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Knowledge of results after relatively good trials enhances self-efficacy and motor learning

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ABSTRACT

Objectives: This study sought to determine whether learners' self-efficacy and motor learning was affected by the type of feedback they were provided.
Method: Participants ($N = 24$, M age = 19.51 years, SD = 1.08) were randomly assigned into one of two groups: knowledge of result after good versus poor trials. The task included throwing a tennis ball with the non-dominate hand to a target while wearing vision distorting goggles. Participants completed the Self-Efficacy Scale (Bandura, 2006) before performing each block of 6 trials. A retention test without knowledge of results was conducted 24 h after the practice phase.
Results: The results demonstrated that learners' motor learning was increased by providing knowledge of results after good rather than poor trials. Furthermore, the Self-Efficacy Scale results revealed that learners' self-efficacy was enhanced by positive feedback.
Conclusions: The current findings indicate that positive feedback impacts learner's self-efficacy, and enhances performance and motor learning.

Within the sport psychology and motor learning domains, it is well established that self-efficacy is effective for facilitating motor skill learning and performance (Moritz, Feltz, Fahrbach, & Mack, 2000). Self-efficacy emerged from social cognitive theory and is defined as the belief and judgment which a person has in regard to his/her ability to execute specific actions relative to the achievement of specific outcomes (Bandura, 1977). Generally, individuals with high levels of self-efficacy, attempt new performances in future trials, expend their effort on these performances and commonly display increased success on future motor skills (Gao, Kosma, & Harrison, 2009).

Bandura (1986, 1997), proposed that self-efficacy emerges from several sources of information; with the most effective source being 'performance accomplishments.' According to 'performance accomplishments,' self-efficacy and the performance ability of individuals are based upon their perceived personal mastery experiences (Bandura, 1997). For example, if an individual executes a successful performance they will have an increased expectation for future successful performances. In contrast, when an individual experiences an unsuccessful performance, this consequently reduces their expectation for later success. One way to inform an individual about their personal mastery is through the use of feedback, specifically feedback about successful performances. Providing performance related feedback to individuals about their successful performances has been shown to improve intrinsic motivation (Badami, VaezMousavi, Wulf, & Namazizadeh, 2011) and motor learning (Chiviacowsky & Wulf, 2007). Furthermore, learners who perceive themselves to be successful are motivated to continue to practice, and those who do not perceive themselves to be successful are less engaged in the acquisition of skill learning (Lee & Wishart, 2005). However, what is not clearly understood is how the content of feedback directly influences self-efficacy and motor learning.

Consistent with Bandura's (1997) conclusion, a review of relevant literature suggests there is a clear relationship between the utilized level of self-efficacy and the delivery method of augmented feedback when performing a motor skill. For example, in a study by Schunk and Cox (1986) participants received performance feedback regardless of their actual performance; the results revealed that feedback had a strong impact on self-efficacy beliefs. In another study, Baron (1988) assessed the effect of two types of feedback (i.e., positive and negative) on the levels of reported self-efficacy. Results of that study indicated that participants who received negative feedback exhibited lower levels of self-efficacy, while participants receiving positive feedback reported higher levels of self-efficacy. Similar findings have been

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reported by Escarti and Guzman (1999), Balagour, Bray, and Dada (2004), and Mahoney, Devonport, and Lane (2008). In all, these studies suggest information provided in the form of positive feedback is a key factor in enhancing self-efficacy.

A related issue that has received recent attention is the exploration of providing augmented feedback in the form of knowledge of results (KR) after relatively good or relatively poor trials. In a pair of studies Chiviacowsky and Wulf (2007) and Badami et al. (2011) had learners practice a throwing task with their non-dominant arm, and a golf putting task, respectively. In those studies participants were assigned to either a group that received KR on the three best performances after each 6-trial block, or a group that received KR after the three poorest performances. The results of the Chiviacowsky and Wulf (2007) study indicated that participants who received KR after good trials demonstrated more effective motor learning than those who were provided KR after relatively poor trials. Results of the Badami et al. (2011) study indicated that providing feedback after good performances increases intrinsic motivation by enhancing the performers' perceived competence of the practiced task. Consistent with the findings of Chiviacowsky and Wulf (2007) and Badami et al. (2011); the results of a recent study by Saemi, Wulf, Varzaneh, and Zarghami (in press) revealed that intrinsic motivation and motor learning were improved when children practicing a throwing task received feedback after relatively good trails rather then relatively poor trials.

Previous research has clearly demonstrated that the use of feedback can improve a learners self-efficacy (Balagour et al., 2004; Escarti & Guzman, 1999; Mahoney et al., 2008). Furthermore, it has also been established that providing KR after good performances rather than poor performances also enhances motor learning (Chiviacowsky & Wulf, 2007) and intrinsic motivation (Badami et al., 2011). However, what has not been investigated is how self-efficacy is impacted when KR is provided after relatively good, or relatively poor motor skill performances while learning a motor skill. Therefore, in the present study, we focused on different types of KR (i.e., KR provided after good trials versus KR provided after poor trials) which was provided to learners performing a throwing task. Rather than providing KR after each trial, we chose to provide summary KR about good or poor performances following a set (e.g., 6) of practice trials. The use of summary KR is an effective method for delivering feedback at a reduced frequency in motor learning paradigms (Lavery, 1962; Magill, 2001; Wulf & Shea, 2004). We hypothesized that learner's receiving summary KR after good trials would have a higher self-efficacy compared to learners receiving summary KR after poor trials. We also hypothesized that participants who received summary KR after good trials would also display superior throwing performance during practice and retention compared to participants that received summary KR after poor trials. Such a finding would not only be valuable for theoretical reasons, but would also be useful for practitioners.

Method

Participants

Twenty- four male undergraduate students (M age = 19.51 years, SD = 1.08) participated in this study. None of them had experience with the prescribed task, and all were naive to the purpose of the experiment. Prior to the study, we obtained the necessary Institutional Review Board approval and informed consent was obtained from all participants.

Apparatus and task

The task was similar to one used in several previous studies (e.g., Chiviacowsky & Wulf, 2007; Saemi et al., in press), and required participants to toss a tennis ball with their non-dominant arm to a target that was placed on the floor in front of them. Participants' non-dominant arm was determined by asking which arm they did not use when writing. During the performance of all practice and retention test trials participants were required to wear opaque eye goggles to prevent them from viewing the outcome of their throw. The target was placed 3 m from the participant. The center of the target was circular and had a radius of 10 cm. The center of the target was surrounded by a series of nine concentric circles with radii of 20, 30, 40, 50, 60, 70, 80, 90 and 100 cm, respectively, which served as zones to assess throwing accuracy. If the ball landed in the center of the target, 100 points were awarded, point values decreased as the ball landed farther away from the center of the target. Specifically, if it landed in one of the other zones, or outside the outer circle, 90, 80, 70, 60, 50, 40, 30, 20, 10, or 0 points, respectively, were recorded. If the ball landed on a line separating two rings, the participant was awarded the higher score. All practice and retention test trials took place in a controlled research laboratory. The same scorer was used for all practice and testing trials. The score was located perpendicular to the center of the target for all trials.

To measure the learner's self-efficacy, we adapted a scale from Bandura's *Guide for Constructing Self-Efficacy Scales* (2006). This measure had ten questions that focused on learner's ability beliefs in throwing a tennis ball. Each question was rated on a 100% scale with a range of 10 equal intervals (for example, 0 = not confident at all, 100 = completely confident). The overall self-efficacy was calculated by summing the scores from all 10 questions (see Table 1). Also, internal consistency of the scale was calculated using Cronbach's α statistic, which revealed that the internal consistency was significantly high (.96).

Procedure

Participants were randomly assigned to either the "KR after good trials" ($n = 12$; M age = 19.25 years; SD = 1.02) or the "KR after poor trials" ($n = 12$; M age = 19.77 years; SD = 1.14) group. All participants were informed that the task goal was to toss the tennis ball with their non-dominant arm to the center of the target in front of them. All participants completed 10 blocks of 6 trials for a total of 60 practice trials. After each block of 6 trials, participants in the "KR after good trials" group received KR on their 3 best tosses in that block, whereas those in the "KR after poor trials" group received KR on their 3 poorest tosses in the block. Before the initiation of the practice session, participants in both groups were informed that at the end of each block of 6 trials they would receive KR on three of the trials completed in the previous block. However, participants did not know if the provided KR was related to poor or good performances; rather they were informed that they were simply going to receive feedback about 3 attempts from the previous block of 6 trials. KR was written on a board and presented to them for a period of 15 s; participants removed their opaque goggles during this 15 s interval so they could accurately read the provided KR. The provided KR consisted of the trial number and respective earned score. Participants in both groups completed the Self-Efficacy Scale (Bandura, 2006) before they performed each block of 6 trials, and following the last block of 6 trials for a total of 11 self-efficacy assessments. All participants returned after 24 h and completed a 10 trial retention test; no KR was provided during the testing session.

Data analysis

Throwing accuracy was analyzed in a 2 (Group: KR after good trials/KR after poor trials) × 10 (Blocks) analysis of variance