

Children's Motor Skill Learning Is Influenced by Their Conceptions of Ability

Ricardo Drews, Suzete Chiviacowsky, and Gabriele Wulf

The present study investigated the effects of different ability conceptions on motor skills learning in 6-, 10-, and 14-year-old children. In each age group, different groups were given either inherent-ability or acquirable-skill instructions before they began practicing a throwing task. Participants were blindfolded and were asked to throw beanbags at a target placed on the floor at a distance of 3 m. All participants performed 40 practice trials and received feedback about the accuracy of their throws after each trial. One day after practice, retention and transfer (greater target distance) tests without instructions or feedback were conducted to assess learning effects. Older participants generally had higher accuracy scores than younger participants. Importantly, instructions emphasizing the learnability of the skill resulted in greater throwing accuracy on the retention test than did those implying an underlying inherent ability. On the transfer test, the same effect was seen for the 14-year-olds, but not for the younger age groups, suggesting that adolescents may be more vulnerable to the threat of their inherent ability being exposed. The present findings demonstrate the importance of ability conceptions for motor learning in children and adolescents. They also add to the mounting evidence of motivational influences on motor skill learning.

Keywords: acquirable skill, inherent ability, throwing

Conceptions of ability are knowledge structures that include beliefs about the inherent stability or changeability of attributes (Ross, 1989). The role of conceptions of ability has been the focus of research in various areas of performance and learning. Ability conceptions refer to people's view of the nature of key abilities. As first suggested by Dweck and her colleagues (Dweck, 1999, 2002; Dweck & Leggett, 1988), individuals tend to differ in whether they view abilities as a natural capacity that is relatively stable and therefore defines the limits of potential achievements (so-called "entity theorists"), or as malleable and dependent primarily on effort or learning ("incremental theorists"). These orientations have different motivational and behavioral consequences. Typically, entity theorists strive to demonstrate their abilities by outperforming others, tend to avoid challenging situations that might demonstrate low ability, and show less effort and persistence when confronted with error feedback. Incremental theorists tend to be more intrinsically motivated and focused on task learning, react to difficult situations by increasing their effort, and see

mistakes as a natural part of the learning process (e.g., Hong, Chiu, Dweck, Lin, & Wan, 1999; Martocchio, 1994; Nicholls, 1984).

Studies examining the influence of conceptions of ability on performance or learning have either compared individuals with different dispositional conceptions of ability (e.g., Belcher, Lee, Solmon, & Harrison, 2003; Li, Lee, & Solmon, 2005, 2008; Sarrazin, Biddle, Famose, Cury, Fox, & Durand, 1996; Taberner & Wood, 1999) or used instructions to induce certain views of ability (e.g., Jourden, Bandura, & Banfield, 1991; Kasimatis, Miller, & Marcussen, 1996; Lirgg, George, Chase, & Ferguson, 1996; Martocchio, 1994; Wood & Bandura, 1989; Wulf & Lewthwaite, 2009). In general, experimental instructions designed to induce specific conceptions of ability tend to override any dispositional conceptions participants may bring to the laboratory. Only a few studies have examined the influence of (induced) conceptions of ability on motor performance and learning (Jourden, Bandura, & Banfield, 1991; Wulf & Lewthwaite, 2009). Using a pursuit-rotor task, Jourden and colleagues (1991) informed participants in an inherent-aptitude condition that the apparatus measured their natural capacity for processing dynamic information, whereas participants in the acquirable-skill condition were informed that the task represented a learnable skill. The latter group showed greater self-efficacy, more positive affective self-reactions, expressed greater interest in the task, and demonstrated greater improve-

Drews and Chiviacowsky are with the School of Physical Education, Federal University of Pelotas, Brazil. Wulf is with the Dept. of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas.

ment across trials. A more recent study (Wulf & Lewthwaite, 2009) found differences in motor learning as a function of conceptions of ability. An acquirable-skill group demonstrated more effective balance learning and greater automaticity in movement control on a retention test than did an inherent-ability group. Also of note is that a control group performed similarly to the latter group, suggesting that the acquirable-skill instructions provided a boost to learning rather than the induced inherent-ability view degrading it.

Conceptions of ability presumably develop with age, as children begin to understand the distinction between ability and effort (Nicholls, 1984, 1989). Findings have shown differences in the understanding ability and effort in children of different age groups, with younger children demonstrating different reasoning about these concepts than older ones (Fry & Duda, 1997; Lee, Carter, & Xiang, 1995; Nicholls, 1978; Xiang & Lee, 1998; Xiang, Lee, & Shen, 2001). Young children do not appear to regard ability as a stable trait, or as an internal quality that can be judged by others, but rather view ability as being linked to, or developed by, effort and persistence (Dweck, 2002; Dweck & Elliott, 1983; Nicholls, 1984; Stipek & Daniels, 1988).

Nevertheless, even young children seem to be able to infer, from the feedback they are given, adults' view of the nature of their abilities. A few studies have demonstrated that conceptions of ability induced by feedback can directly affect young children's reactions to failure, their motivation, and their behavior (e.g., Chiviawsky, Wulf, & Drews, 2012; Cimpian, Arce, Markman, & Dweck, 2007). Cimpian et al. (2007) showed that even 4-year old children were sensitive to subtle differences in the wording of feedback. In that study, feedback about a child's drawing implied either a stable capacity for drawing ("You are a good drawer") or a more situation-specific or effort-related skill ("You did a good job drawing"). Even though both types of feedback appeared to be equally rewarding, when confronted with mistakes, children who were led to believe that the quality of their drawings was a function of an inherent ability exhibited more negative self-evaluations, increased helplessness, and reduced interest in drawing. In a subsequent study, Chiviawsky et al. (2012) extended these findings to the motor domain. Ten-year old children were asked to kick soccer balls at a target and were given feedback that either implied (e.g., "You are a great soccer player") or did not imply ("Those kicks were excellent") an underlying inherent ability. After a second experimental phase in which both groups were given negative feedback ("Those kicks were not very precise"), an immediate retention test 10 min after practice was performed. On that test, children who had received feedback that suggested an underlying inherent ability displayed a significant drop in shooting accuracy, whereas the other group of participants maintained their performance.

An important question is whether children's conceptions of ability could also affect the learning of motor

skills. Previous studies with children (Chiviawsky et al., 2012; Cimpian et al., 2007) were only concerned with immediate effects of ability conceptions. To our knowledge, only one study (Wulf & Lewthwaite, 2009) examined longer-term effects on motor skill learning, but in adult learners. Therefore, the purpose of the current study was to determine whether different ability conceptions would also have consequences for motor learning in children, as measured by retention and transfer tests. One possibility was that inherent-ability versus acquirable-skill instructions would have a temporary effect on performance during practice, perhaps due to increased apprehension resulting from heightened concern for ability revelation in the former condition, but that those influences would subside and not affect performance in a delayed test situation. Alternatively, if children are influenced by ability conceptions in a similar manner as adults, they might show learning benefits with acquirable-skill relative to inherent-ability instructions. Furthermore, we were interested in potential age-related differences in the susceptibility to suggestions about the nature of their abilities. Therefore, we included three different age groups: 6-, 10-, and 14-year-old children. All participants practiced a throwing skill after being provided with different ability-related instructions. One day later, they completed retention and transfer tests without instructions or reminders.

Methods

Participants

One hundred and twenty children age 6 ($M = 6.2$, $SD = 0.24$), 10 ($M = 10.1$, $SD = 0.30$), and 14 ($M = 14.4$, $SD = 0.34$) years (54 girls, 66 boys) were recruited from a city-center private school located in the south of Brazil to participate in the study. All participants were naive as to the purpose of the experiment. The children gave their assent, and informed consent was obtained from their parents or guardians. The study was approved by the university's institutional review board.

Apparatus and Task

The task required participants to throw 100-g beanbags at a circular target placed on the floor, with their nondominant arm, while wearing opaque goggles. The target was a bull's eye. The center circle had a radius of 10 cm and was surrounded by nine concentric circles with radii of 20, 30, 40 . . . 100 cm. The center of the target was placed at a distance of 3 m from the participant. Accuracy scores were based on where the beanbag first contacted the floor. If 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 . . . 0 points, respectively, were recorded. If a beanbag landed on a line, the higher score was awarded.

Procedure

In each age group (6, 10, 14 years), participants were assigned to one of two conditions: An inherent-ability (IA) or acquirable-skill (AS) group. Each of the six resulting groups had 20 participants, with about an equal number of boys and girls in each age group being quasi-assigned to the respective IA and AS groups (6-year-olds: 12:8; 10-year-olds: 11:9; 14-year-olds: 10:10, respectively). Participants were informed about the goal of the task and were instructed to throw the beanbags overhand with the nondominant hand. All participants wore opaque swimming goggles while throwing, but were allowed to look at the target before each experimental phase (i.e., practice, retention, transfer). Feedback about throwing accuracy was provided after each trial during the practice phase. As can be seen from Figure 1, the target area was divided into four quadrants, with areas designated as “long,” “short,” “left,” or “right”. Feedback included information about the distance and direction from the center of the target (e.g., “a little bit to the left” or “much too long”) depending on whether the beanbag landed in the inner (60–100) or outer circles (0–50), respectively.

The instructions provided to the IA groups were modeled after those used in previous studies (Jourden et al., 1991; Wulf & Lewthwaite, 2009). IA group participants were given the following instructions before the beginning of practice: “This task measures people’s ability to aim. We will ask you to perform several throws

today and tomorrow. Aiming is an ability that you are born with. Your mistakes or your success on this throwing task will show your aiming ability.” AS group participants received the following instructions: “This task measures people’s ability to aim. We will ask you to perform several throws today and tomorrow. Aiming is a skill that can be learned. At the beginning, it is common to make errors, but with practice you can learn and improve.” After 20 practice trials, participants were given reminders: “Remember that aiming is an ability that you are born with. Your mistakes or your success on this throwing task will show your aiming ability” or “Remember that aiming is a skill that can be learned. At the beginning it is common to make errors, but with practice you can learn and improve,” respectively. The practice phase consisted of 40 trials. Retention and transfer (target distance: 4 m) tests consisted of 10 trials each and were performed one day later. Vision was again occluded, and no instructions or feedback were given on the second day.

Data Analysis

Accuracy scores during the practice phase were analyzed in 2 (conceptions of ability) \times 3 (age groups) \times 4 (blocks of 10 trials) analysis of variance (ANOVA) with repeated measures on the last factor. The retention and transfer data were each analyzed in 2 (conceptions of ability) \times 3 (age groups) ANOVAs. An alpha level of 0.05 was used as the threshold for significance. Bonferroni adjustments were made for all post hoc comparisons.

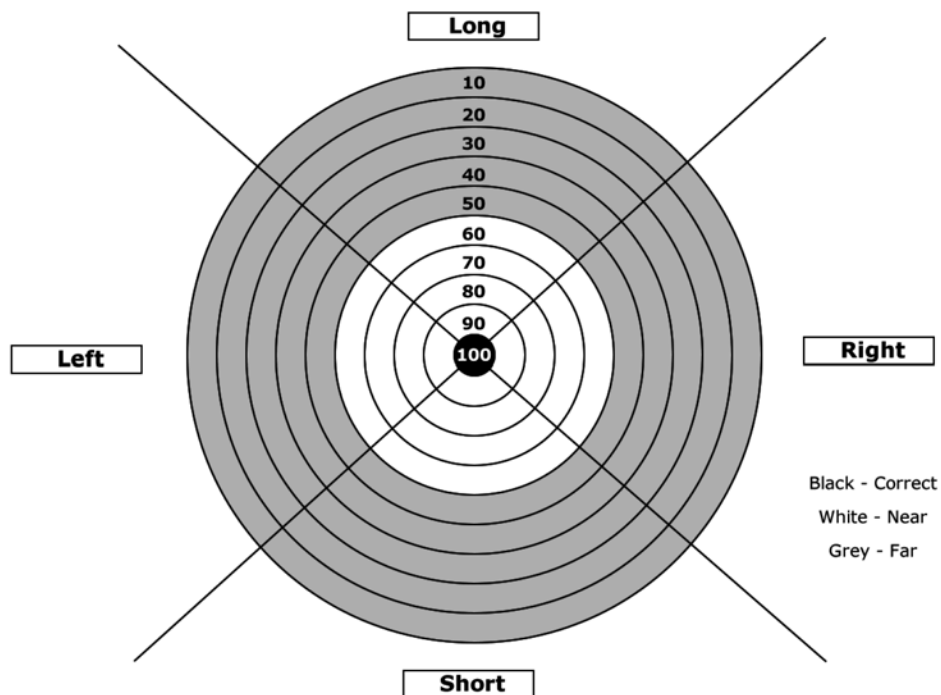


Figure 1 — Target and areas used for providing feedback.

Results

Throwing Accuracy

Practice. Accuracy scores increased in all groups across practice blocks (see Figure 2a-c). In addition, older children demonstrated greater accuracy than younger children. The main effects of block, $F(3, 342) = 6.89, p < .001, \eta^2 = .06$, and age group, $F(2, 114) =$

$49.37, p < .001, \eta^2 = .46$, were significant. *Post hoc* tests indicated significant differences among all age groups, $ps < .001$. The induced conceptions of ability did not affect performance during practice, $F(1, 114) = 2.53, p > .05$. There were no significant interactions among conceptions of ability and age group, $F(2, 114) < 1$, block and age, block and conceptions of ability, $F(6, 342) < 1$, or block, age, and conceptions of ability, $F(6, 342) = 1.17, p > .05$.

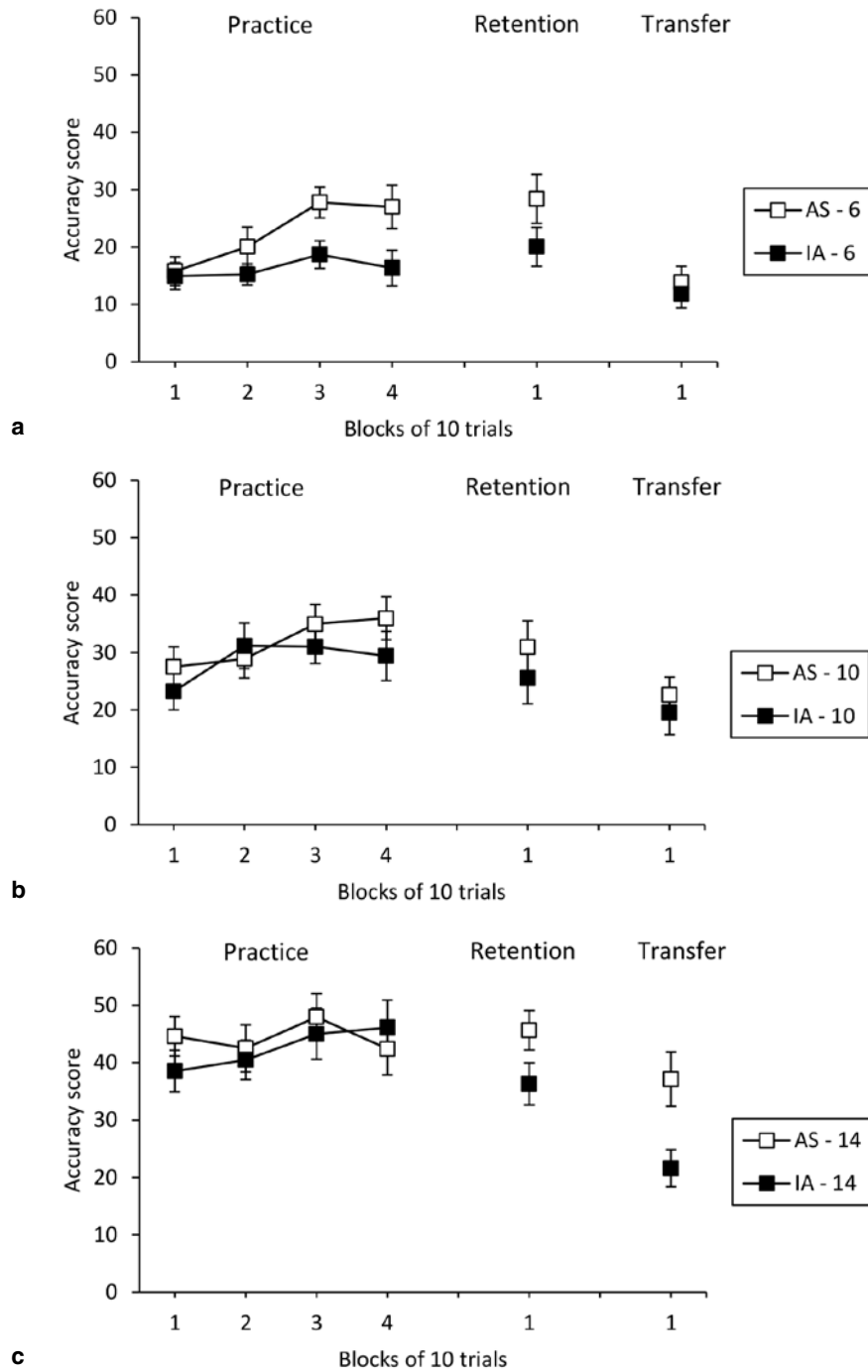


Figure 2 — Accuracy scores for 6-year-old (a), 10-year-old (b), and 14-year-old children (c) during practice, retention, and transfer in the inherent-ability and acquirable-skill conditions. Error bars indicate standard errors.

Retention. On the retention test, the AS groups demonstrated higher accuracy scores than the IA groups, $F(1, 114) = 6.02, p < .05, \eta^2 = .05$. In addition, throwing accuracy increased with age. The main effect of age was significant, $F(2, 114) = 9.11, p < .001, \eta^2 = .14$. *Post hoc* tests revealed significant differences between ages 6 and 14, and 10 and 14, $p < .01$. There was no difference between ages 6 and 10, $p > .05$. There was no interaction of conceptions of ability and age, $F(2, 114) < 1$.

Transfer. On the transfer test with a novel target distance, the AS groups were again more accurate than the IA groups. The main effect of conceptions of ability was significant, $F(1, 114) = 7.36, p < .01, \eta^2 = .06$. In addition, the main effect of age was significant, $F(2, 114) = 10.01, p < .001, \eta^2 = .15$. *Post hoc* tests indicated that only the difference between ages 6 and 14 was significant, $p < .001$. The differences between ages 6 and 10 ($p = .057$) and 10 and 14 ($p = .12$) failed to reach significance. Finally, there was a significant interaction between conceptions of ability and age, $F(2, 114) = 3.24, p < .05, \eta^2 = .05$. Follow-up ANOVAs for each age group revealed that the effect of conceptions of ability was significant for the 14-year olds, $F(1, 38) = 9.48, p < .01$, but not for the 6 or 10-year olds, $F(1, 38) < 1$.

Discussion

The present findings demonstrate that children's conceptions of ability can influence their learning of motor skills. As previously shown for adult learners (Wulf & Lewthwaite, 2009), emphasizing the malleability of abilities through practice led to more effective retention performance than did instructions portraying ability as a fixed capacity. The AS groups outperformed the IA groups across all ages in retention. However, when a novel target distance was introduced on the transfer test, the induced conceptions of ability only affected the performance of the oldest participants (14 years), but not the younger ones (6- or 10-year-olds). In addition, and not surprisingly, age had an effect on throwing accuracy. The 14-year-olds were more accurate than both the 6- and 10-year-olds in retention, and relative to the 6-year-olds in transfer.

The present results are in line with other studies showing that individuals' conceptions of ability can affect performance and learning across a variety of domains. Effects of ability conceptions have been found to range from dispositional views of intelligence affecting grades in junior high school (Blackwell, Trzesniewski, & Dweck, 2007) to learning from error feedback on a general knowledge test (Mangels, Butterfield, Lamb, Good, & Dweck, 2006) to immediate effects on motor performance (Jourden et al., 1991; Chiviawsky et al., 2012), and more long-term effects on motor learning (present study; Wulf & Lewthwaite, 2009). Thus, despite differences in participants' age (adults vs. children), type of learning (cognitive vs. motor), or nature of ability conceptions (dispositional vs. induced), a view of abilities as

changeable through practice or experience, rather than representing relatively fixed entities, generally seems to benefit performance and learning.

While differences in achievement levels (e.g., academic, athletic) between incremental and entity theorists in the long term are presumably due to their distinct motivational sets, including different goal orientations and responses to challenges or setbacks (e.g., Dweck, 1999; Dweck & Leggett, 1988), the more immediate effects of ability conceptions on performance and learning likely have different underlying reasons. An acquirable-skill view relative to an inherent-ability view has been found to be associated with increased self-efficacy (Jourden et al., 1991), more positive self-evaluations (Cimpian et al., 2007; Jourden et al., 1991), reduced nervousness, fewer thoughts about one's own performance and ability, and less attention being directed to body movements (Wulf & Lewthwaite, 2009). In addition, Wulf and Lewthwaite's study demonstrated greater automaticity in motor control for acquirable-skill group participants. An entity view of ability presumably leads to frequent self-evaluations, perhaps even after every trial, as to whether one possesses a certain attribute or not, whereas an incremental view dampens the potential of any given trial to have implications for the self. Wulf and Lewthwaite (2010) suggested that conditions that produce less-than-optimal motivational states presumably provoke (unconscious) access to the self. Self-consciousness, or a self-focus, may lead to self-evaluation and activate self-regulatory processes in attempts to bring self-related thoughts and emotions under control (Carver & Scheier, 1978). Those efforts may tax attentional resources, perhaps to the extent that available attentional capacity is exceeded, with the result that performance and learning suffer. An inherent-ability view of motor abilities also appears to promote an internal attentional focus on body movements (see Wulf & Lewthwaite, 2009) that has been shown to disrupt movement automaticity and reduce accuracy (Wulf, 2012). In contrast, conditions that tend to reduce a focus on the self, such as acquirable-skill instructions, may immunize learners against a self or internal focus.

Some interesting age-related effects were seen on the transfer test. In contrast to the retention test, on which acquirable-skill instructions resulted in enhanced performance across all three age groups, on the transfer test only the 14-year-olds' performance was affected by the different instructions. The differential impact of ability-related instructions as a function of performers' age may reflect the increasing impact of ability conceptions, which starts to rise between the ages of 10 and 12 (see Dweck, 2002, for a review). Whereas younger children often overestimate their abilities and show less interest in social comparison, older children and adolescents tend to underestimate their abilities, and comparisons with others have an increasing impact on their self-evaluation, motivation, and performance. Thus, with a heightened sensitivity to evaluations by others and an increase in the intensity of self-conscious emotions (Zeman, Cassano, Perry-Parrish, & Stegall, 2006), adolescents seem to be more vulnerable

to potential threats to the self—such as the construal of a task as something that exposes the extent of one's inherent ability. Why interactive effects of age and ability conceptions were seen only in transfer, but not in retention, is not clear. One possibility is that the switch to a greater target distance (4 m) had the general effect of directing participants' attention more to the new target and away from ruminations about self-related implications of their performance. Yet, adolescents' greater susceptibility to influences of the social environment may have overridden this potentially beneficial effect and manifested itself in degraded performance in the IA condition. Further, the greater distance in transfer may have been less demanding for adolescents and thus still allowed apportionment of attention to self-related issues.

The present findings are important from both theoretical and practical perspectives. Theoretically, they add to the evidence base for the social-cognitive-affective-motor nature of "motor" behavior (Lewthwaite & Wulf, 2010a). As Lewthwaite and Wulf pointed out, an information-processing account that regards instructions or feedback provided to learners simply as "neutral" information cannot explain the influence of many self-related variables that have been found to impact performance and learning. These include social-comparative information (e.g., Lewthwaite & Wulf, 2010b; Wulf, Chiviacowsky, & Lewthwaite, 2010), learner expectancies (e.g., Wulf, Chiviacowsky, & Lewthwaite, 2012), stereotype threat (e.g., Chalabaev, Sarrazin, Stone, & Cury, 2008), self-efficacy (e.g., Slobounov, Yukelson, & O'Brien, 1997), and others. Future theories of motor learning need to be able to explain how learning is affected not only by the way in which certain factors make the processing of information more or less challenging, but also by the motivational impact of different variables.

From a practical point of view, the current results highlight the importance of how instructions are worded in the context of teaching and learning. Highlighting the learnability of skills would generally be expected to have a positive impact on children's motor learning, but perhaps especially in older children and adolescents who appear to be more susceptible to situations that potentially present a threat to the self. Emphasizing the malleability of abilities may also influence the future engagement of children in physical activity. As demonstrated previously (Cimpian et al., 2007), children's conceptions of ability can easily be influenced by how information or feedback about task performance is worded, and affect their motivation to continue to perform those tasks. This would appear to be particularly important at a time when physical activity in adolescents is declining (Centers for Disease Control and Prevention, 2012).

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