 to 40 minutes each practice. It is important to attend five practices in a row; however, if you miss a session you will not be excluded from the study. You will continue at the next practice, and will still complete five full sessions. During the first day of the study you will be told about your two skills to be learned and you will attempt to do each skill four times. You will also answer questions about how hard you think it will be to learn the skills. You will also watch a video of someone else performing the skills to see if you can see what is being done wrong in the execution of those skills. During the next three practices you will alternate between performing the skill four times, and observing video replay and demonstration of the skill. The final

practice will be similar to the first practice, by attempting the skills four times and watching the videos of someone else performing the skills to see if you can detect what is wrong with the skills. All of your skill performances will be videotaped so you can watch them as video feedback, but also so that two judges can evaluate them. The scores from the judges for these performances will be kept private. Only the researchers involved with the study and the supervisor and will be allowed to see them.

Risks: You may experience muscle soreness, fatigue, or strain, and in rare cases injury from participation. This risk is not above and beyond the risk you take in your regular gymnastics practice. Participation will not require extra time outside of practice, and the skills you will be asked to learn will be within the average physical demands and risks of your training, based on your current skill level. You will also have a chance to rest and take breaks as needed. Muscle soreness and injuries will be treated as if they occurred during a regular practice. All of your coaches have First-Aid and CPR training, there are first-aid kits located in the gym, and there are ice packs available. You may also feel anxious about being videotaped and knowing that your later performance will be evaluated. This is not above and beyond the typical competition setting in gymnastics. You will be reminded that the data and video are confidential, in order to help reduce stress and anxiety levels regarding your performance. Every effort will be made to ensure that any chance of discomfort or distress is minimized.

Potential benefits: The benefit to your participation in this research project is that you will receive video feedback techniques that may help you learn two new gymnastics skills that are required to reach a higher level. Also, the results will provide more insight into how video feedback improves the learning of a gymnastics skill.

Anonymity and Confidentiality: All information and data collected will be coded to maintain confidentiality. Specifically, raw data will be stored using an alphanumeric coding system and stored on password protected USB storage devices. The videotape data that is collected during this study will be used to provide video feedback during the study, as well as skill assessment. . The videotape data of your performances will only be available to the identified researchers on this consent form, as well as the two judges who will be assessing the videotaped skills to provide performance scores. Please be aware there are limitations to anonymity due to the video data and therefore, you will be asked to sign a video release form should you decide to participate. The information on the videotapes will remain strictly confidential as the videotapes will not indicate your name and no one except the identified researchers and judges will have access to these videotapes.

The data will be analyzed on password-protected computers to which only the researchers directly involved in the study will have access. Once analyzed, the data will be kept in a locked room at the University of Ottawa, in a locked filing cabinet, on password protected devices, and only the researchers and judges directly involved in this study will have access to the data. No records bearing your name will leave the institution.

We hope that the data collected for this study will be published in scientific journals. Participant names will not be published in papers or revealed in presentations, protecting the anonymity of the participants. The data will be kept for a period of 10 years following collection. This 10-year

period will allow for publication of the data and a period of time post publication. Specifically, it is expected that if the data is published, publication would occur within 5 years of collection. By conserving the data for 10 years post collection, this will ensure that under conditions in which the data is published, the data would still be available for at least 5 years post publication. After this 10-year period, all the data will be destroyed by the physical resources service of the University of Ottawa. In particular, electronic records will undergo secure deletion and all paper data will be shredded.

I have talked with my parents and even though my parents agreed for me to participate, it is up to me if I want to participate. I can stop or withdraw for any reason, at any time, without any consequences. Also, I am free to ask any questions at any time.

If I have any questions regarding the ethical conduct of this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5
Tel.: (613) 562-5387
Email: ethics@uottawa.ca

There are two copies of the assent form, one of which is yours to keep.

Student Assent: The study has been explained to me. I had a chance to ask questions about the study and I understood the answers. I am signing my name to say yes, I want to be in the study.

Name of Participant (please print): _____

Age: _____

Signature of Participant: _____

Date: _____

Signature of the Researcher: _____

Date: _____