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Full Length Article

Self-controlled video feedback on tactical skills for soccer teams results in more active involvement of players

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ABSTRACT

Many studies have shown that self-controlled feedback is beneficial for learning motor tasks, and that learners prefer to receive feedback after supposedly good trials. However, to date all studies conducted on self-controlled learning have used individual tasks and mainly relatively simple skills. Therefore, the aim of this study was to examine self-controlled feedback on tactical skills in small-sided soccer games. Highly talented youth soccer players were assigned to a self-control or yoked group and received video feedback on their offensive performance in 3 vs. 2 small-sided games. The results showed that the self-control group requested feedback mostly after good trials, that is, after they scored a goal. In addition, the perceived performance of the self-control group was higher on feedback than on no-feedback trials. Analyses of the conversations around the video feedback revealed that the players and coach discussed good and poor elements of performance and how to improve it. Although the coach had a major role in these conversations, the players of the self-control group spoke more and showed more initiative compared to the yoked group. The results revealed no significant beneficial effect of self-controlled feedback on performance as judged by the coach. Overall, the findings suggest that in such a complex situation as small-sided soccer games, self-controlled feedback is used both to confirm correct performance elements and to determine and correct errors, and that self-controlled learning stimulates the involvement of the learner in the learning process.

1. Introduction

Allowing learners to control (some) features of their own learning process enhances motor skill acquisition (for a review see Wulf, 2007). For example, conditions in which learners are able to decide upon the use of physical assistance devices (Hartman, 2007; Wulf, Clauss, Shea, & Whitacre, 2001; Wulf & Toole, 1999), the amount of practice (Post, 2011), task scheduling (Keetch & Lee, 2007; Wu & Magill, 2011), video demonstration (Wrisberg & Pein, 2002; Wulf, Raupach, & Pfeiffer, 2005), or augmented feedback (Chiviacowsky & Wulf, 2002, 2005; Chiviacowsky, Wulf, De Medeiros, Keafer, & Tani, 2008; Janelle, Kim, & Singer, 1995) have been shown to result in superior performance compared to externally controlled conditions. Especially self-controlled feedback has been proven to be effective in a variety of tasks, including throwing tasks (Chiviacowsky et al., 2008; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997), sequential timing tasks (Chen, Hendrick, & Lidor, 2002; Chiviacowsky & Wulf, 2002), and more complex technical tasks like the basketball set shot or trampoline jumping (Aiken, Fairbrother, & Post, 2012; Ste-Marie, Vertes, Law, & Rymal, 2013). The effects

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of self-controlled feedback have typically been assessed by comparing the performances of self-control groups to yoked groups that could not control feedback delivery, but instead received feedback each time the matched participant of the self-control group requested feedback. Thus, even though the frequency and timing of feedback was identical for both groups, learners who were able to control feedback delivery generally performed better than those with an externally controlled (yoked) feedback schedule.

Using this design, the effects of self-controlled video feedback were first examined on learning a relatively simple motor task: a non-dominant hand ball throw (Janelle et al., 1997). Whenever requested, participants of the self-controlled video feedback group received video feedback on the last two trials with additional cueing and transitional suggestions by an expert. The self-controlled group demonstrated better throwing accuracy and form scores than the yoked group. Similar beneficial effects of self-controlled video feedback have been found for learning the basketball set shot (Aiken et al., 2012) and double mini-trampoline skills (Ste-Marie et al., 2013). Interestingly, self-controlled learners decrease the feedback requests across the acquisition period (Chiviacowsky & Wulf, 2002; Janelle et al., 1997; Laughlin et al., 2015; Ste-Marie et al., 2013). For example, when learning the basketball set shot the percentage of feedback requests was highest during the first practice block (33%) and decreased as practice progressed through the last block (19%; Aiken et al., 2012).

Examination of when self-controlled learners request feedback when learning a sequential timing task using questionnaires revealed that the majority requested feedback after perceived good trials while no one requested feedback after supposedly bad trials (Chiviacowsky & Wulf, 2002). The yoked learners, with no control over their feedback schedule, mainly reported that they did not receive feedback after the right trials and most of them would have preferred feedback after good trials. Moreover, on average, the timing errors were lower on trials for which the self-controlled learners requested feedback compared to the trials for which they did not request feedback, whereas the timing errors of yoked participants were similar for feedback and no-feedback trials. This demonstrated that the participants were quite good at estimating their errors, distinguishing good from bad trials, and that the participants had a clear preference for receiving feedback after good trials. This latter finding has been replicated in several studies (Chiviacowsky, Wulf, Wally, & Borges, 2009; Chiviacowsky et al., 2008; Patterson & Carter, 2010). Furthermore, it has been shown that feedback after relatively good trials is more effective than after relatively poor trials (Badami, VaezMousavi, Wulf, & Namazizadeh, 2012; Chiviacowsky & Wulf, 2007; Saemi, Porter, Ghotbi-Varzaneh, Zarghami, & Maleki, 2012). Receiving feedback after relatively good trials might create a larger success experience for the learner, which increases motivation which in turn enhances learning (Chiviacowsky & Wulf, 2007). This is, however, in contrast to the guiding hypothesis, which states that feedback is particularly important after poor trials to guide the learner to the correct performance (Salmoni, Schmidt, & Walter, 1984).

More recent studies suggest that the feedback preferences of self-controlled learners depend on the nature of the task and the mode of feedback delivery (Laughlin et al., 2015; Post, Aiken, Laughlin, & Fairbrother, 2016). The majority of studies showing a preference for feedback after good trials involved learning a relatively simple motor task in a laboratory setting (i.e., sequential timing or beanbag tossing) and straightforward feedback on one single aspect of performance (i.e., timing error or radial error; Chiviacowsky & Wulf, 2002; Chiviacowsky et al., 2008, 2009; Patterson & Carter, 2010). However, this preference for feedback after good trials was not found in studies using more complex motor tasks and more information-rich sources of feedback. For example, basketball players learning a set-shot requested video feedback after both good and poor trials (Aiken et al., 2012). In simple tasks the entire trial can be perceived as good or poor, while this is not the case for more complex tasks. Learners could request feedback to review good aspects of a poor trial or poor aspects of a good trial. Similarly, in contrast to feedback on one single performance aspect such as radial error, video feedback allows learners to identify both good and poor aspects of their performance on any trial. For example, when learning a 3-ball cascade juggling task participants requested feedback on the duration of the juggling attempt primarily after good attempts, while they requested feedback on their technique after both good and poor attempts (Laughlin et al., 2015). Post-experiment interviews demonstrated that participants requested feedback both to confirm success and to correct performance aspects. Thus, the complexity of the task and the information-richness of the feedback source seem to influence the feedback preferences of self-controlled learners.

The reasons underlying the beneficial effects of self-controlled learning are not well understood (Post et al., 2016). Allowing the learner to control the learning process may result in better tailoring to the personal needs of the learner (Chiviacowsky & Wulf, 2002, 2005, 2007), or may be more motivating in general (Bandura, 1993; Chiviacowsky & Wulf, 2005; McNevin, Wulf, & Carlson, 2000; Wulf et al., 2005). It has also been suggested that allowing learners to control (some features of) the learning environment satisfies a basic psychological need (autonomy; Deci & Ryan, 2000), and in addition encourages learners to take charge of their own learning process (Ferrari, 1996; Janelle et al., 1997; Wulf & Lewthwaite, 2016; Wulf et al., 2001). This stimulates (i) intrinsic motivation (Sanli, Patterson, Bray, & Lee, 2013), (ii) deeper processing of relevant information (Janelle et al., 1997), (iii) error estimation (Chiviacowsky & Wulf, 2005), and (iv) the use of self-regulation strategies (Kirschenbaum, 1984). Thus, self-controlled learners use self-regulatory processes to more actively search for, choose, and evaluate the correct motor solution (Wu & Magill, 2011), trying various movement strategies to a greater extent than those without self-control (Wulf & Toole, 1999). This more active involvement results in enhanced learning and performance (Zimmerman, 1989). One way to gain insight into the learner's involvement in the learning process might be through the examination of the conversations between learner and instructor during the feedback sessions.

To date, all studies conducted on self-controlled learning have used individual tasks. Whether self-controlled video feedback is also beneficial for learning complex skills that involve multiple persons, such as tactical skills in invasion games, has yet to be determined. The preferences for feedback after good or poor trials in such tasks are not clear yet, nor whether self-controlled learning stimulates the learners' involvement in their own learning process. The aim of this study was to examine the effects of self-controlled video feedback on tactical skills in soccer teams. Highly talented youth soccer players were assigned to a self-control or yoked group, and received video feedback on their offensive performance in 3 vs. 2 small-sided games. The conversations between the players and coach while watching the video feedback were recorded and transcribed to examine the role of the players and the coach, and to examine whether the video feedback was used to correct errors or to confirm correct performance elements. Based on the self-control literature and given the complexity of the task, we expected that feedback would be requested after both good and poor trials. We expected that feedback requests would decrease across the acquisition phase, and that because of the information-richness of videos, both good and poor aspects of the performance would be discussed. We hypothesized that the self-control group would demonstrate higher performance improvement compared to the yoked group, due to more active involvement in their own learning process.

2. Method

2.1. Participants

Fourteen highly talented female soccer players participated in this study (*M* age = 15.8 years, *SD* = 1.3). They all played in the national soccer talent team, in which they train about fifteen to twenty hours a week and play in a high-level competition for men under 14 years of age. They had, on average, 9.6 years (*SD* = 2.6) of soccer experience. The experiment was approved by the local ethics committee of the research institute and all participants gave their written informed consent; parental consent was provided for players younger than 18 years.

2.2. Tasks and apparatus

Tactical skill was trained and examined in small-sided games with three attackers playing against two defenders and a goalkeeper. We chose to use small-sided games since these games are considered to comprise the basics of the game of soccer according to the Dutch Royal Soccer Association (Dokter, 1993), and many more behavioural observations are possible in a given period of time when compared to an 11 vs. 11 game (Davids, Araújo, Correia, & Vilar, 2013). The playing field measured 40 m in length and 25 m width (field dimensions were advised by the head coach). The six players started at specific locations (Fig. 1) and played according to the official soccer rules, including offside. The players switched roles so that each player played on each of the attacking and defending positions (except for the goalkeeper), but only the attacking positions were of interest in this study.

The tests and training sessions were video recorded using a GoPro camera (resolution 1920 × 1080, 30 Hz; Hero 3, black edition, GoPro, Inc., USA) mounted on a 6.5 m high lifting tower (Showtec LTB-200/6, The Netherlands), behind the goal of the attacking team. The elevated filming position was used to give a good overview of the situation and to help the participants in perceiving depth (Mann, Farrow, Shuttleworth, & Hopwood, 2009). During the training sessions, the GoPro camera was connected to a 15.6 in. laptop via a 10 m long HDMI cable. A HDMI capture card (1080p; StarTech.com) and its accompanying software program StreamCatcher (1.1.0.114; StarTech.com) enabled us to record high quality video clips of each individual trial and to play them back on the laptop immediately after recording.

2.3. Procedure and design

The experiment consisted of a pretest, training intervention and a post-test. The pretest was performed in the week prior to start of the training intervention, which itself consisted of seven training sessions; the post-test was performed in the week after the last

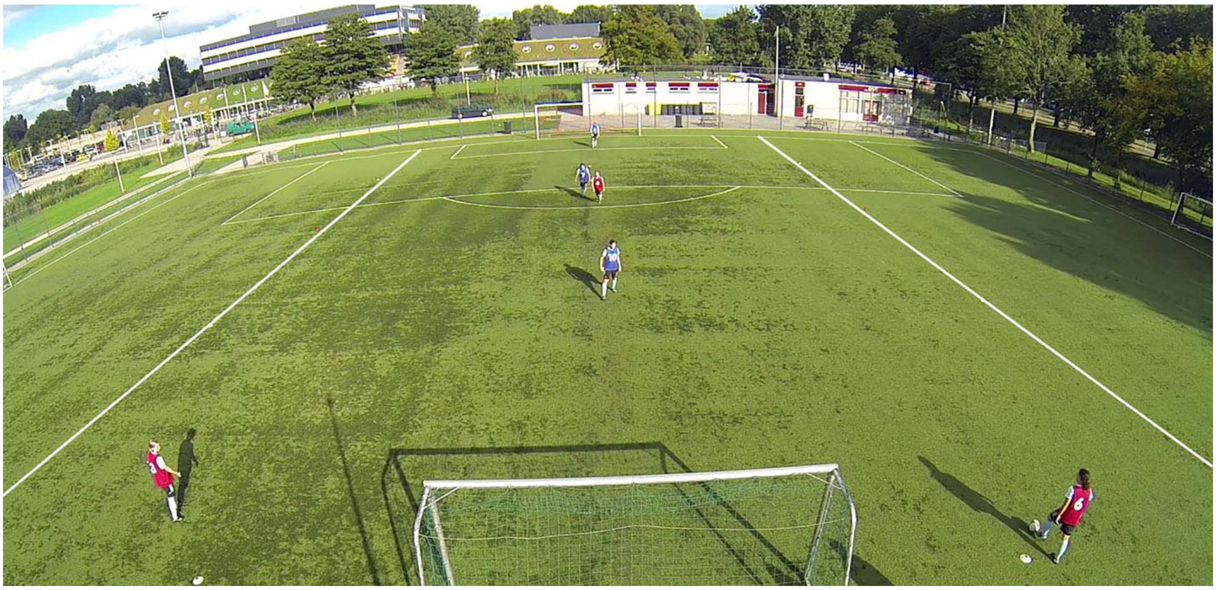

Fig. 1. Overview of the small sided game. Players are located at their specific starting positions.

training session. Participants were randomly assigned to either the self-controlled or yoked group.

Both the pre- and post-test consisted of two test moments on two separate days within one week. The test scores consisted of the average scores of both the test moments, except if a participant only joined one test day, then the score of that day was used (i.e., 3 participants during post-test). On each test day, the soccer players participated 15 times as attacker in the small-sided game (five times on each of the three attacking positions). All trials were recorded with the GoPro camera and afterwards judged by a highly experienced soccer coach (holding the highest coaching qualification in the country and with over 25 years of coaching experience at national and international level); she judged the overall tactical skills of each attacker (i.e., including actions with ball and positioning) in each trial separately on a scale 1–10. Players were unaware of this performance assessment. To assess inter-rater reliability 48 trials (i.e., 16%) were also judged by a second highly experienced soccer coach (same qualifications and experience) and analysed using a two-way mixed, consistency, single-measures ICC (Hallgren, 2012); although not excellent, results showed fair inter-rater reliability, $ICC = 0.542$.

The seven training sessions were performed during four weeks and consisted of the same small-sided game. In each training session, the players participated in 12 attacking trials (four times on each of the three attacking positions). The outcome of the trial was registered to examine when the attackers requested feedback, that is, whether the attackers scored a goal, the defenders scored or no goal was made.

To avoid that only the most dominant player would decide on whether or not to request feedback, the participants of the self-control group individually indicated after each trial whether they wanted to get video feedback on that trial. After each set of two trials, the three attackers got video feedback on the trial of that set that was requested most (thus by majority of votes; in case both trials were requested evenly, the three attackers had 10 s to collectively decide which trial they wanted to play back). In this way, the feedback frequency was set at 50%, but the participants of the self-control group controlled which trial they watched, and the individual preferences for feedback of each player were taken into account. One could argue that a disadvantage of this method is that the feedback delivery does not completely correspond to the feedback requests; however, preliminary examination revealed that the received feedback corresponded with the feedback request in 74% of the trials (i.e., the participant received feedback when requested and did not receive feedback when not requested). In 20% of the trials, they requested feedback but did not receive feedback and in only 6% of the trials they received feedback while they did not request it. The participants of the yoked group received video feedback according to the same schedule as the self-control group.

All participants scored their own and their team performance on a 10-point scale (individual and team perceived performance, respectively) after each trial but prior to the video feedback, starting from training session 3. After the last training session, the participants filled in a questionnaire similar to questionnaires used in earlier self-control studies (e.g., Chiviacowsky & Wulf, 2002; see Table 2). Participants of the self-control group were asked when and how they decided to request feedback and participants of the yoked group were asked whether they received feedback when they needed it most, and if not, when they preferred to receive it.

In the video feedback sessions, the three attackers and the head coach collectively watched the video on the laptop and were allowed to repeat or pause the footage. The head coach of the talent team guided the video feedback sessions, as it has been suggested that video feedback is most beneficial for learning when attentional cues are provided to direct the learners' attention to the critical information in the video (Janelle, Champenoy, Coombes, & Mousseau, 2003; Landin, 1994; Rothstein & Arnold, 1976). The conversations in the video feedback sessions were not structured a priori: we asked the coach to guide the players as she would normally do; this was mainly a questioning approach. The conversations were videotaped and transcribed by a single investigator. After transcribing the investigator coded for all (parts of) conversations whether it focused on negative, neutral or positive aspects of performance or on improvements, and whether the coach or a player showed initiative in the conversation. Based on the word count, the percentage of the conversation that the coach and players talked about negative, neutral, or positive aspects of the performance or improvements were calculated, just as the percentage of the conversation in which the coach or the players showed initiative.

2.4. Data analysis

The performance scores on the pre-test and post-test, as judged by the head coach, were examined using a 2 (group: self-control, yoked) × 2 (test: pre, post) mixed design ANOVA, with repeated measures on the last factor. The individual and team perceived performance during the last five training sessions were analysed with two separate 2 (group: self-control, yoked) × 5 (training session: T3, T4, T5, T6, T7) ANOVAs, with repeated measures on the last factor. The frequency of the feedback requests by the self-control group was examined using a repeated-measures ANOVA on the seven training sessions. We examined the outcome of the trials (i.e., attackers scored, defenders scored or no goal was made) when the participants of both groups did and did not receive feedback using a loglinear analysis. The individual and team perceived performance on feedback and no-feedback trials were examined using separate 2 (group: self-control, yoked) × 2 (Feedback: yes, no) ANOVAs with repeated measures on the last factor. Loglinear analyses were used to analyse the word count, the content of the conversations (i.e., negative, neutral, positive, improvement), and the initiative in the feedback conversations. Loglinear analyses were followed up by chi-square tests on the different levels of one of the variables if necessary. The significance level was set at 0.05 for all testing, any violations of the assumption of sphericity corrected using the Greenhouse–Geisser method, and effect sizes were reported as partial eta squared.

3. Results

3.1. Performance

3.1.1. Tests

The performance scores, awarded by the coach, on the pre-and post-test of the self-control and yoked group are displayed in Fig. 2. Statistical analyses revealed no significant main effects for test, group or an interaction effect, all $ps > 0.33$.

3.1.2. Training sessions

Fig. 3 shows the mean individual and team perceived performance for the self-control and yoked groups during the last five training sessions. The individual perceived performance did not differ significantly between the self-control and yoked group, $F(1, 9) = 1.995$, $p = .191$, $\eta_p^2 = 0.181$. There was a significant main effect for training session, $F(4, 36) = 2.910$, $p = .03$, $\eta_p^2 = 0.244$, post hoc pairwise comparisons revealed significant differences between training sessions 3 and 6, 3 and 7, 5 and 6, 5 and 7, all $ps < 0.04$, indicating higher individual perceived performance in the later training sessions compared to the earlier sessions. The interaction effect was not significant, $F(4, 36) = 0.296$, $p = .878$, $\eta_p^2 = 0.032$.

Also, the team perceived performance did not differ between the self-control and yoked group, $F(1, 9) = 0.563$, $p = .472$, $\eta_p^2 = 0.059$. There was again a significant main effect for training session, $F(4, 36) = 2.681$, $p = .04$, $\eta_p^2 = 0.230$, post hoc pairwise comparisons revealed significant differences between training sessions 3 and 6, 3 and 7, 5 and 6, all $ps < 0.03$. This again indicated higher perceived performance at the later training sessions compared to the earlier sessions. The interaction effect was not significant, $F(4, 36) = 1.904$, $p = .131$, $\eta_p^2 = 0.175$.

3.2. Feedback requests

For each training session, the percentage of trials on which the participants of the self-control group indicated to prefer feedback can be found in Fig. 4. The overall frequency of video feedback requests by the self-control group was 56% during the training sessions. Individual feedback requests ranged from 41% to 70%. There was a significant main effect for training session, $F(6, 18) = 11.312$, $p < .001$, $\eta_p^2 = 0.790$. The percentage of feedback requests was significantly lower during the first training session than during training session 6 and 7, both $ps < 0.05$, and tended to be lower than during the fifth training session, $p = .075$.

3.3. Received feedback

3.3.1. Outcome trial

Fig. 5 shows the percentage of feedback received when the attackers scored, the defenders scored or no goal was made for the self-control and the yoked group. For the self-control group, there was a significant association between the outcome of the trial and whether or not they received feedback, χ^2 (2) = 31.259, $p < .001$, whereas this was not true for the yoked group, χ^2 (2) = 1.687, $p = .430$. For the self-control group, the odds of receiving feedback were 4.1 times higher if the attackers scored than for other outcomes of the trial. Thus, the analyses revealed a difference between the self-control and yoked group: the participants of the self-control group received more often feedback after good trials, that is, when the attackers had scored, whereas participants of the yoked group received feedback after all three outcomes evenly.

3.3.2. Perceived performance

Fig. 6 shows the mean individual and team perceived performance on the feedback and no-feedback trials for the self-control and yoked groups. The individual perceived performance revealed a main effect for feedback, $F(1, 12) = 8.666$, $p = .01$, $\eta_p^2 = 0.419$, but

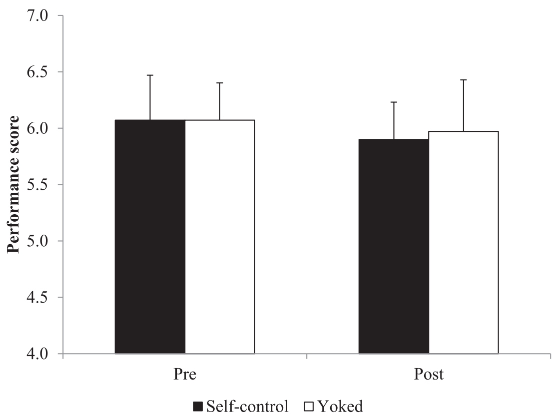

Fig. 2. Mean performance scores (and *SD*) the self-control and yoked group on the pre-test and post-test.

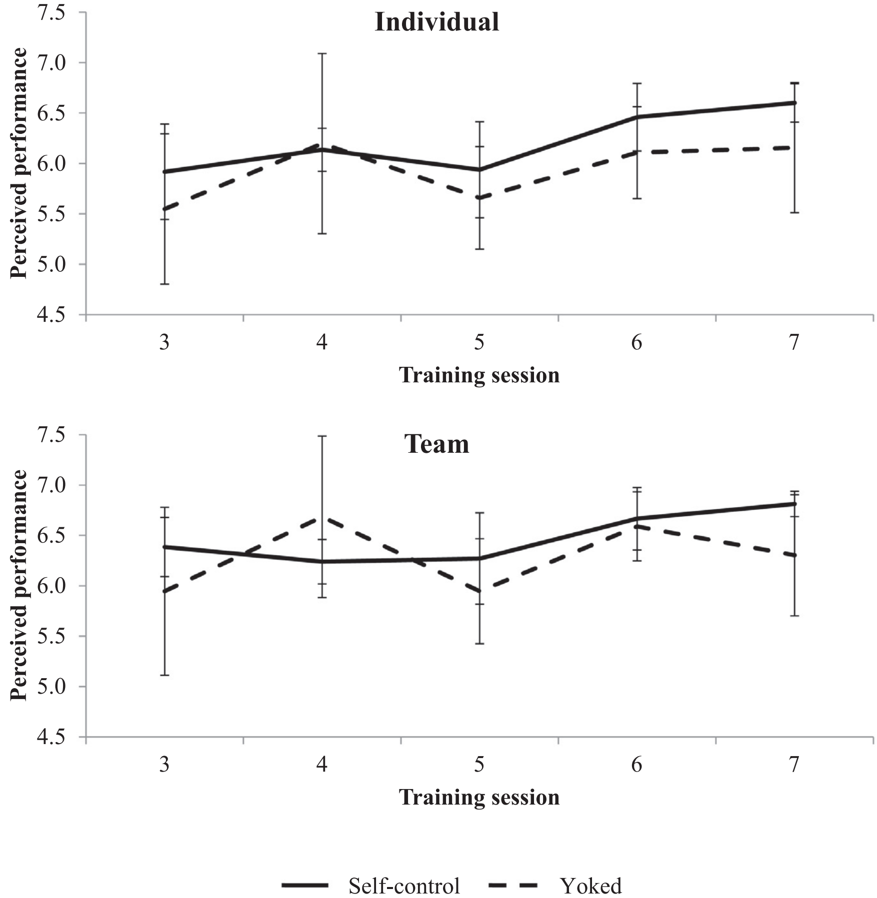

Fig. 3. Mean individual and team perceived performance (± *SD*) the self-control and yoked group for training session 3–7.

this was overruled by a significant feedback x group interaction effect, $F(1, 12) = 19.106$, $p < .001$, $\eta_p^2 = 0.614$. Perceived performance on the feedback trials was higher than on the no-feedback trials for the self-control group only, $p < .001$. The main effect of group was not significant, $F(1, 12) = 0.099$, $p = .759$, $\eta_p^2 = 0.099$. The team perceived performance also revealed a main effect for feedback, $F(1, 12) = 22.605$, $p < .001$, $\eta_p^2 = 0.653$, and again this was overruled by a significant feedback x group interaction effect, $F(1, 12) = 27.907$, $p < .001$, $\eta_p^2 = 0.699$. Perceived performance on the feedback trials was higher than on the no-feedback trials for the self-control group only, $p < .001$. The main effect of group was not significant, $F(1, 12) = 0.155$, $p = .701$, $\eta_p^2 = 0.013$.

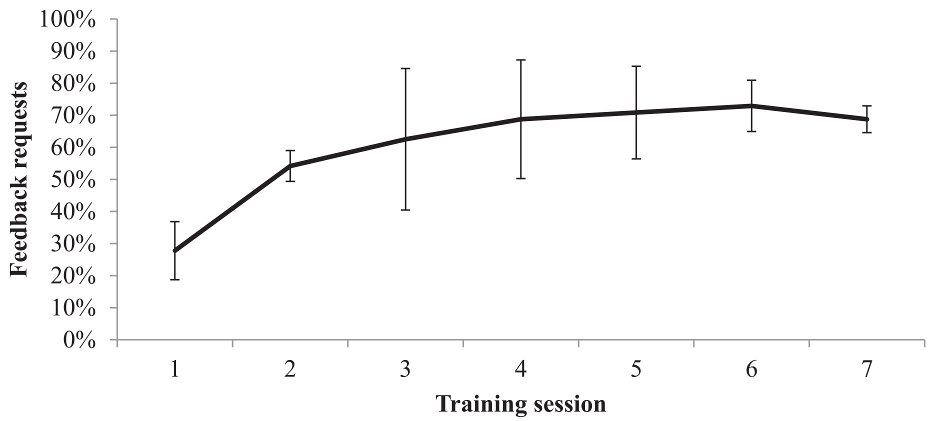

Fig. 4. Percentage feedback requests (± *SD*) of the seven training sessions.

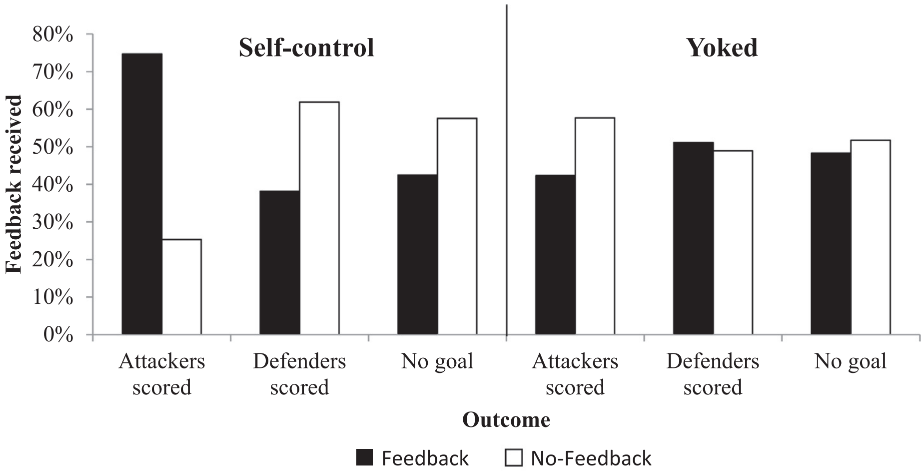

Fig. 5. Percentage of feedback received when the attackers scored, the defenders scored or no goal was made for the self-control and the yoked group.

3.4. Feedback sessions

Table 1 shows the average word count per feedback session for the coach, the players, and for the coach and players combined for each of the training sessions of the self-control and yoked group. Loglinear analysis showed a significant association between the group and the number of words spoken by the coach or players, χ^2 (1) = 7.287, p = .01. Although the coach spoke more words than the players in both groups (i.e., the proportion of words spoken by the coach was 57% in conversations with the self-control group and 64% with the yoked group), in the conversations of the self-control group the proportion of words spoken by the players (43%) was larger than in the yoked group (36%). Also, a significant association between the training session and the number of words spoken by the group (i.e., coach and players combined) was found, χ^2 (6) = 14.914, p = .02. In training session 5 the conversations of the self-control group were longer (i.e., more words were being said by coach and players combined) compared to the yoked group (on average 171.5 and 112.7 words per conversation, respectively), and in training session 7 the conversations of the yoked group were longer than of the self-control group (146.2 and 123.4 words, respectively), $ps < 0.01$. However, one should notice that in training session 5, where the conversations of self-control group were longer, the input of the coach and players in the self-control group was similar (52% and 48% respectively), χ^2 (1) = 0.209, p = .647; while in training session 7, where the conversations of yoked group were longer, the input of the coach in the yoked group was significantly larger compared to the input of the players (64% and 36% respectively), χ^2 (1) = 12.082, $p < .001$.

In the self-control group the coach and players talked 32.1% about positive aspects of the performance, 27.6% about negative aspects, 28.1% about improvements, and 12.3% of the conversations was neutral. In the yoked group these were 24.9%, 32.1%, 35.2%, and 7.9% respectively. Statistical analysis revealed that there was no significant association between the group and content of the conversation, χ^2 (3) = 2.704, p = .440. In both groups improvements and positive and negative aspects of the performance were discussed in more or less equal proportions, and only a small part of the conversation consisted of neutral statements.

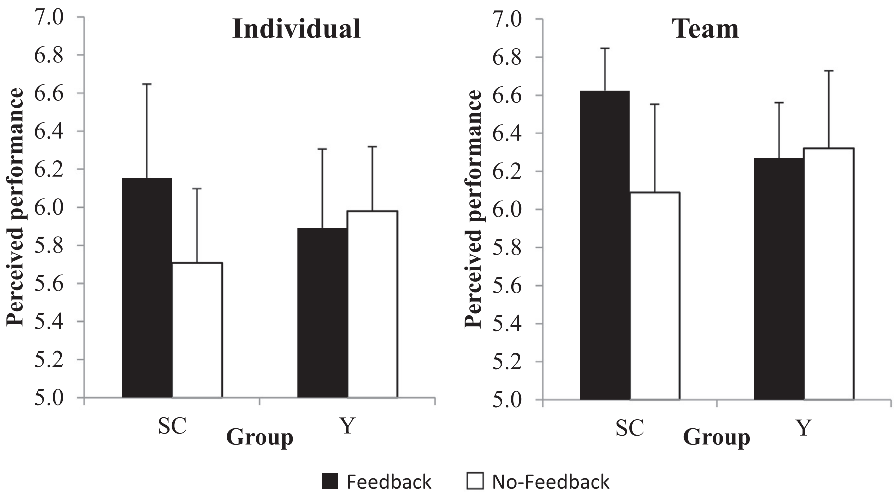

Fig. 6. The mean (and *SD*) individual and team perceived performance on the feedback and no-feedback trials for the self-control and yoked groups.

Table 1
Average word count per feedback session for the coach, the players, and combined for each of the training sessions of the SC and Y group.

Training	SC group			Y group		
	Coach	Players	Combined	Coach	Players	Combined
1	55.3	44.0	99.3	47.3	29.3	76.7
	56%	44%		62%	38%	
2	66.5	45.7	112.2	50.9	29.1	80.0
	59%	41%		64%	36%	
3	50.1	42.0	92.1	47.8	30.1	77.8
	54%	46%		61%	39%	
4	58.3	41.8	100.2	63.9	35.8	99.7
	58%	42%		64%	36%	
5	88.7	82.9	171.5	70.2	42.5	112.7
	52%	48%		62%	38%	
6	94.9	60.6	155.5	99.5	46.4	145.9
	61%	39%		68%	32%	
7	73.8	49.6	123.4	93.9	52.3	146.2
	60%	40%		64%	36%	
Total	487.6	366.6	854.2	473.6	265.4	739.0
	57%	43%		64%	36%	

In the self-control group 31.0% of the conversation was on initiative of the players and 69.0% on initiative of the coach, whereas in the yoked group 17.8% was on initiative of the players and 82.2% initiated by the coach. There was a significant association between the group and whether the coach or the players took initiative, χ^2 (1) = 4.568, p = .03. The odds of players showing initiative were 2.08 times higher in the self-control group than in the yoked group.

3.5. Post training questionnaire

The results of the post training questionnaires are presented in Table 2. Participants of the self-control group provided mixed responses on the question when they requested feedback. Of the seven participants, three participants indicated that they mostly requested feedback after supposedly good trials, two participants after bad trials, and two participants after good and bad trials equally. Also, the information the participants used to decide whether to request feedback was equivocal; three participants mainly evaluated their own performance and four participants mainly evaluated their team performance to decide upon feedback request. The seven participants of the yoked group all indicated that they received feedback when they needed it most.

Table 2
Post training questions and answers of participants of self-control and yoked group.

Group	Question		n	%
Self-control				
	When did you ask for feedback?			
		Mostly after you thought you had a good attack	3	43%
		Mostly after you thought you had a bad attack	2	29%
		After good and bad trials equally	2	29%
		Randomly	0	0%
		None of the above	0	0%
	When did you NOT ask for feedback?			
		Mostly after you thought you had a good attack	1	14%
		Mostly after you thought you had a bad attack	2	29%
		None of the above	4	57%
	How did you decide whether to ask for feedback?			
		Mainly evaluating my own performance	3	43%
		Mainly evaluating the team performance	4	57%
Yoked				
	Did you receive feedback when you needed it the most?			
		Yes	7	100%
		No	0	0%
	If "NO" when would you have preferred to receive feedback?			
		Mostly after good trials	0	0%
		Mostly after bad trials	0	0%
		After good or bad trials equally	0	0%
		Randomly	0	0%

4. Discussion

In this study we sought to examine whether the beneficial effects of self-controlled learning, as earlier found in individual tasks (e.g., Chiviacowsky & Wulf, 2002), generalize to tasks involving multiple persons. Therefore, the aims of this study were to examine the effects of self-controlled video feedback on tactical skills in small-sided soccer games, and whether self-controlled video feedback stimulates the learners' involvement in their own learning process. One of the most interesting findings to emerge from this study was that the participants of the self-control group showed a preference for receiving feedback after relatively good trials. The participants in this group requested feedback more often after they had scored a goal compared to trials in which they did not score or the opposing team scored, and their individual and team perceived performance was higher on feedback trials than on no-feedback trials. The results revealed that the yoked group received feedback randomly, confirming that the yoking manipulation was successful. That is, they received feedback in equal proportions after they scored, the opponents scored or no score was made, and there was no difference in perceived performance between feedback and no-feedback trials. This is consistent with numerous previous studies on self-control using simple individual tasks (Chiviacowsky & Wulf, 2002; Chiviacowsky et al., 2008, 2009; Patterson & Carter, 2010), and suggests that (self-controlled) feedback is mainly used to confirm success (Chiviacowsky & Wulf, 2002).

The preference for feedback after good trials, however, is not consistent with recent findings of more complex individual skills (Aiken et al., 2012; Post et al., 2016; Laughlin et al., 2015). These studies revealed no differences in performance between feedback and no-feedback trials (Aiken et al., 2012; Post et al., 2016), and that the participants requested feedback after both good and poor trials (Aiken et al., 2012; Laughlin et al., 2015) or mostly after poor trials (Post et al., 2016). Interestingly, the participants of the current study gave varying responses in the post training questionnaire. Out of seven, three self-control participants indicated that they intended to request feedback mostly after good trials, two participants mostly after supposedly bad trials, and two participants after good and bad trials equally. As performance in small-sided soccer games is complex, it could be that the trials were too complicated to label as either good or bad. Some aspects in a trial might have been good and other aspects not, which has also been found earlier in rowing (Sigrist, Rauter, Riener, & Wolf, 2011). It could be that the participants focused on a certain aspect of their performance rather than on the overall performance in the trial. This was also supported by the findings on the content of the video feedback conversations, which showed that the participants and coach talked in similar proportions about positive and negative aspects of the performance and how to improve it. Only neutral statements were made less often. This shows that although the participants requested feedback more often after relatively good trials, in the feedback conversations both positive and negative aspects of performance were discussed. Thus it seems that video feedback was being used both to confirm success (Chiviacowsky & Wulf, 2002) and to correct performance errors (Salmoni et al., 1984), which confirms that the use of self-controlled video feedback for complex tasks is less straightforward than for simple tasks and warrants future research.

The analyses of the conversations also revealed that the coach had a major role in the feedback conversations. She spoke most and showed most initiative in the conversation. Nevertheless, the participants of the self-control group spoke more and showed more initiative in comparison to the participants of the yoked group. Therefore, the ability to control video feedback seems to have a positive effect on the involvement of the players in their learning process, which has been suggested as an underlying mechanism for the effectiveness of self-controlled learning (Janelle, 1997; Wulf & Lewthwaite, 2016; Wulf et al., 2001). Self-controlled learning environments satisfy the basic psychological need of autonomy, and this is associated with greater self-regulated learning. Self-regulated learning is the process whereby learners set goals for their learning and then try to monitor, regulate, and control their cognition, motivation, and behaviour to attempt to achieve their goals. Thus self-regulated learners plan, set goals, organize, self-monitor, and self-evaluate at various points during the learning process. They feel more responsible for improving performance, which leads to a higher motivation to practice and perform well, and thus results in more active involvement of the learner in the learning process (Janelle, 1997). Furthermore, in self-controlled learning environments learners seem to use feedback as a means to protect or enhance their perceptions of competence (Wulf & Lewthwaite, 2016), and this increases learners' confidence in being able to do well on the task. Both autonomy and enhanced performance expectancies affect performance and learning by strengthening the coupling of the learners' goals to their movement actions (Wulf & Lewthwaite, 2016). Thus learners become more task-focused and less self-focused. In contrast, *controlling* learning environments do not support people's basic psychological need of autonomy, and hence tend to cause stress (Reeve & Tseng, 2011; Wulf & Lewthwaite, 2016). As a result, attentional capacity can be taken away from the task resulting in reduced learning. Future research should be directed at gaining more insight into how and why participants use self-controlled learning to enhance learning of complex tasks, and this may involve the feedback preferences of learners in relation to their personal goalsetting.

In contrast to earlier findings on individual tasks, the current study did not reveal positive performance effects (i.e., in performance scores as awarded by the coach) of self-controlled feedback from pre- to posttest The players themselves noticed an improvement in performance across the training sessions (i.e., increased individual and team perceived performance), but no significant difference was found in perceived performance between the self-control and yoked group. This suggests that self-controlled video feedback was not directly beneficial for performance in the more complex tasks in small-sided soccer games. Instead, it suggests that the effects of self-controlled feedback on tasks involving multiple persons are more indirect (i.e., more active involvement in learning process).

There are a number of possible explanations for the lack of direct beneficial effects of self-controlled video feedback on tactical skills. First, performance in small-sided games is multifactorial; next to tactical skills, performance also depends on technical, physiological, and psychological skills (Reilly, Williams, Nevill, & Franks, 2000), as well as on the quality of teammates and opponents. A highly experienced soccer coach assessed the performance of the individual players in each trial. Given the experience and qualifications of the assessor sufficient validity and reliability was expected, but a check of inter-rater reliability was only fair, not excellent. Due to its subjective character, it could be that our measure of performance was too crude and that its sensitivity was insufficient to pick up on the subtle improvements you might expect from a four-week training intervention. Using a detailed notational analysis system to assess performance of the players may be more suitable to reveal the possibly subtle changes in performance or changes in decisions or playing style of the participants (Van Maarseveen, Oudejans, & Savelsbergh, 2017). Second, it is not unlikely that the number of training sessions employed in the current study was too low to induce a significant performance effect. Seven training sessions in four weeks, and each training session consisting of only participating four times in each of three attacking positions, resulted in a relatively small training load, especially in comparison to the total weekly training regimen of 15–20 h of the participants. Third, the feedback delivery did not completely correspond to the feedback requests. However, as the correspondence was quite good (74%), it seems unlikely that the design of the study could explain the lack of beneficial effects of self-controlled feedback. Finally, the seven participants of the yoked group all indicated in the post training questionnaire that they received feedback when they needed it most. This may be caused by the fact that this study was the first time that the players (of both the self-control and yoked group) received immediate video feedback on the field, and that as a consequence all players valued the video feedback anyway. Furthermore, as the coach had a major role in the conversations around the video feedback, she may have highlighted elements in the performance of each trial in such a way that it made the feedback valuable for all players. This was also supported by the fact that the participants did not show a decrease in feedback requests across the acquisition period as found in earlier studies (Chiviacowsky & Wulf, 2002; Janelle et al., 1997; Laughlin et al., 2015; Ste-Marie et al., 2013). In future studies, to further examine the direct beneficial effects of self-controlled video feedback, other complex in situ tasks involving multiple persons could be used that more thoroughly tax the individual players.

In conclusion, in this study the effects of self-controlled video feedback on complex skills involving multiple persons were examined in situ. Although we did not find a significant beneficial effect of self-controlled video feedback on the tactical skills of the soccer players, we did find relevant effects of self-controlled feedback regarding the feedback preferences and the involvement of the players. The self-control group showed a preference for requesting video feedback after relatively good trials, but both good and poor aspects of performance were discussed in the conversations around the video feedback. Allowing the players to control video feedback, resulted in a higher involvement of the players in the learning process as the players of the self-control group talked more and took more often initiative in the feedback conversations compared to the yoked group, which is especially valuable for talent development programs.

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References

Aiken, C. A., Fairbrother, J. T., & Post, P. G. (2012). The effects of self-controlled video feedback on the learning of the basketball set shot. *Frontiers in Psychology, 3*, 1–8. http://dx.doi.org/10.3389/fpsyg.2012.00338.

Badami, R., VaezMousavi, M., Wulf, G., & Namazizadeh, M. (2012). Feedback about more accurate versus less accurate trials: Differential effects on self-confidence and activation. *Research Quarterly for Exercise and Sport, 83*, 196–203. http://dx.doi.org/10.1080/02701367.2012.10599850.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*, 117–148.

Chen, D. D., Hendrick, J. L., & Lidor, R. (2002). Enhancing self-controlled learning environments: The use of self-regulated feedback information. *Journal of Human Movement Studies, 43*, 69–86.

Chiviacowsky, S., & Wulf, G. (2002). Self-controlled feedback: Does it enhance learning because performers get feedback when they need it? *Research Quarterly for Exercise and Sport, 73*(4), 408–415. http://dx.doi.org/10.1080/02701367.2002.10609040.

Chiviacowsky, S., & Wulf, G. (2005). Self-controlled feedback is effective if it is based on the learner's performance. *Research Quarterly for Exercise and Sport, 76*(1), 42–48. http://dx.doi.org/10.5641/027013605X13076330976713.

Chiviacowsky, S., & Wulf, G. (2007). Feedback after good trials enhances learning. *Research Quarterly for Exercise and Sport, 78*, 40–47.

Chiviacowsky, S., Wulf, G., De Medeiros, F. L., Keafer, A., & Tani, G. (2008). Learning benefits of self-controlled knowledge of results in 10-year-old children. *Research Quarterly for Exercise and Sport, 79*(3), 405–410. http://dx.doi.org/10.1080/02701367.2008.10599505.

Chiviacowsky, S., Wulf, G., Wally, R., & Borges, T. (2009). Knowledge of results after good trials enhances learning in older adults. *Research Quarterly for Exercise and Sport, 80*(3), 663–668. http://dx.doi.org/10.5641/027013609X13088500160082.

Davids, K., Araújo, D., Correia, V., & Vilar, L. (2013). How small-sided and conditioned games enhance acquisition of movement and decision-making skills. *Exercise and Sport Sciences Reviews, 41*, 154–161.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*, 227–268.

Dokter, R. (1993). *The Dutch vision on youth soccer.* Zeist, Netherlands: Koninklijke Nederlandse Voetbalbond.

Ferrari, M. (1996). Observing the observers: Self-regulation in the observational learning of motor skills. *Developmental Review, 16*, 203–240.

Hallgren, K. A. (2012). Computing inter-rater reliability for observational data: An overview and tutorial. *Tutorials in Quantitative Methods for Psychology, 8*, 23–34.

Hartman, J. M. (2007). Self-controlled use of a perceived physical assistance device during a balancing task. *Perceptual Motor Skills, 104*, 1005–1016.

Janelle, C. M., Barba, D.a., Frehlich, S. G., Tennant, L. K., & Cauraugh, J. H. (1997). Maximizing performance feedback effectiveness through videotape replay and a self-controlled learning environment. *Research Quarterly for Exercise and Sport, 68*, 269–279. http://dx.doi.org/10.1080/02701367.1997.10608008.

Janelle, C. M., Champenoy, J. D., Coombes, S. A., & Mousseau, M. B. (2003). Mechanisms of attentional cueing during observational learning to facilitate motor skill acquisition. *Journal of Sports Sciences, 21*, 825–838.

Janelle, C. M., Kim, J., & Singer, R. N. (1995). Subject-controlled performance feedback and learning of a closed motor skill. *Perceptual and Motor Skills, 81*, 627–634.

Keetch, K. M., & Lee, T. D. (2007). The effect of self-regulated and experimenter-imposed practice schedules on motor learning for tasks of varying difficulty. *Research Quarterly for Exercise and Sport, 78*, 476–486. http://dx.doi.org/10.5641/193250307X13082512817543.

Kirschenbaum, D. S. (1984). Self-regulation of sport psychology: Nurturing an emerging symbiosis. *Journal of Sport Psychology, 6*, 159–183.

Landin, D. (1994). The role of verbal cues in skill learning. *Quest, 46*(3), 299–313.

Laughlin, D. D., Fairbrother, J. T., Wrisberg, C. A., Alami, A., Fisher, L. A., & Huck, S. W. (2015). Self-control behaviors during the learning of a cascade juggling task. *Human Movement Science, 41*, 9–19.

Mann, D. L., Farrow, D., Shuttleworth, R., & Hopwood, M. (2009). The influence of viewing perspective on decision-making and visual search behaviour in an invasive

sport. *International Journal of Sport Psychology, 40*, 546–564.
McNevin, N., Wulf, G., & Carlson, G. (2000). Effects of attentional focus, self-control, and dyad training on motor learning: Implications for physical rehabilitation. *Physical Therapy, 80*, 373–385.
Patterson, J. T., & Carter, M. (2010). Learner regulated knowledge of results during the acquisition of multiple timing goals. *Human Movement Science, 29*, 214–227.
Post, P. (2011). Self-controlled amount of practice benefits learning of a motor skill. *Research Quarterly for Exercise and Sport, 82*, 37–41. http://dx.doi.org/10.5641/027013611X13275191443900.
Post, P. G., Aiken, C. A., Laughlin, D. D., & Fairbrother, J. T. (2016). Self-control over combined video feedback and modeling facilitates motor learning. *Human movement science, 47*, 49–59.
Reeve, J., & Tseng, C. M. (2011). Cortisol reactivity to a teacher's motivating style: The biology of being controlled versus supporting autonomy. *Motivation and Emotion, 35*, 63–74.
Reilly, T., Williams, A. M., Nevill, A., & Franks, A. (2000). A multidisciplinary approach to talent identification in soccer. *Journal of Sports Sciences, 18*, 695–702.
Rothstein, A. L., & Arnold, R. K. (1976). Bridging the gap: Application of research on videotape feedback and bowling. *Motor Skills: Theory into Practice, 1*, 36–62.
Saemi, E., Porter, J. M., Ghotbi-Varzaneh, A., Zarghami, M., & Maleki, F. (2012). Knowledge of results after relatively good trials enhances self-efficacy and motor learning. *Psychology of Sport and Exercise, 13*(4), 378–382. http://dx.doi.org/10.1016/j.psychsport.2011.12.008.
Salmoni, a. W., Schmidt, R.a., & Walter, C. B. (1984). Knowledge of results and motor learning: A review and critical reappraisal. *Psychological Bulletin, 95*(3), 355–386. http://dx.doi.org/10.1037/0033-2909.95.3.355.
Sanli, E. A., Patterson, J. T., Bray, S. R., & Lee, T. D. (2013). Understanding self-controlled motor learning protocols through the self-determination theory. *Frontiers in psychology, 3*, 611.
Sigrist, R., Rauter, G., Riener, R., & Wolf, P. (2011). Self-controlled feedback for a complex motor task. In: BIO web of conferences; The International Conference SKILLS (Vol. 1), Montpellier, France. DOI: 10.1051/bioconf/20110100084.
Ste-Marie, D. M., Vertes, K.a., Law, B., & Rymal, A. M. (2013). Learner-controlled self-observation is advantageous for motor skill acquisition. *Frontiers in Psychology, 3*, 1–10. http://dx.doi.org/10.3389/fpsyg.2012.00556.
Van Maarseveen, M. J. J., Oudejans, R. R. D., & Savelsbergh, G. J. P. (2017). System for notational analysis in small-sided soccer games. *International Journal of Sports Science and Coaching, 12*, 194–206.
Wrisberg, C. A., & Pein, R. L. (2002). Note on learners' control of the frequency of model presentation during skill acquisition. *Perceptual Motor Skills, 94*, 792–794.
Wu, W. F. W., & Magill, R. A. (2011). Allowing learners to choose. *Research Quarterly for Exercise and Sport, 82*, 449–457. http://dx.doi.org/10.1080/02701367.2011.10599777.
Wulf, G. (2007). Self-controlled practice enhances motor learning: Implications for physiotherapy. *Physiotherapy, 93*, 96–101. http://dx.doi.org/10.1016/j.physio.2006.08.005.
Wulf, G., Clauss, A., Shea, C. H., & Whitacre, C. A. (2001). Benefits of self-control in dyad practice. *Research Quarterly for Exercise and Sport, 72*, 299–303. http://dx.doi.org/10.1080/02701367.2001.10608964.
Wulf, G., & Lewthwaite, R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic Bulletin & Review, 23*(5), 1382–1414.
Wulf, G., Raupach, M., & Pfeiffer, F. (2005). Self-controlled observational practice enhances learning. *Research Quarterly for Exercise and Sport, 76*, 107–111. http://dx.doi.org/10.5641/027013605X13076330976948.
Wulf, G., & Toole, T. (1999). Physical assistance devices in complex motor skill learning: Benefits of a self-controlled practice schedule. *Research Quarterly for Exercise and Sport, 70*, 265–272. http://dx.doi.org/10.1080/02701367.1999.10608045.
Zimmerman, B. J. (1989). Models of self-regulated learning and academic achievement. In B. Zimmerman, & D. H. Schunk (Eds.). New York: Springer-Verlag.