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# Positive social-comparative feedback enhances motor learning in children

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ABSTRACT

*Objectives:* The present study investigated the influence of social-comparative feedback on the learning of a throwing task in 10-year-old children.
*Design:* Two-group experimental design, including a practice phase and retention test.
*Method:* Both groups of participants, a positive social-comparative feedback and a control group, received veridical feedback about their performance (accuracy score) after each practice trial. In addition, after each block of 10 trials, the positive feedback group was given bogus feedback suggesting that their own performance was better than that of a peer group's on that block. One day after the practice phase, a retention test without (veridical or social-comparative) feedback was performed to assess learning effects as a function of feedback.
*Results:* The positive feedback group demonstrated greater throwing accuracy than the control group on the retention test. In addition, questionnaire results indicated that this group scored higher in terms of perceived competence than the control group.
*Conclusions:* These findings demonstrate that feedback can have an important motivational function that affects the learning of motor skills in children.


Over the past few years, there has been converging evidence to suggest that augmented feedback has not only an informational function in the process of learning motor skills (Schmidt & Lee, 2011) but rather impacts learning via its motivational properties. Studies related to feedback and coaching behavior have shown that practice conditions that induce positive feelings related to participants' performance results can boost perceptions of competence and self-efficacy as well as motor performance and learning (Allen & Howe, 1998; Amorose & Horn, 2000; Koka & Hein, 2003; Mouratidis, Vansteenkiste, Lens, & Sideridis, 2008). Furthermore, video feedback about learners' best performances (so-called self-modeling; e.g., Clark & Ste-Marie, 2007) has been found to enhance not only their intrinsic motivation but also motor learning relative to video feedback about their actual (or average) performance. More recently, studies following up on findings indicating that learners preferred to receive feedback after "good" trials (Chiviacowsky & Wulf, 2002) have shown that providing feedback after relatively successful trials (i.e., trials with relatively small errors) can enhance motor learning relative to feedback after less successful trials (i.e., trials with larger errors) (Chiviacowsky & Wulf, 2007; Chiviacowsky, Wulf, Wally, & Borges, 2009; Saemi, Wulf, Varzaneh, & Zarghami, 2011). In a study by Badami, VaezMousavi, Wulf, and Namazizadeh (2012), for example, the authors asked participants (young adults) to putt golf balls into a circular target, and after each block of 6 trials feedback was provided about the 3 most accurate trials in one group, or the 3 least accurate trials in another group. The group that, unbeknownst to the participants, received feedback after their best practice trials, demonstrated more effective learning on a retention test without feedback than participants who received feedback after poor trials. In addition, feedback after good trials has been demonstrated to enhance participants' intrinsic motivation (Badami, Vaezmousavi, Wulf, & Namazizadeh, 2011), and self-confidence or self-efficacy (Badami et al., 2012; Saemi, Porter, Ghotbi-Varzaneh, Zarghami, & Maleki, 2012).

In a related line of inquiry, the effects of normative feedback on motor performance and learning have been examined in adults (e.g. Hutchinson, Sherman, Martinovic, & Tenenbaum, 2008; Johnson, Turban, Pieper, & Ng, 1996; Lewthwaite & Wulf, 2010a, 2010b; Wulf, Chiviacowsky, & Lewthwaite, 2010). Normative feedback involves norms such as a peer group's actual or false average

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performance or improvement scores. In a study by Hutchinson et al. (2008), providing participants with (false) feedback suggesting that their performance was in the top 10th percentile resulted in enhanced performance (i.e., increased exertion tolerance and sustained effort on an isometric force production task) compared with feedback indicating performance was in the bottom 10th percentile. Furthermore, task enjoyment and self-efficacy were increased in the former group. In another study (Lewthwaite & Wulf, 2010b), the learning of a balance task was enhanced by positive relative to negative or no normative feedback. More recently, Wulf, Chiviacowsky, and Lewthwaite (2012, Experiment 1) replicated the beneficial effects for learning in a study with older adults (ages 61–81) practicing the same balance task. Participants who received feedback implying that their performance was better than that of their peers demonstrated superior learning than a control group without social-comparative information. Participants also reported being less concerned about their ability and less nervous while balancing than the control group. Finally, Wulf et al. (2010) used a sequential timing task and provided normative feedback about performance improvement relative to the previous block of trials. Even though participants did not receive feedback about their own improvement from block to block (only error feedback after each trial), a group of participants who were given normative improvement feedback implying they were improving more than average demonstrated more effective learning, as measured by a no-feedback transfer test, than a group led to believe their improvement was below average.

The conviction of performing above average has been shown to increase self-efficacy (Hutchinson et al., 2008), reduce nervousness and concerns about one's ability (Wulf et al., 2012), and increase movement automaticity (Lewthwaite & Wulf, 2010b). It presumably alleviates self-related concerns that hamper performance and learning, which are present when one believes oneself to be performing below average, or even in the absence of social-comparative information (see Lewthwaite & Wulf, 2010a).

Previous studies have examined the effects of social-comparative feedback solely in adults. Therefore, we asked whether motor learning would also be enhanced in children who believed they were outperforming their peers. In previous research, some feedback manipulations have resulted in similar effects in children and adults, while other feedback-related variables had different effects in different age groups. For example, self-controlled relative to yoked feedback schedules have been found to be effective in both adults (e.g., Chiviacowsky & Wulf, 2002; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997; Patterson & Carter, 2010) and children (Chiviacowsky, Wulf, Medeiros, Kaefer, & Tani, 2008). Similarly, feedback after "good" as opposed to "poor" trials has been shown to have learning benefits in adults (e.g., Chiviacowsky & Wulf, 2007) as well as children (e.g., Saemi et al., 2011). However, learning in adults, but not in children, appears to benefit from more precise feedback (Newell & Kennedy, 1978). Also, Sullivan, Kantak, and Burtner (2008) demonstrated that, while a reduced frequency of feedback improved the learning of a discrete arm movement in adults, when compared with a KR frequency of 100%, the opposite pattern of results was found in children. Finally, in self-controlled feedback paradigms, adults who selected a relatively low versus high feedback frequency did not show different degrees of learning (Chiviacowsky, Godinho, & Tani, 2005); yet, children who chose a low frequency demonstrated impaired learning relative to those who chose a high feedback frequency (Chiviacowsky, Wulf, Medeiros, Kaefer, & Wally, 2008). Thus, children can differ from adults in terms of how they respond to different types of feedback.

The purpose of the present study was therefore to determine whether the learning advantages of positive feedback would generalize to children. Two groups of 10 year-old children were asked to toss beanbags to a target while wearing opaque goggles to increase the value of augmented feedback. While both groups received feedback about the accuracy of their throws after each trial, only one group (positive feedback) received (bogus) social-comparative feedback suggesting that their performance was above the average of their peers. To determine the influence, if any, of positive feedback on children's motivation (in particular, perceived competence) we used the perceived competence subscale from an adapted version of the Intrinsic Motivation Inventory (IMI; McAuley, Duncan, & Tammen, 1989; Whitehead & Corbin, 1991). A retention test without feedback was performed one day after the practice phase to examine learning effects as a function of feedback. We hypothesized that the positive feedback group would demonstrate more effective learning and higher perceived competence than the control group.

## Method

### Participants

Thirty-two 10-year old Brazilian children ($M = 10.4$, $SD = 0.36$) participated in the study. Informed consent was obtained from the school, the parents/guardians, and participants provided their assent. The study was approved by the university's institutional review board. Participants had no prior experience with the experimental task and were not aware of the specific purpose of the study.

### Apparatus and task

The task was the same as that used in a previous study (Chiviacowsky, Wulf, Medeiros, Kaefer & Tani, 2008). Participants were asked to throw beanbags (100 g) at a circular target placed on the floor with their non-dominant arm while wearing opaque goggles. The target was placed at a distance of 3 m from the participant and had a radius of 10 cm. Concentric circles with radii of 20, 30, 40, 50, 60, 70, 80, 90, and 100 cm drawn around the target served as zones to assess the accuracy of the throws. When the beanbag landed on the bull's eye, 100 points were awarded. If it landed in one of the other zones, or outside the circles, 90, 80, 70, 60, 50, 40, 30, 20, 10, or 0 points, respectively, were recorded (Fig. 1).

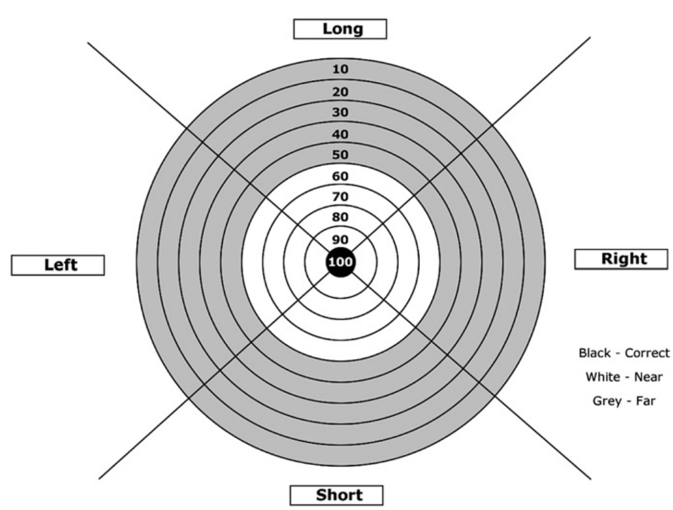


**Fig. 1.** Schematic of the target and zone areas used for providing feedback.

*Procedure*

Participants were quasi-randomly assigned to the positive feedback and control groups, with an equal number of males and females (10 boys and 6 girls) in each group. Participants wore opaque swimming goggles while throwing to prevent them from viewing the target during practice and retention. However, they were allowed to look at the target before both experimental phases. Participants were informed about the goal of the task and were instructed to throw the beanbags overhand with the non-dominant hand, keeping their feet behind a line on the floor.

During the practice phase both groups received veridical feedback regarding throwing accuracy after each trial. Feedback was provided in terms of the direction and distance from the center of the target. To provide directional information, the target area was divided into four quadrants with areas designated as "long", "short", "left", or "right" (see Fig. 1). Feedback included information about distance ("near" or "far") referring to circles 60 to 100 or circles 0 to 50, respectively, and direction (for example: "near left", "far long"). In addition, participants in the positive feedback group were informed that they would receive a feedback statement, after each 10-trial block, about their performance relative to that of children of the same age from other schools in the city, who had also performed the same task recently. In fact, the experimenter informed them that their throws on the previous block were, on average, better than the throws of the other children on the same block (bogus feedback). The practice phase consisted of 60 trials. Thus, participants in the positive feedback group received veridical feedback after each practice trial and (false) social-comparative feedback after each 10-trial block (i.e., 6 times), while the control group received only veridical feedback after each trial. One day later, a retention test was performed, consisting of 10 trials (with vision occluded and without feedback).

After the practice phase, all children filled out a questionnaire to assess their perceived competence on a 2-item subscale of the Intrinsic Motivation Inventory adapted for children (e.g., Chatzopoulos, Drakou, Kotzamanidou, & Tsorbatzoudis, 2006; Likesas & Zachopoulou, 2006; Whitehead & Corbin, 1991). A Portuguese version has been validated for adults and partially for children (Simões & Alarcão, 2011). The 2 items included: "After throwing for a while, I felt competent" and "I did well on this task". There were 4 possible responses for each statement, ranging from "not competent/not well" to "very competent/very well". Each response was accompanied by appropriate "smiley" or "frowny" faces. For analysis purposes, we used a 7-point scale, such that the responses in each category were given 1, 3, 5, or 7 points, respectively. Internal consistency of the 2 perceived competence items was determined via the Cronbach's alpha coefficient.

*Data analysis*

Accuracy scores were analyzed in 2 (group: positive feedback versus control) × 6 (blocks of 10 trials) analysis of variance (ANOVA) with repeated measures on the last factor for the practice phase, and in a one-way ANOVA for the retention test. The average perceived-competence score was analyzed in a one-way ANOVA.

## Results

*Throwing accuracy*

*Practice*

Both groups increased their accuracy scores across practice blocks (see Fig. 2, left panel). The main effect of block was significant, $F(5, 150) = 2.72$, $p < .05$, $\eta^2 = .08$, while the main effect of group, $F(1, 30) < 1$, and the interaction of group and block were not significant, $F(5, 150) = 1.40$, $p > .05$.

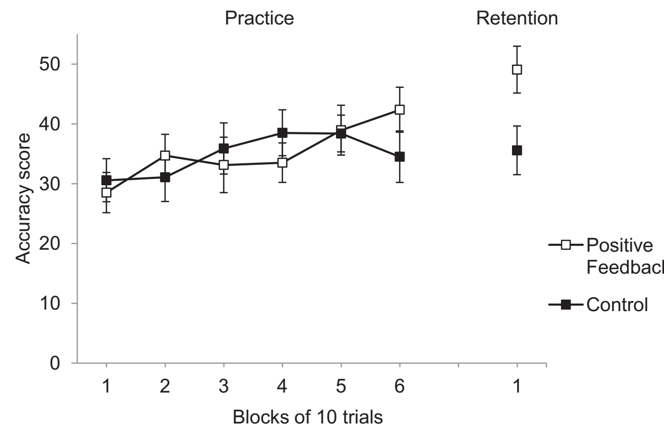


**Fig. 2.** Accuracy scores on blocks of 10 trials during practice and retention for the positive feedback and control groups (Note: Error bars indicate standard errors).

*Retention*

On the no-feedback retention test one day later, the positive feedback group had higher accuracy scores than the control group (see Fig. 2, right). The difference between groups was significant, with $F(1, 30) = 5.70$, $p < .05$, $\eta^2 = .16$.

*Perceived competence*

Cronbach's alpha coefficient for the perceived-competence subscale was 0.72, indicating an acceptable level of internal consistency. Positive feedback group participants had higher perceived competence scores after practice than control group participants, $F(1, 30) = 32.54$, $p < .001$, $\eta^2 = .52$.

## Discussion

The present study was designed to test the effectiveness of positive social-comparative feedback for the learning of a motor task in 10-year-old children. The motivational commonality of factors affecting performance and learning of motor skills has begun to spark the interest of researchers (see Lewthwaite & Wulf, 2012). Effects of normative or social-comparative feedback, typically given in addition to veridical information about the learner's performance, can be argued to be motivational in nature. In previous studies, (bogus) positive feedback – suggesting that a learner's performance is superior to that of peers – has been shown to enhance motor learning in young adults (Lewthwaite & Wulf, 2010b; Wulf et al., 2010) as well as older adults (Wulf et al., 2012). The present study appears to be the first to examine social-comparative feedback effects more specifically on children's motor learning. We chose to compare positive feedback to a control condition with only veridical feedback, as previous findings have demonstrated that positive feedback can *enhance* motor learning, relative to negative feedback and control conditions, with no difference between the latter two (Lewthwaite & Wulf, 2010b).

The present results are in line with findings of previous studies in motor learning (Lewthwaite & Wulf, 2010b; Wulf et al., 2010, 2012) as well as in sports/physical education contexts of motor performance (Cairney, Hay, Faught, Léger, & Mathers, 2008; Marsh, Chanal, & Sarrazin, 2006; Marsh, Gerlach, Trautwein, Ludtke, & Brettschneider, 2007). The present findings demonstrate that the belief that one is performing better than average, or better than one's peers, results in a motivational boost that, in turn, can enhance learning in 10-year-old children. The social-comparative feedback resulted in children's evident recognition that they performed more effectively than their peers on this task. The motivational effects of social-comparative feedback were not immediately seen during the practice phase of this study; however, they affected the learning of the task, as demonstrated by more effective performance on the delayed retention test – in the absence of veridical and social-comparative feedback, or visual information about the movement outcome. Research in sports and physical education contexts has previously demonstrated the important effects of high levels of perceived competence with children's engagement and performance levels. For example, Marsh and colleagues (Marsh et al., 2006, 2007), using questionnaires and physical tests of motor performance, showed that pre-adolescents and adolescents' sport self-concepts and performance reciprocally influenced each other, with findings generalizing over age and gender. In another study, Cairney et al. (2008) observed that self-efficacy levels of 10 years-old children, as measured by the Children's Self-perceptions of Adequacy in and Predilection for Physical Activity scale (CSAPPA), was significantly related to the Léger shuttle run performance.

Social comparison is ubiquitous, and comparisons with others can inform people about their skill and standing relative to others. Thus, they serve as a means for self-assessment and the development of a self-concept (Cheng & Lam, 2007). Indeed, children as young as 3 years old can express distress after performing worse than others (Stipek, Recchia, & McClintic, 1992), and 4–5 year olds assessed themselves more favorably after social success than failure (Butler, 1998). It is not surprising that positive social-comparative information in the process of learning a novel motor task is associated with higher perceived competence. Certainly, positive normative comparisons have previously been shown to increase self-efficacy, positive self-reactions, and task interest (Bandura & Jourden, 1991; Hutchinson et al., 2008; Kavussanu & Roberts, 1996). Such thoughts can also reduce concerns about one's performance and ability-related thoughts, as well as lead to reduced nervousness (Wulf et al., 2012). Yet, it is interesting that motivational manipulations have the potential to directly impact motor learning – presumably moderating the extent to which memories are consolidated (e.g., Trempe, Sabourin, & Proteau, 2011).

The present findings add to the mounting evidence that motivational factors affect the learning of motor skills. Our findings highlight the influence of social-comparative information on individuals' motivation and learning. While we would not suggest the use of false social-comparative feedback as an applied intervention, practitioners should be aware of the fact that feedback rarely provides "neutral" information, and almost always has motivational consequences. Future studies can replicate and extend this effect with other forms of motivational feedback, or motor tasks, as well as measures of baseline perceived competence (a limitation of the present study). They might examine whether it is the affective response to positive evaluative feedback that serves to moderate learning. Importantly, there is now converging evidence to suggest that there is considerable potential for enhancing the learning process by recognizing good performances or improvements (Wulf et al., 2010).

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