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A test of optimal theory on young adolescents' standing long jump performance and motivation

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ABSTRACT

The OPTIMAL theory of motor learning contends that an external focus of attention (EF), enhanced expectancies (EE), and autonomy support (AS) are key attentional and motivational variables that optimise motor performance. We examined how integrating an EF into EE and AS interventions would impact young adolescents' standing long jump performance and self-efficacy, perceived competence, task effort, task importance and positive affect. Forty-eight participants completed 3 jumps in a baseline, EF (focus on jumping towards the cone), EE-EF (positive social-comparative feedback/high success probability) and AS-EF (self-definition of success) conditions. Both the EF and AS-EF conditions (but not the EE-EF condition) improved jump performance from baseline. The EF, EE-EF and AS-EF conditions improved young adolescents' self-efficacy, perceived competence, task effort and positive affect in comparison to baseline and were predictors of jump performance (as was task importance). However, in the EE-EF condition motivational states improved (from baseline) but this did not translate into performance improvements. The findings show that directing attention to visual external cues both independently and when framed within AS conditions enhanced young adolescents' jump performance and motivation through efficient goal-action coupling. In practice, PE teachers and sports coaches working with young adolescents can support autonomy by allowing self-definition of success using an external cue to enhance effective goal-action coupling, motor performance and motivation.

1. Introduction

The OPTIMAL (Optimizing Performance Through Intrinsic Motivation and Attention for Learning) theory of motor learning (Wulf & Lewthwaite, 2016) contends that an external focus of attention (EF), enhanced expectancies (EE) and autonomy support (AS) are attentional and motivational variables central to motor performance and learning. Researchers propose that these variables make independent and interactive contributions to efficient goal action coupling by priming and optimizing the motor system for successful task execution (Wulf & Lewthwaite, 2016; Wulf, Lewthwaite, Cardozo, & Chiviacowsky, 2017). An EF (i.e., a focus on the intended movement effect or movement outcome) has consistently been shown to enhance motor performance and learning compared with an internal focus on body movements and no instructed focus (Wulf, 2013). According to the constrained action hypothesis (Wulf, McNevin, & Shea, 2001), verbal instruction and feedback which promotes an EF improves motor efficiency (e.g., muscular activity) and effectiveness (e.g., throwing accuracy) by promoting unconscious, automatic and reflexive motor control (Marchant, 2011; Wulf, 2013). Similarly, instruction and feedback can enhance expectancies for future task success by suggesting that performance was better than average through social comparative feedback (e.g., performance 20% better than peers; Chiviacowsky, Cardozo, &

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Chalabaev, 2018), through highlighting good performances (Wulf, Chiviacowsky, & Lewthwaite, 2012), or through setting out achievable performance criteria (Marchant, Carnegie, Wood, & Ellison, 2018; Ziv, Ochayon, & Lidor, 2019). Finally, conditions that support an individual's basic psychological need for autonomy (Deci & Ryan, 2008) enhance motor performance and learning through motivational mediators (e.g., positive affect). In motor/movement settings, AS can be provided by: allowing control over the extent of practice (Post, Fairbrother, Barros, & Kulpa, 2014), the frequency of skill demonstrations (Maarseveen, Oudejans, & Savelsbergh, 2018), the use of assistive devices (Hartman, 2007) and by altering task variables such as performing with a dominant versus a non-dominant hand (Wulf et al., 2017). Autonomy support can also be provided through language which is "suggestive" rather than "controlling" (e.g., "*you may want to cradle and deliver the ball in a windmill fashion*"- cricket bowling skill; Hooyman, Wulf, & Lewthwaite, 2014).

The performance enhancing effects of OPTIMAL variables are explained through attentional and motivational mechanisms (Wulf & Lewthwaite, 2016). To begin with, an EF contributes to performance through enhanced attentional control (e.g., greater motor automaticity; Wulf, 2013), but it may also have a positive indirect effect on motivation (i.e., self-efficacy) – although experimental evidence is limited (e.g., Pascua, Wulf, & Lewthwaite, 2015). In contrast, the benefits of EE and AS are mediated through motivational characteristics which include self-efficacy (Bandura, 1977), perceived competence (Ryan, 1995), task effort (Hutchinson, Sherman, Martinovic, & Tenenbaum, 2008), task importance (Gonçalves, Cardozo, Valentini, & Chiviacowsky, 2018) and positive affect (Stoate, Wulf, & Lewthwaite, 2012). Although autonomy supportive conditions can facilitate performance through EE, both EE and AS make individual contributions to motivation and motor performance (Wulf & Lewthwaite, 2016). Enhancing expectancies has improved self-efficacy and perceived competence when feedback was provided after good rather than poor performance, when (false) positive-social comparative feedback was given, and when performance criteria suggested a high likelihood of success (Ghorbani, 2019; Gonçalves et al., 2018; Wulf et al., 2017). Furthermore, EE has increased task effort and task importance when bogus social comparative feedback suggested performance was better than their peers (Gonçalves et al., 2018; Hutchinson et al., 2008). EE has also been associated with positive affect (e.g., positive feelings) due to its link with dopamine release, which contributes to the consolidation of motor memories and readies the motor system for effective goal-action coupling (Sugawara, Tanaka, Okazaki, Watanabe, & Sadato, 2012; Wulf & Lewthwaite, 2016). However, some studies indicate that enhancing expectancies has not always benefited motor performance and learning (e.g., Ong, Hawke, & Hodges, 2019; Ong & Hodges, 2018). Similarly, conditions which support an individual's need for autonomy (AS) have been positively correlated with self-efficacy for motor tasks (Lemos, Wulf, Lewthwaite, & Chiviacowsky, 2017). Autonomy support has boosted self-efficacy when participants could choose to alter task variables and when autonomy supportive language was used (Hooyman et al., 2014; Wulf, Chiviacowsky, & Drews, 2015). Moreover, AS in the form of self-selected feedback frequency has increased participants' positive affect (Lemos et al., 2017).

To date, research investigating OPTIMAL theory on young adolescents (aged 11–13 years) and children (aged 5–10 years) is limited. Similarly, the application of OPTIMAL theory into motor performance settings is also limited despite its importance within the OPTIMAL theory (Chua, Wulf, & Lewthwaite, 2018; Wulf & Lewthwaite, 2016). Indeed, the benefits of OPTIMAL variables may have a greater positive effect in young adolescents and children given their developmental characteristics. For example, young adolescents and children have lower working memory capacities and may benefit more from an EF than adults (Van Maarseveen, Oudejans, & Savelsbergh, 2018). Furthermore, adolescents (aged 11–14 years) are more sensitive to social comparison than adults (Zeman, Cassano, Perry-Parrish, & Stegall, 2006) and can benefit from positive-social comparative feedback (Drews, Chiviacowsky, & Wulf, 2013). Young adolescents and children generally have a limited opportunity to make active choices in comparison to adults (Patall, Cooper, & Robinson, 2008); therefore, AS may have a more pronounced positive effect on their motor performance (Lemos et al., 2017). Moreover, evidence of the potential motivational effects of an EF is limited, as too is the effects of EE and AS on the performance and motivation of young adolescents (Ávila, Chiviacowsky, Wulf, & Lewthwaite, 2012; Bahmani, Wulf, Ghadiri, Karimi, & Lewthwaite, 2017; Gonçalves et al., 2018; Lemos et al., 2017; Pascua et al., 2015; Wulf, Chiviacowsky, & Cardozo, 2014). Furthermore, research has shown that combining OPTIMAL variables (e.g., an EF and AS) has additional additive benefits on children's motor performance in comparison to applying a single OPTIMAL variable (Abdollahipour, Nieto, Psotta, & Wulf, 2017). Yet, it is currently unclear how combining OPTIMAL variables impacts young adolescents' motor performance and motivation.

In adult populations, research has also demonstrated that an EF when paired with EE and AS has additive benefits on motor performance (Wulf & Lewthwaite, 2016). For example, in a throwing task, an EF (a focus on the target) when coupled with EE (positive-social comparative feedback) (EE-EF), improved motor performance and subsequent learning as compared to control and, independent EF and EE conditions (Pascua et al., 2015). Additionally, self-efficacy and positive affect were enhanced and contributed to improved motor performance. Furthermore, Wulf et al. (2015) found that an EF (concentration on the target) and AS (choice to throw with dominant arm) both independently improved throwing performance (vs. a control group), but when combined an EF and AS had additive benefits on performance and self-efficacy (Wulf & Lewthwaite, 2016). These studies show that the attentional benefits of an EF (i.e., motor automaticity; Wulf, 2013) can be combined with the motivational benefits of EE and AS (i.e., increased self-efficacy and positive affect) to augment motor performance (Abdollahipour et al., 2017; Makaruk et al., 2019; Wulf & Lewthwaite, 2016). Despite these findings, only Marchant, Carnegie, et al. (2018) have demonstrated that OPTIMAL variables can be implemented simultaneously (e.g., EE via visual illusion and EF via instruction) to boost adult's motor performance without the need for separate instructions (i.e., first choice of ball colour and then provide the EF instruction; Abdollahipour et al., 2017). Additionally, most OPTIMAL studies measure the impact of an EF, EE and AS on motor learning (e.g., Wulf et al., 2017), despite the importance motor performance within the OPTIMAL framework (i.e., conditions that optimise performance facilitate later learning; Wulf & Lewthwaite, 2016). If young adolescents are limited in working memory capacity (in comparison to adults) it may be counter-productive to promote an EF, EE and AS via multiple instructions (Brocken, Kal, & Van der Kamp, 2016; Buszard et al., 2017). Therefore, given the nature of an EF (e.g., highlighting movement outcomes), it may be possible to integrate an EF into EE and AS interventions via environmental cues to optimise young adolescents' motor performance (Marchant, Carnegie, et al., 2018).

In standing long jump tasks (the task used in the present study), the benefits of an EF have been well-documented (e.g., Asadi, Farsi, Abdoli, Saemi, & Porter, 2019; Coker, 2016; Coker, 2018; Marchant, Griffiths, Partridge, Belsley, & Porter, 2018; Porter, Ostrowski, Nolan, & Wu, 2010). However, recent studies have suggested that the presence of an external cue (i.e., a cone) may have augmented the effects of an EF by promoting a concrete movement goal and increased the perceived attainability of the movement outcome (e.g., enhancing expectations of successful performance) in comparison to an EF which did not promote a visual cue (Marchant, Griffiths, et al., 2018). Effectively, EF conditions which do not promote a clear visual goal are sub-optimal to performance as the presence of a visual task goal (i.e., a cone to jump towards) can have added motivational effects which may contribute to efficient goal-action coupling (Coker, 2016; Wulf & Lewthwaite, 2016). Marchant, Griffiths, et al. (2018) reported that children's standing long jump performance was better under a distal-EF (jump as close to the cone as possible) compared to a proximal-EF (jump as far past the start line as possible), an internal focus, and a control group. Whilst the benefits were explained by the constrained action hypothesis (e.g., greater motor automaticity), the placement of a cone at the end of the jump mat (and explicit EF cueing) in the distal-EF condition inadvertently emphasised the task goal and thereby enhanced expectancies by providing a clear and meaningful external visual cue (e.g., an EF; Coker, 2016). Conversely, Asadi et al. (2019) indicated that an EF can be promoted in a standing long jump task via AS by allowing participants to choose where to focus their attention (AS). Asadi et al. (2019) explained that allowing participants to choose a jump distance target (which they focused on externally) likely resulted in increased attainability of the goal (EE) (Coker, 2016) and replicated the attentional benefits of an EF to improve jump performance. Although these studies do not describe an integrated OPTIMAL approach, an EF was framed within EE and AS conditions identifying its potential to optimise approaches which enhance young adolescents' motor performance.

The present study aimed to assess the predictions of the OPTIMAL theory that conditions which direct attention externally, enhance expectancies and support autonomy initially benefit motor performance (Wulf & Lewthwaite, 2016), as a precursor to effective motor learning processes (Abdollahipour, Valtr, & Wulf, 2019). Specifically, we examined whether an EF could be augmented by EE and AS to improve young adolescents' standing long jump performance. First, we hypothesised that the EF, EE-EF and AS-EF conditions would enhance jump performance as compared to baseline (e.g., Marchant, Carnegie, et al., 2018). Second, we hypothesised that each condition would increase participants' self-efficacy, perceived competence, task effort, task importance and positive affect (Ghorbani, 2019; Gonçalves et al., 2018; Lemos et al., 2017). Finally, we aimed to explore differences between EF, EE-EF and AS-EF conditions on jump performance and the motivational characteristics of self-efficacy; perceived competence, task effort, task importance and positive affect. Based on previous research (Pascua et al., 2015; Wulf et al., 2015), we hypothesised that standing long jump performance and the motivational characteristics would be enhanced in the EE-EF and AS-EF conditions as compared to the EF condition.

2. Methods

2.1. Participants

Based on a repeated measures factorial design, with an estimated effect size of $\eta p^2 = 0.25$ (i.e., a large effect size) (Marchant, Griffiths, et al., 2018), an alpha level of 0.05, and a power value of 90%, a sample size of 7 participants was identified as providing adequate statistical power using G*power software (Version.3.1; Faul, Erdfelder, Lang, & Buchner, 2007). In total, 48 male PE students aged 11–13 years participated in the study. Testing was conducted in a local high school in the north west of England and took place within a normal physical education lesson. Before any testing took place, the study was approved by the university ethics committee (SPA-REC-2018-319). All participants were naïve to the purpose of the study and provided written informed consent prior to the testing.

2.2. Apparatus and task

Participants completed three maximal effort standing long jumps in four counterbalanced conditions (i.e., baseline, EF, EE-EF and AS-EF conditions) for a total of 12 jumps (Chua et al., 2018). Jumps were performed on an anti-slip jump mat (Eveque; England) that included measurement lines in 2 cm increments to a distance of 250 cm. The primary outcome measure was jump distance (Marchant, Griffiths, et al., 2018) and secondary outcome measures were the motivational characteristics: self-efficacy (Ghorbani, 2019), perceived competence (Teixeira da Silva, Thofehrn Lessa, & Chiviacowsky, 2017), task effort (Hutchinson et al., 2008), task importance (Gonçalves et al., 2018) and positive affect (Lemos et al., 2017). A manipulation check was also completed verbally by participants after each experimental condition to determine comprehension and adherence to the instructions (Perreault & French, 2016).

2.3. Procedure

After a short warm-up involving walking/jogging at a moderate-intensity and two low-effort jumps, a general explanation of the task was provided alongside a figure demonstrating correct jumping technique. Jump distance for the warm-up jumps were not recorded. No demonstration was provided by the experimenter to avoid constraining individual's movement patterns (Vidal, Wu, Nakajima, & Becker, 2018). Additionally, only the experimenter was present during testing to minimise observer effects. To gauge the participant's current perception of jump competence, a pre-test measure of perceived competence was obtained prior to the baseline jumps (see Section 2.4.2 for details of the perceived competence measure). Participants then completed three jumps in baseline, EF, EE-EF and AS-EF conditions in a counterbalanced order. Verbal instruction/feedback was provided by the experimenter prior to each jump and was specific to each condition. Baseline instructions were "*jump to the best of your ability*". To standardise the task environment in the experimental conditions (i.e., EF, EE-EF, AS-EF), a 30 cm-high cone with a square base was used as the visual cue to promote an EF (Coker, 2016; Marchant, Griffiths, et al., 2018). A cone was not presented in the baseline condition so as not to influence attentional focus or elicit any unintentional motivational effects (Coker, 2016). In the EF condition, the cone was placed in front of the participant at the end of the jump mat, 250 cm from the start line. Participants were instructed to "*jump as close to the cone as possible*" (Marchant, Griffiths, et al., 2018; Porter et al., 2010). In the EE-EF condition, the base corner of the square cone was placed to the side of the jump mat 106 cm from the start line to represent normative standing long jump data for 11-year-old young adolescents in the bottom 5th percentile (Catley & Tomkinson, 2013). In line with other studies (Gonçalves et al., 2018) this aimed to increase the likelihood for successful performance (e.g., enhance performance expectations). To manipulate expectations of "successful" performance, participants were instructed that "*the cone represents where children your age typically jump to…try to jump as far as you can past the cone*". All participants exceeded the cone and received the positive-social comparative feedback "*well done, you've jumped further than what we would usually see for children of your age*" (Chiviacowsky et al., 2018). In the AS-EF condition, participants were instructed to "*place the cone at a distance which you believe you can jump past… try to jump as far as you can past the cone*" (Asadi et al., 2019). The distance of the cone which was placed to the side of the jump mat could be adjusted prior to each jump. Participants were given a short break between jumps and a two-minute rest period between conditions, during which they completed a manipulation check and a questionnaire to collect the secondary measures of self-efficacy, perceived competence, task effort, task importance and positive affect.

2.4. Task and measures

2.4.1. Primary measure

Jump distance was measured in centimetres (cm) by the experimenter from the start line to the back of the participant's heel which landed closest to the start line (Marchant, Griffiths, et al., 2018; Porter et al., 2010).

2.4.2. Secondary measures

The five secondary measures (self-efficacy, perceived competence, task effort, task importance and positive affect) were collected after each condition (i.e., baseline, EF, EE-EF, AS-EF) via a questionnaire. An additional measure of perceived competence was also collected prior to the baseline condition. A self-efficacy questionnaire was adapted for this experiment in accordance with Bandura's guidelines (2006) for creating self-efficacy measures. Specifically, participants were asked how confident they were on a scale of 0 ("not confident at all") to 10 ("extremely confident") that they would be able to successfully jump 1 m, 1.5 m and 2 m, which were noted on the jump mat for participants when completing the scale. In the AS-EF condition, cone placement by the participant was recorded (from the base corner of the square cone) in centimetres (cm) after each trial. Perceived competence was measured by asking participants to respond to the item "*I think I am pretty good at this jumping activity";* task effort was measured with the item "*I tried very hard while jumping";* and task importance was measured with the item "*it was important for me to do well at this jumping task"*. Similar to past studies (Ávila et al., 2012; Gonçalves et al., 2018), participants responded to these three items on a 1 ("strongly disagree") to 7 ("strongly agree") Likert scale. Positive affect was measured by asking participants to place a tick mark on a line with endpoints labelled "not happy at all" (0 mm) and "very happy" (200 mm) (Lemos et al., 2017). The manipulation check involved asking participants to respond to the following items on a 1 ("not at all/none") to 10 ("very much so/a lot of effort") Likert scale: *"Did you understand the instructions you had been given?"* (i.e., *comprehension*) and "*How much effort did you put into focusing on the cone?" (EF adherence in the EF-only condition*). Finally, participants also provided verbal reports when asked "*What were you thinking about whilst jumping?"* (Lemos et al., 2017; Perreault & French, 2016).

2.5. Data analysis

Data were analysed using SPSS version 25.0 (IBM Corporation, 2017). Means and standard deviations (mean ± standard deviation) were used to describe the data. Jump distances were averaged across the three jumps completed in each condition. Similarly, the three self-efficacy scores (1 m, 1.5 m and 2 m) collected after each condition were averaged across each condition. A series of six, one-way repeated-measures ANOVAs were used to determine statistically significant differences for jump performance and the secondary measures (self-efficacy, perceived competence, task effort, task importance and positive affect). A Pearson's correlation coefficient was used to assess the relationship between jump performance and participant's cone placement in the AS-EF condition. Standard multiple regression analysis examined the relationships between the motivational characteristics (self-efficacy, perceived competence, task effort, task importance and positive affect) and jump performance. Manipulation checks were reported as descriptive statistics. Where sphericity was violated a Greenhouse-Geisser correction was applied. For post-hoc tests, pairwise comparisons with Bonferroni adjustments were used. Level of significance was set at $p < .05$ and effect sizes were calculated using partial eta squared (ηp^2) (where 0.01, 0.06 and 0.14 were estimated as small, medium and large effect sizes respectively (Larson-Hall, 2009).

3. Results

An overview of the primary and secondary outcome measures, and the manipulation check can be found in Table 1. The

Table 1
Means (SD) for jump performance (cm), questionnaire and manipulation check.

	Jump performance (cm)	Self-efficacy	Perceived competence	Task effort	Task importance	Positive affect	Instruction comprehension
Pre-test	–	–	4.40 (1.15)	–	–	–	–
Baseline	142.26 (20.61)	6.23 (2.48)	4.83* (1.14)	5.65 (1.07)	5.69 (1.23)	140.83 (28.01)	–
EF	148.93 (19.63)	7.11** (2.27)	5.46** (1.15)	6.33** (0.85)	5.94 (1.33)	154.44** (28.09)	9.60 (0.89)
EE-EF	145.92 (19.88)	7.28** (2.42)	5.69** (1.02)	6.29** (0.79)	5.92 (1.41)	155.29** (29.58)	9.64 (0.76)
AS-EF	148.46 (17.76)	7.29** (2.41)	5.58** (1.19)	6.29** (0.84)	5.92 (1.34)	154.63** (32.42)	9.71 (0.77)

* Indicates significant differences from pre-test ($p > .05$).
** Indicates differences from baseline ($p < .05$). EF = external focus, EE = enhanced expectancies, AS = autonomy support.

manipulation check revealed that instruction comprehension was very high (Table 1). Adherence to an EF was also very high in the EF condition with scores of 8.81 (SD = 1.21) on the 10-point Likert scale. Additionally, verbal reports indicate that 61% of participants thought about jumping to/past the cone in the EF condition in comparison to 27% and 50% in the EE-EF and AS-EF conditions respectively.

3.1. Primary outcome measure

There was a significant main effect for condition on jump performance, $F_{(2,113)} = 11.385$, $p < .001$, $\eta p^2 = 0.195$. Mean jump distances in the different conditions were as follows: baseline = 142.26 cm (SD = 20.61), EF = 148.93 cm (SD = 19.63), EE-EF = 145.92 cm (SD = 19.88) and AS-EF = 148.46 cm (SD = 17.76) respectively. Post-hoc analysis indicated that participants jumped significantly further in the EF (+6.67 cm) and AS-EF (+6.20 cm) conditions as compared to the baseline condition ($p < .001$). No differences were observed between the EE-EF condition and baseline ($p = .123$). In terms of comparing the different conditions, jump performance in the EF condition was significantly better than the EE-EF condition (+3.66 cm), $p = .023$ (Fig. 1). No other differences were observed between the conditions.

3.2. Secondary outcome measures

In the AS-EF condition, the one-way ANOVA revealed that cone placement increased incrementally, $F_{(1,78)} = 3.908$, $p = .031$, $\eta p^2 = 0.077$; jump 1 = 139.85 cm (SD = 17.54), jump-2 = 142.15 cm (SD = 18.45), jump 3 = 143.56 cm (SD = 18.25) (Mean cone placement = 141.85 cm (SD = 18.15)) (Fig. 2). A significant positive correlation was observed between cone placement and AS

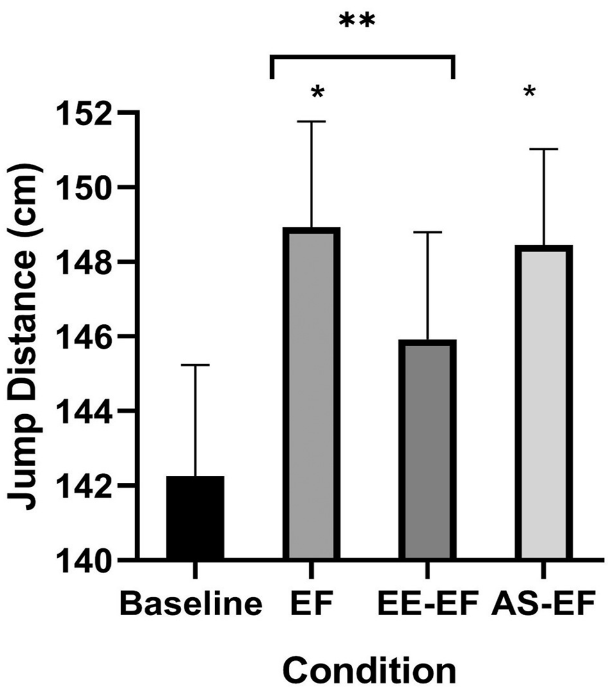

Fig. 1. Mean Jump Performance (cm). Note: Error bars depict standard error. *Indicates significant differences compared to baseline ($p < .05$). **Indicates significant differences between OPTIMAL conditions ($p < .05$). EF = external focus, EE = enhanced expectancies, AS = autonomy support.

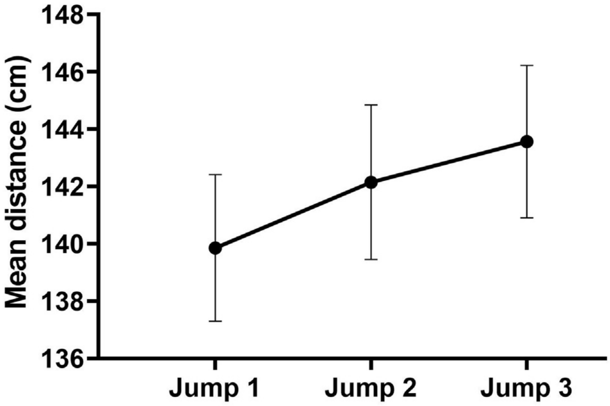

Fig. 2. Mean cone placement distance for 3 jumps (cm) in the autonomy support (AS) condition. Note: Error bars depict standard error.

jump distance ($r = 0.721, p < .001$). For each jump, mean jump distance exceeded the mean cone placement in the AS-EF condition: jump 1 (+8.67 cm), jump 2 (+4.94 cm) and jump 3 (+6.21 cm).

An ANOVA revealed significant main effects for condition on self-efficacy, $F_{(2,141)} = 17.900, p < .001, \eta p^2 = 0.276$. Mean self-efficacy was significantly higher ($p < .001$) in the OPTIMAL conditions compared to baseline (Table 1). Post-hoc testing did not reveal any significant differences between OPTIMAL conditions. A significant main effect for condition on perceived competence was observed, $F_{(3,142)} = 30.792, p < .001, \eta p^2 = 0.395$. Pairwise comparisons highlighted that all conditions including baseline, demonstrated significantly improved perceived competence versus the pre-test measure ($p < .001$), whilst perceived competence was significantly greater in the OPTIMAL conditions versus the baseline condition ($p < .001$) (Table 1). No statistical differences between OPTIMAL conditions were observed. There was a main effect of task effort, $F_{(2,108)} = 13.3, p < .001, \eta p^2 = 0.221$, where the OPTIMAL conditions significantly increased task effort from baseline ($p < .001$) (Table 1). Post-hoc analysis did not disclose any differences in task effort between OPTIMAL conditions. No differences were found between OPTIMAL conditions and baseline for task importance (Table 1). Condition had a significant main effect on positive affect, $F_{(2,97)} = 8.404, p < .001, \eta p^2 = 0.152$, with OPTIMAL conditions producing significantly greater positive affect scores as compared to the baseline condition (EF and EE-EF, $p < .001$; AS-EF, $p = .028$) (Table 1). No differences in positive affect were revealed between OPTIMAL conditions.

Multiple regression analysis indicated that the model which included the motivational characteristics (i.e., self-efficacy, perceived competence, task effort, task importance and positive affect) significantly predicted jump performance, $F_{(4,47)} = 9.183$, *Adjusted* $R^2 = 0.411, p < .001$. Specifically, both self-efficacy ($\beta = 0.475, p = .004$) and task effort ($\beta = -0.350, p = .041$) made statistically significant contributions to jump performance. Perceived competence, task importance and positive affect did not make statistically significant contributions to jump performance.

4. Discussion

The present study investigated the effects of combining OPTIMAL theory informed approaches on a motor performance task. Specifically, we examined if young adolescent's standing long jump performance and motivational characteristics (e.g., self-efficacy) could be enhanced by integrating an EF into EE and AS interventions. Based on predictions of the OPTIMAL theory, we hypothesised that each OPTIMAL condition would improve jump performance and motivational characteristics when compared to baseline. As expected, an EF improved young adolescent's standing long jump performance as compared to no instructed focus (i.e., baseline) (Wulf, 2013). This finding supports the suggestion that children and young adolescents do not automatically adopt an EF when executing movements (Coker, 2018; Marchant, Griffiths, et al., 2018). Consequently, it is not adequate to simply instruct young adolescents to jump to the best of their ability, but rather to direct their focus to an external visual cue (i.e., a cone to aim towards/ jump past). Alongside its attentional benefits (Wulf, 2013), an EF enhanced motivational states (as indicated by increased self-efficacy, perceived competence, task effort and positive affect relative to the baseline condition) by potentially clarifying a visual task-relevant goal (Coker, 2016; Marchant, Griffiths, et al., 2018; Pascua et al., 2015). This likely increased the perceived attainability of the movement goal (Coker, 2016) and perceptions of success through the mediators of self-efficacy and task effort. Perceived competence and positive affect subsequently increased through implicit feedback regulation as participants jumped closer to the cone (i.e., jumped further). These findings further support the point that EF instruction which does not promote a visual task goal may not be conducive to optimal motor performance in young adolescents given their reliance on visual coding (Coker, 2016; Marchant, Griffiths, et al., 2018; Ste-Marie et al., 2012). However, the benefits of an EF are not restricted to the use of visual cues for this age group (Abdollahipour, Land, Cereser, & Chiviacowsky, 2019; McNamara, Becker, Weigel, Marcy, & Haegele, 2019), suggesting that the clarity and relevance of EF instruction may also greatly contribute to effective goal-action coupling (e.g., Russell, Porter, & Campbell, 2014).

In contrast to OPTIMAL theory predictions (Wulf & Lewthwaite, 2016), we found that combining EE with an EF by placing a cone in an easily attainable position and providing positive-social comparative feedback (EE-EF) led to improved self-efficacy, perceived competence, task effort and positive affect as compared to baseline. However, this did not translate into improved jump performance. One potential explanation for the lack of performance improvement is that the criteria for success may have been too easy (Ong & Hodges, 2018). This is especially the case for the older participants in the sample (e.g., aged 13 years) who possessed more advanced motor functions and are more sensitive to perceptions of their own performance and social comparison (Zeman et al., 2006). Although task goals which are perceived as easy reduce task effort in adults (Ong & Hodges, 2018); the setting of an achievable goal increased task effort in the EE-EF condition. This indicates that setting an achievable goal using an EF cue (i.e., a cone to aim towards/jump past) is beneficial to young adolescents' engagement in a motor task, especially where social comparative information is available (Drews et al., 2013). However, caution is required as the regression analysis associated low task effort with "good" performance. Thus, it is possible that participants may have attempted to be perceived as an "effortless learner" to protect self and social-worth (Jackson, 2003) whilst still applying the effort required to satisfy task goals. Jackson (2003) explained that young adolescent boys may negatively manipulate perceptions of their effort to influence others' perceptions that their achievements are a result of their ability rather than effort. This thereby increases perceptions of effortless achievement in the event of task success. In addition, Wulf and Lewthwaite (2016) explained that to effectively enhance expectancies; challenging and meaningful manipulations (Priebe & Spink, 2014) should be provided for reward-related dopamine to be released to enhance goal-action coupling. Therefore, although the task outcome was satisfied (i.e., jump past the cone), it is not enough to perceive that task success will optimise motor performance, there must be a worthy challenge (Locke & Latham, 2002). Weinberg (2010) explains that goals should be moderately challenging yet realistically achievable to optimise motor performance. Therefore, if the cone had been placed at the participant's baseline jump distance (Coker, 2016) the task goal may have been more challenging, meaningful and specific, thereby fostering a greater sense of achievement in prevailing success (Wulf & Lewthwaite, 2016). Yet the instruction to "*jump as far as you can past the cone"* may have added motivation to perform better than simply satisfying the task goal; however, the closeness of the cone likely disrupted optimal goal-action coupling by promoting a more proximal EF (Wulf & Su, 2007). In contrast, self-selecting a personal goal using an EF cue in the AS-EF condition with the same verbal instruction (i.e., jump as far past the cone as possible), likely optimised goal-action coupling as the task goal was more meaningful and challenging to each individual. Moreover, the wording of the statement "*I tried very hard when I jumped"* may have overstated the increase in task effort in the EE-EF condition. Given that the task outcomes were easily attained, it is possible that the effort perceptions increased but participants may not have exerted maximal effort given the increased likelihood for success. Instead the statement *"I tried as hard as I could to jump as far as possible past the cone"* may have elicited different effort perceptions. These findings suggest that instruction comprehension may be influenced by visual task goals.

The present study is the first to demonstrate that young adolescents' jump performance can be enhanced by allowing self-regulation of a task-relevant visual external cue (i.e., a cone to aim towards/jump past). Previous findings (e.g., Asadi et al., 2019) have shown that providing the opportunity for choice had a similar performance benefit to an EF (e.g., greater motor automaticity). Perhaps, allowing the distance of focus to change between individuals and with task experience (i.e., distance of the cone placement) likely afforded each individual a task environment which suited their needs, made the task goal more meaningful and attainable, and created an optimal EF distance (Coker, 2016; Priebe & Spink, 2014; Wulf & Su, 2007). In addition to performance benefits, the opportunity for choice improved self-efficacy, perceived competence, task effort and positive affect relative to the baseline condition. Moreover, the incremental increase in cone placement and subsequent success further demonstrated increased self-efficacy levels (as highlighted by the setting of progressively harder task goals; Wolf, Herrmann, & Brandstätter, 2018) and highlighted that young adolescents are sensitive to perceptions of their own performance and prefer to set achievable but challenging goals to increase positive affect (Wulf & Lewthwaite, 2016). Moreover, the positive relationship between cone placement and jump distance indicates that young adolescents can self-regulate performance goals through mediation of effort perceptions (Locke & Latham, 2002). The resulting incremental success from setting harder goals increased self-efficacy, perceived competence and positive affect (Locke & Latham, 2006) demonstrating that expectations for future performances were enhanced as a function of combining AS with an EF (e.g., AS facilitated EE) (Wulf & Lewthwaite, 2016). However, whilst self-selected goal criteria may have added greater meaning to the task goal (Priebe & Spink, 2014), it did not influence task importance presumably due to young adolescents' need to protect their social-worth (Drews et al., 2013; Jackson, 2003). Overall, it appears advantageous to provide an external cue within AS environments to enhance young adolescents' motivation and motor performance (Wulf & Lewthwaite, 2016).

The study's final aim was to examine performance and motivational differences between OPTIMAL conditions. In contrast to our hypothesis and the OPTIMAL theory (Wulf & Lewthwaite, 2016), differences were only found for performance between the EF and EE-EF conditions. As no differences in the motivational characteristics (e.g., positive affect) were observed, it is important to explore the attentional influences of the EF cue (Wulf, 2013). The closeness of the cone in the EE-EF condition (i.e., 106 cm) may have indirectly promoted a more proximal-EF (i.e., a focus closer to the body) which has been found to disrupt motor automaticity and subsequent performance (Wulf et al., 2001). In contrast, the distance of the cone in the EF condition (i.e., 250 cm) may have elicited greater automatic motor control by directing attention further from the body (e.g., a distal-EF) (McNevin, Shea, & Wulf, 2003). Supporting this proposition, Coker (2018) highlighted that a distal-EF promoted better jumping biomechanics (e.g., optimised knee flexion) which contributed to enhanced jump performance. Indeed, verbal reports from the present study indicate that the EE-EF condition evoked less thoughts about jumping past the cone (i.e., an EF) than the EF-only condition, suggesting that an optimal focus of attention was disrupted by the closeness of the cone (i.e., a more proximal EF) in the EE-EF manipulation. Furthermore, self-selection of performance criteria in the AS-EF condition likely created an individualised optimal focus distance resulting in similar attentional and performance benefits as an EF alone (Maurer & Munzert, 2013; Wulf & Su, 2007). These findings have implications for the OPTIMAL theory. Firstly, attentional mechanisms may be a greater contributor to performance than motivation (at least in acute motor performance settings), suggesting that motivational interventions can disrupt an optimal focus of attention when combined.

Secondly, despite the additive benefits (Abdollahipour et al., 2017; Wulf & Lewthwaite, 2016) some approaches to combing OPTIMAL variables are not conducive to optimal performance (i.e., the EE-EF condition in the present study).

The current study had several potential limitations that need to be discussed. Firstly, participants' adherence to an EF was only directly measured in the EF condition; therefore, it is unclear how much focus was attended to the cone in EE-EF and AS-EF conditions. Yet, verbal reports taken across the three experimental conditions suggest that participants generally had more thoughts about jumping to/past the cone in the EF condition compared to the EE-EF and AS-EF conditions. Additionally, the primary purpose of the EE-EF and AS-EF conditions were to investigate the effects of the implicit success manipulation, positive-social feedback and choice of success criteria using an external cue. Therefore, whilst it was not the intention to manipulate the distance of the EF in the EE-EF and AS-EF conditions, it is important to acknowledge that the presence of the cone may have inadvertently directed attention differently in each condition (i.e., more proximally in the EE-EF and AS-EF condition, and more distally in the EF condition). Hence, the differences in jump performance cannot solely be attributed to the EE and AS manipulations as different attentional foci distance may have been promoted across the conditions. This suggests that motivational manipulations can disrupt optimal attentional mechanisms and thus impede efficient goal-action coupling (Wulf & Lewthwaite, 2016). Future research should consider controlling the EF distance when integrating an EF into EE and AS manipulations. Additionally, a between-groups design with independent AS and EE conditions would benefit future studies testing the OPTIMAL theory predictions for young adolescent's motor performance (Abdollahipour et al., 2017). Furthermore, differences in instructions (i.e., jump close to the cone vs. jump past the cone) may have promoted different movement intentions and jump biomechanics (Coker, 2018; Wulf, 2013). As such, future research should examine how young adolescents' instruction comprehension is influenced by visual task goals. Additionally, given that different instructions can influence working memory load and instruction comprehension (Buszard et al., 2017; Van Maarseveen et al., 2018; Wulf, 2013) it may be beneficial to measure these mediators in future research to better understand how to optimise young adolescents' motor performance. Finally, as the OPTIMAL manipulations failed to enhance perceptions of task importance, future studies should examine how perceptions of task importance can be improved especially where social comparison is involved.

From a practical perspective, physical education teachers and sports coaches working with young adolescents should use EF instructions to direct attention to a visual task-relevant cue to optimise goal action coupling, motor performance and boost motivation (e.g., self-efficacy) (Ste-Marie et al., 2012; Wulf & Lewthwaite, 2016). However, clarity of instructions may be an equally important function in goal-action coupling in addition to the role of directing attention to task-relevant visual cues (Abdollahipour, Valtr, & Wulf, 2019; McNamara et al., 2019). Additionally, it may be beneficial to allow self-regulation of success criteria (AS) using a visual task-relevant cue (EF) to promote implicit motor learning and an individualised focus of attention distance. Moreover, self-regulation of performance goals with an external cue allows teachers and coaches to implement OPTIMAL variables into the environment to enhance motor performance where explicit instructions and feedback cannot always be provided.

5. Conclusion

This study demonstrates that the OPTIMAL theory can be an effective framework for enhancing young adolescents' immediate motor performance. Specifically, these findings extend the work from adult populations (Marchant, Carnegie, et al., 2018), by identifying that young adolescents' motor performance and motivation can be enhanced by promoting an EF and integrating an EF into conditions which support autonomy. However, whilst motivation improved in the EE-EF condition, this was not reflected in improved motor performance highlighting that attentional mechanisms may be a stronger contributor to performance than motivation. Additionally, in line with OPTIMAL theory predictions, each OPTIMAL condition contributed to enhanced self-efficacy, perceived competence, task effort and positive affect. This demonstrates that an EF independently and interactively (i.e., EF-AS) improved motor performance and motivation of young adolescents (relative to baseline) through EE (Wulf & Lewthwaite, 2016). These findings suggest that the motivational benefits of EE can be observed without explicit EE manipulations. Given that the OPTIMAL theory predicts that conditions that optimise motor performance facilitate learning (Wulf & Lewthwaite, 2016), future research should examine how combined OPTIMAL variables impact young adolescents' motor learning in more complex tasks (e.g., throwing and catching). In practice, sports coaches and PE teachers should utilise external cues and offer AS to enhance the immediate motor performance and motivation of young adolescents.

Declaration of Competing Interest

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