Learning Versus Correct Models: Influence of Model Type on the Learning of a Free-Weight Squat Lift

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It has been assumed that demonstrating the correct movement is the best way to impart task-relevant information. However, empirical verification with simple laboratory skills has shown that using a learning model (showing an individual in the process of acquiring the skill to be learned) may accelerate skill acquisition and increase retention more than using a correct model. The purpose of the present study was to compare the effectiveness of viewing correct versus learning models on the acquisition of a sport skill (free-weight squat lift). Forty female participants were assigned to four learning conditions: physical practice receiving feedback, learning model with model feedback, correct model with model feedback, and learning model without model feedback. Results indicated that viewing either a correct or learning model was equally effective in learning correct form in the squat lift.

Key words: observational learning, learning, knowledge of results

While it is recognized that a host of social, psychological, and developmental issues may impact the modeling process (Bandura, 1986; McCullagh, 1993; McCullagh, Weiss, & Ross, 1989), one issue that has received renewed attention recently in the literature is model characteristics. Model characteristics could include such factors as age (Bandura & Kupers, 1964), similarity (Gould & Weiss, 1981; McCullagh, 1987), status (McCullagh, 1986), or skill level (Landers & Landers, 1973). Two primary issues related to skill level have been addressed in the literature. Whether the model is skilled or unskilled has produced contradictory findings (Landers & Landers, 1973; Lirgg & Feltz, 1991; Weir & Leavitt, 1990). A related but separate issue is whether the model is a correct or learning one. The difference between these two paradigms is subtle but distinct. In the skilled versus unskilled experiments, participants do not have an opportunity to watch performance gradually improve over trials. In the correct versus learning paradigms, participants are afforded the opportunity to watch the learning model improve with the idea that they will learn from the error-correction process.

A basic assumption regarding the observational learning process is that because the observer is attempting to reproduce the behavior of the model, the imitation of efficient strategies of correct models would best aid the observer (Lee & White, 1990). There also exists the generally held belief that observers symbolically represent the model's performance by creating a perceptual code. This cognitive representation is developed through repeated demonstrations and serves as a referent against which comparisons are later made (Sheffield, 1961). Would it not follow then that watching a model perform a skill correctly would enable one to create an accurate referent against which to compare one's later performance? This has been a question of much debate recently, as investigators seek to determine whether a correct model, which initially and consistently displays flawless performance, or a learning model, which experiences acquisition difficulties while gradually improving performance, is more effective for observational learning. The possibility exists that observing a learning model "provides a conceptual insight into the cognitive bases of the task to be learned" (Lee, Swinnen, & Serrien, 1994, p.331), and this may be beneficial.

Lee and White (1990) suggested that the observer of a learning model may benefit from accompanying the learning model in the error-detection and problem-solving activities inherent in motor learning. They also counter the proponents of correct model usage by stating that the assumption of their superiority is based on the idea that motor learning is degraded when errors are made. This may not be true in all cases, as a learner...
may actually use error information gleaned from observation to improve performance on subsequent trials.

Pollock and Lee (1992) have suggested that the preferred use of correct models lacks both theoretical and empirical support. Because the demonstration is optimal, the problem-solving process which involves error detection and correction is omitted. They found that observers of both learning and correct models performed substantially better than those not watching a model. However, the correct model failed to evoke better performance than the learning model, thereby contradicting the aforementioned observational learning assumptions and typical teaching recommendations. A correct model did not elicit superior performance.

In one study examining the influence of model skill level, Adams (1986) hypothesized that watching a learning model can be enhanced further through the use of knowledge of results (KR). An observer viewing a learning model but getting none of the model's KR would see the person's behavior change but not know why. The observer makes an uncritical observation of the demonstration which, according to Adam's, will not aid greatly in the learning of a skill. However, when the observer gets the model's KR, it can help form the cognitive representation and allow the observer to participate in the cognitive activities of the learning process. A learner observing a model and receiving the latter's KR should have more positive transfer than one who merely watches the performance, because, in addition to forming a cognitive representation, the observer will have the opportunity to engage in error detection, response appraisal, and hypothesis formation and testing (Adams, 1986).

Adams (1986) examined his notions using a timing task. He found that participants viewing a learning model receiving KR performed slightly better than both a group that observed but did not receive model KR as well as a control group (no model). Unfortunately, he did not use a correct model, prohibiting the comparison of the two model types.

One study could be identified that employed correct and learning models in combination with model KR. Using a timing task, McCullagh and Caird (1990) compared learning and correct modeling conditions to physical practice. The physical practice group executed the skill to be learned and received KR about their own movements. The correct model group saw the skill demonstrated without error. The importance of model KR was evaluated by having one group of learning model observers receive the model's KR and the other simply view the model without getting model feedback. The utilization of delayed retention and transfer tests improved on past research designs by attempting to assess the effects of modeling on learning as well as performance. The researchers also separated the effects of modeling and KR, which had been confounded in previous investigations by giving participants who viewed a model only the model's KR and not KR about their own movements.

Their results indicated that participants in the learning model group performed just as well as those who physically practiced and received KR about their own movements on the timing task. The correct model group did not perform as well as either of these two groups, while participants in the learning model group who did not receive model KR performed worst of all. Thus, in line with the predictions of Lee, Swinnen, & Serrien (1994) observers who view a learning model and receive that model's KR may become more actively involved in cognitive processing, which leads to better performance. One new finding of this study was that the results were generalizable over time. That is, learning was persistent over delayed retention as well as transfer trials, indicating that modeling has an effect on both performance and learning. This research also supports the contention that in the absence of KR one can learn about one's own movement.

McCullagh and Caird (1990) have cited several limitations of their study. They recognized that the timing movement was very simple and only an outcome score was obtained. The present study used a more complex task in which form components could be assessed also. In addition, deficiencies of past research (e.g., confounding of KR and modeling) and suggested modifications (e.g., assessment of performance and learning) were addressed. Thus, the authors of this study compared the effectiveness of correct versus learning models in the acquisition of a sport skill, the free-weight squat. Experimental groups similar to those used by McCullagh and Caird were utilized. The control group physically practiced and received feedback about their own movements (PP + F). A correct model group (C + F) observed correct demonstrations and heard verbal feedback about the model's performance. In the learning model conditions, participants viewed a learning model and either received feedback about the model's movement (LM + F) or did not (LM - F). Both performance and learning of the skill were assessed through the use of a delayed retention test in which no feedback was given.

Based on previous findings by McCullagh and Caird (1990) and on conceptual predictions by Lee et al. (1994), it was hypothesized that the physical practice with feedback and learning model with model feedback groups would have the highest performance scores on all trials, followed by the correct model and learning model with no model feedback groups, respectively. The effect of giving feedback to participants watching a learning model should engage them in error detection-correction and problem-solving processes of observational learning, which should also aid performance and learning.
Method

Participants

The participants in this study were 40 female undergraduate students enrolled in a kinesiology course. The students volunteered to participate as part of their course participation credit and were assigned randomly to treatments on a rotating basis. All participants gave their written informed consent, and none had performed free-weight squats previously. The participants were told that they would be filmed for the purposes of this experiment and judged on the basis of these tapes by two independent judges. They were also told that the judges had no knowledge of participant identity and only knew participant numbers. This information was included in the informed consent also. Participants were instructed to wear shorts and a T-shirt to perform the task.

Task

The task to be learned was a free-weight squat lift. The apparatus used was a 25-lb weight bar with one 2.5-lb plate placed on each end, making the total weight 30 lbs. This relatively light weight was chosen for the study because it allowed the participants to concentrate on technique and form and probably would not result in undue fatigue for the trials necessary to assess learning.

The camera used was a Panasonic Handycam VHS portable video camera with remote control (Panasonic, Franklin Park, IL). The camera operator served as the timekeeper to ensure the proper starting of each trial. To ensure accurate representation of participant performance, the camera was placed in relation to the participant as follows: the participant was instructed to stand with the heels on a line of red tape, which was placed 10 yards lateral to the camera. During the first, fourth, and fifth trials of acquisition and the first trial of retention, the camera was facing in this lateral position. During the second acquisition and retention trials, the camera was placed at an angle of approximately 30 degrees to the front of the participant. During the third acquisition and retention trials, the camera was placed at a 30 degree angle to the rear of the participant. This protocol of side-front-back-side-side camera placement during the acquisition trials was standard for all participants. During the retention phase, the placement was side-front-back.

During the course of the experiment, one person was responsible for giving the physical practice participants appropriate feedback. Both knowledge of performance (KP) cues, which were directed at proper form, and KR cues, directed at outcome, were provided. Feedback was given according to a standardized feedback sheet which addressed 12 different aspects of the squat movement considered by weight lifting instructors as important for proper form (e.g., foot-hand placement, knee bend, back position) and outcome, which was the number of squats performed in the 30-s trial period. The outcome goal was to complete 14 squats in 30 s.

During the acquisition trials, those participants who were assigned randomly to one of the observational learning conditions were shown either correct or learning models on a Panasonic 1230 VHS tape player connected to a Panasonic 19-in color monitor (Panasonic, Franklin Park, IL).

Model

An adult female weightlifting instructor served as the correct model. During each of five 30-s trials, she executed 14 squats demonstrating the correct squatting technique. She was filmed from the side-front-back-side angles corresponding to the order in which the participants would be filmed.

The participants in the physical practice plus feedback (PP + F) condition were learning models for those participants in the learning model conditions (LM + F and LM - F). This procedure of yoking participants is identical to the McCullagh and Caird experiment. Learning condition participants watched 30-s acquisition trials of the previously tested physical practice participant prior to her performance of trials. Thus, participants watched one demonstration and then performed one trial, repeating this process until all five acquisition trials were completed. The film of one PP + F participant was used as the learning model for participants in both the LM + F and LM - F groups until the next PP + F participant was tested, after which this participant's video was used as the learning model. Each participant in the modeling groups viewed the same model for each trials.

Procedure

On arrival, participants were asked again if they had ever performed free-weight squats. If participants had performed a squat before, they were excluded from the experiment. After completing demographic information questionnaires, participants were shown the experimental setup and viewed a safety video so they would know what to do if they experienced any difficulty.

Participants in the PP + F condition performed five 30-s trials with a 2-min rest between each trial. During the rest period, participants were given two KP cues from the standardized feedback sheet. The cues given were those deemed most corrective by the experimenter (e.g., "keep feet shoulder-width apart"). Participants were also given one KR cue (e.g., "you did 12 squats during that trial"). These participants did not watch any videos other than the safety video and were the only participants to receive feedback about their own movements. Their acquisition trials were filmed and used for the next learning condition participants.
Participants in the C + F performed five 30-s trials with a 2-min rest between each trial. Prior to their first trial and during the rest period between each trial, participants viewed the videotape of the correct model performing squats. As participants viewed the correct model they were told to perform in the same cadence as the model, resulting in 14 repetitions in 30 s. They heard two KP and one KR cue about the model’s performance which were standardized for all correct model participants and from the same standardized list as cues given in other modeling conditions (e.g., “notice that the feet are shoulder-width apart”). These cues were provided to hold constant the number of feedback cues across conditions.

Participants in the LM + F condition performed five 30-s trials with a 2-min rest between each trial. Prior to their first trial and during the rest period between each trial, participants viewed the videotape of the previously tested learning model (PP + F) performing squats. As participants viewed the learning model, an experimenter verbally announced the same two KP and one KR cues given to that PP + F participant for each trial.

Participants in the LM - F condition performed five 30-s trials with a 2-min rest between each trial. Prior to their first trial and during the rest period between each trial, participants viewed the videotape of the learning model (PP + F) but did not receive feedback about the learning model’s or their own performance. Participants in both learning model conditions were told they were watching a person attempting to learn the skill.

After completing the five acquisition trials, all participants received instruction on appropriate stretches to alleviate any soreness, scheduled an appointment for a retention trials session, and were reminded not to practice before that time. Following a 2-day rest period, participants returned for the retention trials session. All participants performed three 30-s trials with a 2-min rest between each trial. No KR or KP was given to participants in any of the four treatment groups, and no model videos were shown. Participants were filmed from the side, front, and back, respectively. On completing the retention trials, participants’ questions were answered concerning the testing protocol, purpose of the study, and results.

Judging

Videotapes of all participants’ acquisition and retention trials were evaluated individually by two judges who were weight lifting instructors. The judges were in no way involved in the testing and, thus, blind to the experimental conditions. Each participant was identified by number only. Each judge watched the tapes and judged the participant’s performance on a standardized scoring sheet reflecting 12 items pertaining to performance and proper squatting technique. Judges used one scoring sheet per trial per participant. Judges were trained using pilot videos to ensure interjudge reliability. Interjudge correlations were very high, ranging from .95–.98 for form scores, while some perfect correlations were obtained for outcome scores. Therefore, for the purpose of data analysis, an average score was used.

Dependent Measures

Two dependent measures were assessed in this study: form and outcome scores. A form score was calculated for each trial by totaling the 12 individual scores reflecting performance on each of 12 components of the lift. The score for each of these elements could range from 1–5, with a higher score indicating better performance. Therefore, the composite score for one trial could fall between 12 (1 point for each of the 12 components) and 60 (5 points for each component). A form score for acquisition was calculated by first adding the individual element scores and dividing by 12 to get a mean for each trial that would range from 1–5. The same procedure was done to obtain a retention form score.

Outcome scores were simply the number of squats the participant completed during each 30-s trial. The goal was 14 squats. For analyses, an absolute outcome score was calculated by taking the absolute difference between the obtained score and 14.

Results

Separate analyses were conducted for acquisition and retention on the dependent measures. First, because there were low correlations (r < -.08 to -.25) between the form and outcome scores, multivariate analyses of variance (MANOVA) were conducted with trials as a repeated measure. An alpha level of .05 was used for all statistical tests.

Acquisition

For acquisition, a 4 (Group) x 5 (Trials) MANOVA on form and outcome scores produced a significant trials effect, A = .20, F(8,26) = 12.97, p < .01. The group effect approached but did not reach significance, A = .69, F(6,64) = 2.09, p < .10. Follow-up univariate tests on the trials effect produced significant effects for both outcome, F(4,132) = 9.31, p < .01, and form, F(4,132) = 45.5, p < .01. Participants improved their scores over trials except from Trial 4 to 5, and outcome error scores increased (see Figure 1). Tukey’s post hoc tests indicated that for form scores, participants performed significantly worse on Trial 1 than all other trials. Also, Trial 2 was significantly different from Trials 3, 4, and 5. For outcome error, participants performed worse on Trials 1 and 5 than on the other trials.
Retention

For retention the 4 (Group) x 3 (Trials) MANOVA on form and outcome produced a significant groups effect, \( \Lambda = .63, F(6,52) = 2.48; p < .05 \), and a significant trials effects, \( \Lambda = .31, F(4,25) = 15.41, p < .01 \). A follow-up univariate on outcome scores produced no significant effects. However for form, both the group effect, \( F(3,28) = 4.01, p < .05 \), and the trial's effect, \( F(2,56) = 16.81, p < .01 \), were significant. Post hoc analyses indicated that both the correct model group (\( M = 3.4 \)) and the LM + F group (\( M = 3.3 \)) performed significantly better than the LM - F group (\( M = 2.4 \)). Inspection of the means showed a slight improvement from Trial 6 (\( M = 2.8 \)) to Trial 7 (\( M = 3 \)) and Trial 8 (\( M = 3 \)).

Discussion

The primary finding from the acquisition phase indicated that participants improved on both form and outcome. All groups improved significantly from the first to fourth trials. However, outcome error increased significantly from the fourth (\( M = 2 \)) to fifth trials (\( M = 2.8 \)). A number of participants reported some level of fatigue, which probably contributed to this result. Participants also improved their form scores over acquisition trials. Contrary to the hypotheses, and unlike the McCullagh and Caird (1990) study, no significant group effects were found (\( p = .06 \)). An examination of the direction of means, as illustrated in the figures, favors the idea that the correct and learning model plus feedback groups performed better than the other groups on both form and outcome.

An examination of the retention data reveals whether the manipulations had any effect on learning. Only the form score data produced any significant group effects supporting previous research, which has suggested that modeling has a greater impact on form than outcome (Feltz, 1982). The correct model group and the learning model group that received model feedback performed significantly better than the learning model group that received no feedback. The physical practice with feedback group fell in between. These results do not support those previously reported by McCullagh and Caird (1990). In that study, which only assessed an outcome variable, the physical practice with KR and learning model with model KR performed the best. Here, the correct model and learning model with feedback performed the best when form scores were assessed.

Two primary differences between the studies were the type of task employed and the type of feedback provided, both of which could have altered the results. In the McCullagh and Caird (1990) experiment, participants learned a simple timing task that required them to execute a movement sequence in a specified criterion time. Without KR, it is difficult for individuals to know if they are close to the criterion. In the present study, the authors chose a realistic skill that had both form and outcome components. The criterion was to execute 14 squats in a 30s period, an outcome that probably could be self-evaluated more easily. In addition, the KP feedback provided in the present study was explicitly directed to assist in modifying form components of the movement. Thus, the quality of the feedback provided in the present study was far "richer" than that provided for simply timing movements and, when coupled with demonstrations, may have provided an optimum learning environment. The authors found that with this type of skill, individuals who watched a model (whether correct or learning) and heard that model's feedback, performed better than when they did not receive model feedback. This would support the contention of Lee et al. (1994) that feedback helps observers get involved actively in the learning process. Further experimentation is needed, however, to clearly delineate the role of feedback in the observational learning process. A factorial design that crosses the practice and demonstration conditions with feedback could help unravel the independent and additive effects of feedback and demonstrations.

One finding similar to the McCullagh and Caird (1990) and the present study was that individuals can
learn by receiving KR and KP about someone else’s performance, although the individuals never receive feedback about their own movements. Participants in the C + F and LM + F conditions in this study learned from observing their respective models and getting model feedback, despite the fact that they never received external feedback about their own movements. This finding demonstrates the power of observational learning when combined with practice. For example, some commercial videotapes show the correct model repeatedly, but no feedback cues about the model’s performance are available. Future research will need to determine the effectiveness of correct demonstrations in the presence and absence of such feedback cues.

References


Authors’ Notes

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