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Coaching cues in amateur boxing: An analysis of ringside feedback provided between rounds of competition

Israel Halperin [a, b, *], Dale W. Chapman [a, b], David T. Martin [a, b], Chris Abbiss [b], Gabriele Wulf [c]

[a] Physiology Discipline, Australian Institute of Sport, Leverrier Crescent, Bruce, ACT 2617, Australia
[b] Centre for Exercise and Sport Science Research, School of Exercise & Health Science, Edith Cowan University, Joondalup, WA 6027, Australia
[c] Department of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas, USA

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ABSTRACT

Feedback is commonly employed to enhance motor learning and performance. While numerous studies have investigated the causal effects of feedback on motor learning, an analysis of real-time feedback provided during training and competitive sporting environments is lacking. Therefore, the feedback provided by 12 boxing coaches to athletes between rounds of the 2015 Australian Boxing Championships was recorded and transcribed. The feedback statements were then analyzed according to three feedback variables that have been shown to be critical for optimizing performance: Attentional focus (external, internal, neutral), autonomy support (autonomy-supportive, controlling, neutral), and feedback valence (positive, negative, neutral). Collectively, 445 feedback statements provided during 25 bouts, of which 14 were won and 11 were lost, were analyzed for each of the three categories. Coaches provided on average 8 feedback statements per round. Excluding neutral statements, coaches delivered more internal (15%) compared with external focus feedback (6%), more controlling (53%) compared with autonomy-supportive feedback (6%), and more positive (29%) relative to negative feedback (12%). Furthermore, during winning bouts coaches delivered less internal (12% vs. 19%), less controlling (48% vs. 58%), and more positive (36% vs. 18%) feedback, when compared with losing bouts. These results demonstrate for the first time the type and frequency of feedback delivered during amateur boxing bouts. While these findings may or may not reflect causal relationships, it is interesting that feedback that has been found to enhance motor performance was more often used during winning rather than losing bouts.

1. Introduction

In the field of motor learning, the term augmented feedback refers to information provided by an external source, such as a coach, training apparatus, or video (Hodges & Williams, 2012; Lauber & Keller, 2014). Over the past few years, numerous experimental studies have shown that the effectiveness of augmented feedback (or just feedback) primarily depends on three factors (Wulf & Lewthwaite, 2016), including the type of attentional focus it induces (internal vs. external focus); the extent to which it supports the performer's need for autonomy (autonomy-supportive vs. controlling); and its valence (positive vs. negative). In the following sections, we describe research findings related to these three factors. We then report on a study in which we recorded and analyzed, with respect to each factor, the verbal feedback boxing coaches provided to their athletes between competitive rounds of the 2015 Australian Boxing Championships.

1.1. Attentional focus

How feedback directs an athlete's focus of attention has been shown to play an important role for the performance as well as learning of sport skills (Wulf, 2013). Specifically, providing instructions that lead individuals to focus on a body part – resulting in an *internal* focus of attention – hinders performance. Conversely, instructions that direct performers' attention to the intended effects of their movements (e.g., a dart hitting a target) – resulting in an *external* focus – enhance performance and learning. For

* Corresponding author. Physiology Department, Australian Institute of Sport, PO Box 176, Leverrier Street, Belconnen Canberra, Australia Capital Territory 2616, Australia.
E-mail address: Israel.halperin@ausport.gov.au (I. Halperin).

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example, focusing on the movement of the wrist during a basketball shot has been found to impair shooting accuracy relative to a focus on the hoop (Zachry, Wulf, Mercer, & Bezodis, 2005). Accuracy in dart throwing has also been improved with an external focus on the dart or target (Lohse, Sherwood, & Healy, 2010; Marchant, Clough, & Crawshaw, 2007). Likewise, force production is affected by the attentional focus. Maximum vertical jump height (e.g., Wulf, Dufek, Lozano, & Pettigrew, 2010) or standing long-jump distance (e.g., Porter, Ostrowski, Nolan, & Wu, 2010) increased when an external focus was adopted rather than internal focus (and no instructed focus). Discus-throwing performance has been demonstrated to benefit from external focus instructions (Zarghami, Saemi, & Fathi, 2012). Also, greater forces were produced with external focus in single joint (Marchant, Greig, & Scott, 2009) and multi-joint exercises (Halperin, Williams, Martin, & Chapman, 2016). As exercises are executed more efficiently with an external focus (e.g., on the weight lifted), muscular endurance in trained individuals is reported to increase (Marchant, Greig, Bullough, & Hitchen, 2011). The benefits of external focus for movement effectiveness (e.g., accuracy, balance) and movement efficiency (e.g., force production, speed, endurance) generalize across tasks, skill levels, and age groups (Wulf, 2013).

According to the constrained action hypothesis (Wulf, McNevin, & Shea, 2001), an internal focus promotes a conscious type of control, causing individuals to constrain their motor system and interfere with automatic control processes. In contrast, an external focus promotes a more automatic mode of control by utilizing unconscious, fast, and reflexive control processes. Several studies have provided evidence for increased automaticity with an external focus by showing reduced attentional-capacity demands (Kal, Van Der Kamp, & Houdijk, 2013), high-frequency movement adjustments (McNevin, Shea, & Wulf, 2003), and reduced pre-movement times, representing more efficient motor planning (Lohse, 2012).

The performance advantages resulting from an external focus are often seen immediately (Halperin, Chapman, Martin, & Abbiss, 2016; Marchant et al., 2009; Porter, Anton, & Wu, 2012). Therefore, coaching cues that refer to body parts or movements, for example, during a boxing bout would not be expected to be optimal for the athlete's subsequent performance.

1.2. Autonomy support

Feedback allowing participants to make choices and exert control over practice environments typically results in enhanced learning and performance, when compared with controlling feedback, absent of choices and/or a sense of control (Teixeira, Carraça, Markland, Silva, & Ryan, 2012; Wulf, 2007). For example, allowing participants to choose when to receive feedback has been found to enhance the learning of movement form in overhand throwing (Janelle, Kim, & Singer, 1995), and a serial martial art sequence (Lim et al., 2015). Similarly, allowing learners to decide on the number of basketball shots to be completed (Post, Fairbrother, & Barros, 2011), when to view video demonstrations of the skill (Wulf, Raupach, & Pfeiffer, 2005), or the order of balance exercises (Wulf & Adams, 2014) leads to more effective learning compared with control conditions without choices. Interestingly, even giving individuals choices that are incidental to the task has a positive effect on learning (Lewthwaite, Chiviacowsky, & Wulf, 2014).

Autonomy-support also includes providing a rationale, asking for an opinion, or making a suggestion. There is evidence indicating that the type of instructional language (i.e., autonomy-supportive versus controlling) has an impact on motor learning (Hooyman, Wulf, & Lewthwaite, 2014). Hooyman and colleagues varied the way in which instructions for performing a novel task (cricket bowling action) were presented. Autonomy-supportive language, that is, instructions that gave the participant a sense of choice (e.g., "When starting the approach of the pitch you may want to cradle and deliver the ball in a windmill fashion so the ball travels over the shoulder and not to an angle or to the side."), led to superior learning than controlling language that offered little leeway for how to execute the skill (e.g., "When initiating the approach of the pitch you must cradle the ball so it travels in a circular pattern. At the apex of the pitch the ball must be directly over the shoulder. Do not throw it at a side angle."). Throwing accuracy was higher for the group that received autonomy-supportive rather than controlling language instructions.

Allowing individuals to exercise control over the environment satisfies a basic psychological need for autonomy (e.g., Deci & Ryan, 2000, 2008). Supporting performers' need for autonomy has consistently been found to have positive effects on motor learning, independent of which factor the learner is given control over, and the benefical effects on performance are sometimes seen immediately (Wulf & Adams, 2014). The benefits of autonomy support are robust and generalize across tasks, age groups, populations, etc. (see Sanli, Patterson, Bray, & Lee, 2013). It is interesting to note that providing autonomy support also enhances performers' motivation to engage in exercise activity (Wulf, Freitas, & Tandy, 2014). Thus, respecting athletes' need to be autonomous would seem to be important not just in practice or training sessions, but possibly in competitions as well.

1.3. Feedback valence

Lack of confidence or concerns about one's capabilities are not conducive to optimal performance. Over the past few years, there has been converging evidence that practice conditions that enhance learners' expectancies of future performance result in improved performance as well as more effective learning (e.g., McKay, Lewthwaite, & Wulf, 2012; Palmer, Chiviacowsky, & Wulf, 2016; Trempe, Sabourin, & Proteau, 2012; for a review, see Lewthwaite & Wulf, 2012). Some of this research has specifically investigated the effects of feedback valence. It has been shown, for example, that feedback emphasizing successful rather than unsuccessful performances enhances motor learning (e.g., Chiviacowsky & Wulf, 2007). Subsequent studies demonstrated increases in performers' intrinsic motivation (e.g., Saemi, Wulf, Varzaneh, & Zarghami, 2011) and perceptions of competence or self-efficacy (Badami, Vaezmousavi, Wulf, & Namazizadeh, 2001; Saemi, Porter, Ghotbi-Varzaneh, Zarghami, & Maleki, 2012) resulting from positive feedback Furthermore, positive social-comparative feedback has been found to enhance movement accuracy (McKay et al., 2012), performance in a continuous submaximal force production task (Hutchinson, Sherman, Martinovic, & Tenenbaum, 2008), and balance (Lewthwaite & Wulf, 2010). Importantly, the performance benefits resulting from positive feedback generalize to experienced athletes. In one study, positive feedback improved running economy among trained runners relative to a control condition (Stoate, Wulf, & Lewthwaite, 2012).

Feedback has an influence on individuals' expectancies – which are an important factor in motor performance contexts. Indeed, enhanced expectancies resulting from positive feedback have consistently been found to be more effective for subsequent performance and learning than reduced expectancies resulting from feedback highlighting errors, or even "neutral" control conditions. High performance expectancies appear to prepare the performer for successful movement through diverse effects at cognitive, motivational, neurophysiological, and neuromuscular levels – ensuring what Wulf and Lewthwaite (2016) termed *goal-action coupling*. Higher performance expectancies are assumed to serve as protection against responses that would detract from optimal

performance, including off-task activity or self-referential thinking (e.g., McKay, Wulf, & Lewthwaite, 2015). That is, enhanced expectancies serve to maintain a focus on the task goal and prevent or reduce a self-focus (or other non-task activity). In contrast, low expectations for a positive outcome, promoted by negative feedback, may act in the manner of a self-invoking trigger (McKay et al., 2015) and produce performance-related concerns, anxiety, negative affective reactions, and neuromuscular activity that are incompatible with optimal performance (see Wulf & Lewthwaite, 2016).

1.4. Additive effects

Interestingly, three recent studies reported that a combination of two of the three factors described above (external focus of attention, autonomy support, positive feedback) led to superior motor learning and performance compared to either one in isolation (Pascua, Wulf, & Lewthwaite, 2015; Wulf, Chiviacowsky, & Cardozo, 2014; Wulf, Chiviacowsky, & Drews, 2015). Each of the three studies was dedicated to the examination of the combined effects of these factors (external focus and autonomy support, external focus and positive feedback, autonomy support and positive feedback) on motor learning, when compared with each feedback type alone and/or a control condition. The result indicated that not only did each factor alone lead to superior learning, but each combination of two factors further increased the learning benefits. Furthermore, a recent study demonstrated that the presence of all three factors resulted in more effective learning than all combinations of two factors (Wulf, Lewthwaite, Cardozo, & Chiviacowsky, 2016). These findings are in line with the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016), according to which an external focus, autonomy support, and enhanced expectancies for performance contribute – in additive and non-competing fashion – to optimize motor performance and learning.

1.5. Present study

As illustrated, a large number of experimental studies report strong causal effects of described types of feedback on learning and performance. However, to our knowledge only Porter, Wu, and Partridge (2010) have previously reported the types and frequencies of feedback coaches provide in training and competition. In their study, highly-trained track and field athletes completed a questionnaire about the types of feedback coaches provided, with an emphasis on attentional focus. The authors reported that 85% of feedback provided in training, and 70% in competitions promoted an internal focus of attention, which is not very effective according to the experimental literature. The study provides important initial information concerning the type of feedback provided in real-life sporting environments. However, some limitations of that study, including the use of close-ended questions and the reliance on the athletes' ability to accurately recall the feedback. Also, Porter and colleagues were not concerned with other aspects of feedback, such as those related to its valence or autonomy support. Hence, further investigation is warranted to allow for systematic examination of the gap between factors that have been shown to enhance motor performance in studies and the real-life practices of coaches.

Amateur boxing is a popular Olympic sport in which athletes attempt to score points by delivering fast and forceful punches to their opponents in a tactical and strategic manner (Chaabène et al., 2014). Depending on gender, boxing bouts are comprised of 3–4 rounds lasting 2–3 min with 1 min of rest between rounds (Chaabène et al., 2014). Importantly, during the rest period athletes commonly receive feedback from their coaches in their respective corners. Such feedback is of great importance as it holds the potential to impact punching performance (Halperin, Chapman, et al., 2016) and change the strategy and/or tactics of the athletes in the subsequent round(s). Thus, the sport of amateur boxing is well suited for the investigation of ecologically valid, real-time feedback provided in competitions due to its expected impact on subsequent performance. Accordingly, we sought to record and analyze real-time verbal feedback provided by boxing coaches to their athletes during the rest periods of boxing competitions, and categorize these recordings based on the previously described feedback themes. Furthermore, we sought to investigate if differences exist in the type and frequency of feedback provided by coaches and the outcome of the bout.

2. Method

An observational single-group design was used to describe the style of verbal coaching feedback used between a coach and athlete during a boxing bout (between rounds). The verbal feedback was recorded with the use of a digital voice recorder (Olympus 4 GB VN31PC) and tie clip microphone secured to the lapel or collar of the shirt worn. The recorded coaching feedback provided between rounds was transcribed and then categorized independently by the first (IH) and last (GW) authors. All feedback statements were coded once for each of three feedback categories. Thus, each feedback statement was coded three times (see Analysis).

2.1. Participants

During the 2015 Australian amateur boxing championships twelve coaches (11 males and 1 female [age: 42 ± 6]) representing different states in Australia agreed to participate in this study, which was a sample of convenience. Boxing coaches who had athletes compete in this specific event were approached, provided with a verbal description of the study, and then asked if they would be willing to participate. Two coaches did not wish to participate, and those who agreed were provided with a written informed consent. All coaches who participated had over 8 years of coaching experience (range: 8–20) and coached athletes that regularly competed in national level events, and most have also coached athletes that competed in international-level events. The study was approved by the Australian Institute of Sport Ethics Committee.

2.2. Analysis

Prior to the coding procedure, extensive discussions were held concerning the most appropriate ways to analyze the data. After transcribing and reading the feedback statements, the authors decided that analyzing each sentence within each of three categories would by the most suitable approach. Pilot scores of the first twenty feedback sentences were completed simultaneously by both coders to insure inter-rater reliability. This allowed for detailed discussions as to which feedback should be placed within which category, and to develop a strong rationale for the categorisation procedure.

Overall, coaching feedback was recorded from 25 bouts, totaling 57 rounds. Specifically, six coaches were recorded over a single bout; six coaches were recorded twice over two bouts; and three coaches were recorded during three bouts. Of the bouts recorded nineteen bouts included male athletes, and six included female athletes, and 14 bouts were won and 11 were lost. All matches went for the entire duration (i.e., no knockouts occurred). Each verbal feedback recording was transcribed by a single investigator. After transcribing, each sentence was considered as a separate entity, but only if the following cue was different in content to the previous one. The identified feedback statements were independently

scored by two investigators once per feedback category: Attentional focus, autonomy support, and feedback valence. Each feedback category included a "neutral" option for situations in which the investigator determined the feedback was different or irrelevant to the specific category. Scoring each feedback statement once per category was based on an initial subset of scoring (20 feedback statements) and observing that there were occasions that the identified feedback was applicable to more than one category. Thus, each feedback statement was coded three times: once in the attentional focus category as external focus, internal focus or neutral; once in autonomy support category as either autonomy-supportive, controlling, or neutral; and once in the feedback valence category as either positive, negative, or neutral. The definitions used for each feedback category are described next, Statements leading the athlete to focus on a body part or muscle group were defined as internal focus feedback (e.g., "lifts your hands" and "move your feet"). Conversely, instructions leading the athlete to focus on the intended movement effect, including aiming at a target, such as the opponent's body part (e.g., "punch his chin" or "aim for a liver shot"), or an external object such as the ring (e.g., "push off the ground when you punch") or a boxing glove (e.g., "whenever you see her gloves move counter with a hook") were scored as external focus feedback (see Table 1 for more examples).

Feedback that involved suggestions, included a rationale or asking for the athlete's opinion, or was generally stated in a way that gave the athlete options, was scored as autonomy-supportive (e.g., "try to avoid leaning on the ropes this round, ok?", and "when working the inside, try to roll under her punches, ok?"). Thus, feedback statements that were phrased as questions allowing athletes to decide whether or not they adopt the recommendations in subsequent rounds were coded as autonomy-supportive. In contrast, feedback that specifically instructed the athletes on a course of action, absent of the possibility of making a choice (e.g., "you need to settle on your legs more" and "start throwing long uppercuts"), was scored as controlling (see Table 2 for more examples).

Feedback describing the athlete's performance, tactics, round scores, abilities, effort, etc. in a positive (e.g., "perfect round, mate, keep it up" and "your punches are all landing perfectly") or negative manner (e.g., "he keeps catching you with your hands down" and "you are looking messy in the inside") were coded as such (see Table 3 for more examples).

The neutral statement examples provided in each of the three tables (Tables 1–3) were considered as such only in view of the specific category. Thus a specific feedback statement could have been considered as neutral in one category, but not in another category. For example, the statement "excellent round" was coded as neutral in the attentional focus category, but as positive in the feedback valence category.

The percentage of feedback provided within each round was calculated by category and score (e.g., positive or negative), and separately for winning and losing bouts. A chi-square test of independence was used to examine differences between the feedback in winning and losing bouts. Statistical significance as accepted at $p \leq 0.05$. All data are presented as mean ± SD counts or as a percentage.

3. Results

Tables 1–3 provide examples of feedback in each of the three categories – attentional focus, autonomy support, and feedback valence. The tables include examples from different coaches and from both winning and losing bouts. Within the 25 bouts 445 feedback statements were identified and analyzed per category. The average number of feedback statements provided to each athlete per round was 8 ± 2. On a few occasions a feedback statement was scored twice within a given category, for example, if it was partly positive and negative. Specifically, one feedback statement was scored as both autonomy-supportive and controlling, and five were scored as influencing performance expectancies positively and negatively (e.g., "You're punching your way in perfectly and scoring good points, but then you drop your guard and get caught."). The agreement between the investigators was high with only 28 disagreements out of a total 1347 feedback statement scored (2% disagreement rate). In the small number of cases in which disagreement existed, a discussion was held in order to understand its causes. All disagreements were on sentences which were coded as controlling by one of the coders, and as neutral by the other. It was decided to listen to these specific feedback statements again, and determine whether they were stated in a controlling fashion or in a neutral tone. All disagreements were resolved after listening to the feedback statements the second time. Further, out of all feedback statements provided, only 6% (25 of 445) were coded as neutral in all three categories. This statistic demonstrates that most feedback statements were categorized in at least one of the three categories.

Across all bouts, the feedback distribution for attentional focus was 5.8% external, 15.2% internal, and 78.8% neutral (Fig. 1); for autonomy support, the distribution was 5.8% supportive, 52.5% controlling, and 41.6% neutral (Fig. 2); and for feedback valence the distribution was 12.9% positive, 29.0% negative, and 58.0% neutral (Fig. 3). The observed distribution with respect to attentional focus feedback in winning bouts was 5.2%, 12.4% and 82.2% for external, internal, and neutral, respectively. Coaches in losing bouts implemented 7% more internal feedback (external: 6.6%, internal: 19.4%, neutral: 73.8.5%), but the differences between winning and losing bouts were not statistically different [X^2 (2, N = 445) = 4.7, p = 0.09] (Fig. 1). The observed distribution with respect to autonomy support in winning bouts was 6.7%, 48.8% and 44.4% for autonomy-support, controlling, and neutral, respectively. Coaches

Table 1
Examples of Attentional focus feedback provided by coaches between the rounds.

External:	Internal:	Neutral:
"Long lead to her head."	*"Chin down, hands up."*	*"Big work rate, you want to take the next 3 rounds."*
"If her hands are low, punch high, if her hands are high, punch low."	*"Toes in and out."*	*"Back her up as much as you can."*
"Punch his chest when you go in."	*"Keep your hands up."*	*"You need to fire up this round."*
"Aim your hooks to his body."	*"This lead hand of yours needs to do more work."*	*"What are you waiting for? He hasn't hit you with anything, mate you have to engage to win this fight ok?"*
"You are missing when going for the head, so aim a bit lower, to his chest."	*"Keep your front foot on the outside."*	*"You have to start dictating now, you need the next round."*
"Work on getting that hook to his body."	*"Go forward on your feet."*	*"You have got to lead her to the middle."*
"Come in, hit her body, and then come up to the head."	*"On the inside let your hands go."*	*"You have got to be as aggressive as you possibly can this round, ok?"*
"After the right to the body, end with a lead hook over her arms."	*"You need to settle in your legs, too much falling around."*	*"Throw a second punch after those little punches, ok?"*

Table 2
Examples of autonomy-support feedback provided by coaches between the rounds.

Autonomy-support:	Controlling:	Neutral:
"Let's try not and go back too much, ok?"	*"Listen – move and jab and use a second attack if it's there."*	*"It was close round."*
"Try to drive that straight through his guard if you can."	*"Take a half step back and let your punches go as you come in."*	*"Breath, buddy, breath."*
"Try a few more liver shots today."	*"Throw a few more punches when working the inside."*	*"You are judging the distance perfectly."*
"If you want to do that then let's switch the tactics – let's pull it in."	*"Hold your ground, stay in the center of the ring."*	*"She doesn't like exchanging and locks everything away."*
"Put this guy away if you can this round, ok?"	*"You have got to win this fight."*	*"You won the first two rounds easily."*
"When we go 1-2-3 then let's try 1-2-3-4, ok mate?	*"Stick that back foot out and move off when you are on the ropes."*	*"Your punches are getting on, and he tagged you only once the whole fight."*
"Let's try not and go back too much ok?"	*"Back her up as much as you can."*	*"He is just as tired as you."*
"How about we go for her body this round?"	*"Follow in on him when he is tired."*	*"Look at him, he is wide open."*

Table 3
Examples of feedback valence provided by coaches between the rounds.

Positive:	Negative:	Neutral:
"You are scoring good points."	*"You are forcing your punches out as you are out of range; you are probably half a foot out of range."*	*"Look he is wide open."*
"You are doing brilliant, stay in the moment."	*"One thing you're doing wrong – you are throwing your lead punches and then you are falling in."*	*"Faint him when he comes, when he misses get on it again."*
"Going well, keep picking him off and letting those big shots go, I can hear them from here."	*"Keep your hands up a bit; you are getting caught on the way in with your hands down."*	*"When he is coming in bang that left."*
"That was a better round, much better."	*"Don't fall in on him like that."*	*"Move and get your double jab going."*
"You are beating him with your work rate."	*"You are getting caught with little punches you don't need to get caught with."*	*"Draw him in and bring that upper cut."*
"You had a few brilliant attacks in there mate."	*"Listen, last part of the round we lost, too passive when going backwards."*	*"Use a long lead to the head and long rear to the body."*
"You are looking good, looking sharp."	*"The timing of your jab is a little bit out."*	*"Bring that right hand over the top."*
"This is your fight; you are looking 100% focused in there."	*"You need to settle in, too much falling around.*	*"Jab and look for a second attack with your head on the other side."*

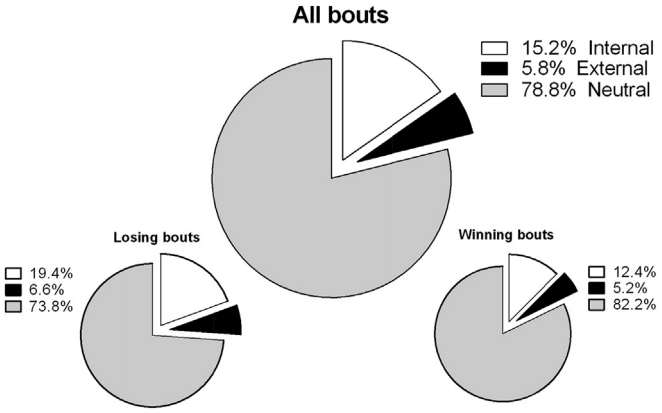

Fig. 1. Illustrates percentage distribution of feedback related to attentional focus in all bouts (upper pie chart), in winning (right pie chat), and losing (left pie chart) bouts.

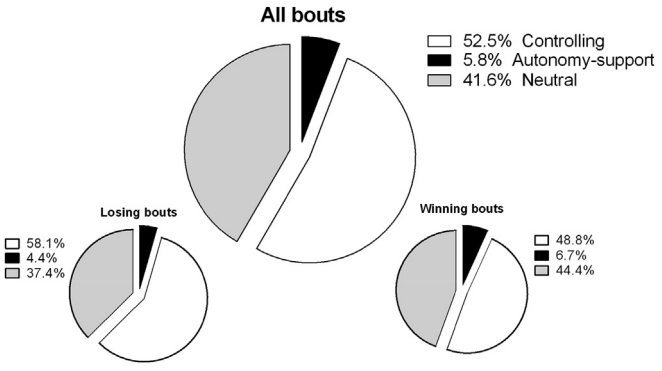

Fig. 2. Illustrates percentage distribution of feedback related to autonomy-support in all bouts (upper pie chart), in winning (right pie chat), and losing (left pie chart) bouts.

in losing bouts implemented 10% more controlling feedback (autonomy-support: 4.4%, controlling: 58%, neutral: 37.4%), although the differences between winning and losing bouts were not statistically different [X^2 (2, N = 445) = 3.9, p = 0.14] (Fig. 2). In winning bouts the observed distribution feedback related to the valence of feedback was 36% positive, 12.5% negative, and 51.4% neutral. In losing bouts it was 18.5% positive, 13.6% negative, and 67.7% neutral. The 18% difference in positive feedback between winning and losing bouts was statistically significant [X^2 (2, N = 445) = 17.4, $p < 0.001$] (Fig. 3).

4. Discussion

Coaches delivered an average of 8 verbal feedback statements per round, irrespective if it was a winning or losing bout. Excluding the neutral feedback, coaches provided more feedback that promoted an internal (15.2%) compared to an external focus of attention (5.8%), was controlling (52.5%) compared to autonomy-supportive (5.8%), and more positive (29%) compared to negative (12.9%). Moreover, coaches provided considerably more positive feedback in winning bouts (36% vs. 18.6%), compared with losing bouts. Furthermore, despite not reaching statistical significance, coaches in losing bouts provided 7% more internal and 10% more controlling feedback. In the following sections we discuss the results in view of each factor as it relates to the sport of boxing.

Coaches underutilized feedback promoting an external focus relative to that inducing an internal focus. Such use of attentional feedback is in contrast to experimental research and recommendations (Wulf, 2013). A large body of evidence demonstrates that external focus instructions or feedback are superior to internal focus and neutral/control instructions, and this effect has consistently been found for different populations, untrained, trained and competitive athletes, numerous different motor tasks (Wulf, 2013). Of specific relevance to boxers, Halperin, Chapman, et al. (2016) and

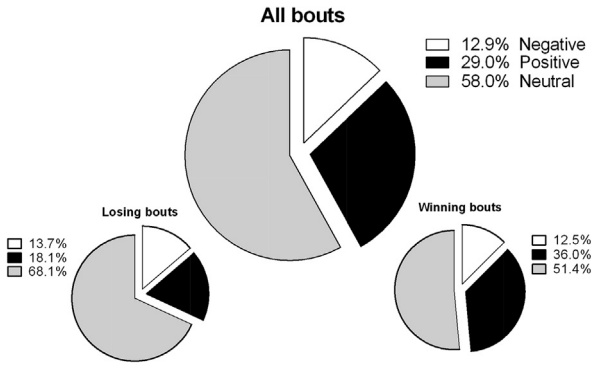

Fig. 3. Illustrates percentage distribution of feedback related to feedback valence in all bouts (upper pie chart), in winning (right pie chat), and losing (left pie chart) bouts.

Halperin, Williams, et al. (2016) investigated the effects of attentional focus instructions on punching velocity and impact forces among intermediate and elite level boxers and kickboxers. Athletes were asked to punch a punching integrator with maximal effort under three focus conditions: external ("Focus on punching the pad as fast and as forcefully as you possibly can"), internal ("Focus on moving your arm as fast and as forcefully as you possibly can"), and neutral/control ("Focus on punching as fast and as forcefully as you possibly can"). Irrespective of the athlete's level, external instructions led athletes to punch 4% faster and 5% more forceful compared with internal, and 2% faster and 3% more forceful compared with control conditions. While it can be justifiably argued that the punching integrator does not replicate a boxing bout, it does highlight a possible competitive advantage. This is especially the case in amateur boxing in which the winning/losing margins are typically very close and thus a small advantage could be of a considerable value.

Within the present study we found that boxing coaches heavily relied on controlling feedback (52.5%) and implemented little autonomy-supportive feedback (5.8%). This is in direct contrast with expectations based on experimental research demonstrating superior motor performance and learning, as well as exercise behavior, under autonomy-supportive conditions (Teixeira et al., 2012; Wulf, 2007). A recent study examined the effects of self-selected (autonomy-supportive) versus controlling conditions on punching performance with a world champion kickboxer and in a competitive amateur cohort (Halperin, Chapman, Martin, Lewthwaite, & Wulf, 2016). The athlete delivered two sets (rounds) of 12 maximal effort punches to a punching integrator separated by 5 s, over six testing days. In one round the punches were delivered in an order selected by the athlete but in the other round the order was predetermined. Across all days the athlete punched harder and/or faster in the self-selected condition. It is not clear if similar effects would be observed during a boxing match, which is an open dynamic environment and differs to the constrained situation of striking a punching integrator. It is also plausible that the 1-min time constraint might make it too challenging for coaches to provide relevant feedback allowing the athletes to make choices. Yet, the wording of instructions has been shown to have an impact on performance (e.g., Hooyman et al., 2014). Thus, this finding highlights a possible discrepancy between the real world practices of coaches in competitions and optimal feedback based on current research findings.

Coaches used positive feedback (29%) more frequently than negative feedback (12.9%), which is in line with literature demonstrating superior learning and performance outcomes with positive compared to negative feedback (e.g., Chiviacowsky & Wulf, 2007; Hutchinson et al., 2008; Pascua et al., 2015; Wulf, Lewthwaite, & Hooyman, 2013). For example, it has been found that providing participants with false-positive feedback about their performance in a submaximal grip test to task failure elicited superior performance in the following test, compared to subjects who received false-negative feedback and even neutral feedback (Hutchinson et al., 2008). Running economy has also been shown to be enhanced when trained runners received positive feedback about their running efficiency compared to a no-feedback control group (Stoate et al., 2012). Furthermore, highlighting good performances rather than poor ones (Chiviacowsky & Wulf, 2007) or providing positive social-comparative feedback (e.g., Hutchinson et al., 2008; Lewthwaite & Wulf, 2010; Wulf et al., 2014) has been shown to improve the performance and learning of tasks requiring movement accuracy, balance, or force production. The ability to sustain effort, and to move efficiently and accurately, are of importance to the sport of boxing.

A comparison of winning and losing bouts provides some interesting findings. The percentage of external focus feedback provided per round in winning and losing bouts was the same. However, coaches provided more internal focus instructions in the losing compared to winning bouts (12.4% vs. 19.4%). This finding points to a possible relationship between greater usage of internal instructions and the match outcomes. Furthermore, coaches in losing bouts tended to implement more controlling feedback (58%) compared to coaches in winning bouts (48.8%). It can be speculated that controlling feedback reduces the athlete's inclination to attempt alternative tactics developed with experience, which may in turn be successful. Moreover, controlling language undermines self-efficacy and positive affect relative to autonomy-supportive language (Hooyman et al., 2014), which is not conducive to optimal performance. Conversely, it is also possible that coaches felt the need to be more controlling in their language when the match was not going in favor of their athletes. Hence, the controlling feedback can also occur as a result of the athlete failing to perform as expected, as indicated by the losing outcome. Finally, it is interesting to note that coaches in both winning and losing bouts delivered a comparable amount of negative feedback (13.7% vs. 12.5%), while coaches of winning bouts provided double the amount of positive feedback (36% vs. 18.6%). Of course, it is not possible to draw conclusions about cause-effect relationships from the present study. Due to its possible important implications, this topic requires further investigation.

To conclude, this study is the first to use recorded real-time feedback provided by coaches to athletes in a stressful and important competitive event. The results are of value as they provide a reference point allowing to differentiate between feedback delivered in real life events, the research findings, and the gap between them. Indeed, it seems coaches do not take full advantage of the possible benefits of certain feedback in competitions. This finding is in line with the report of Porter et al. (2010) who examined feedback provided in track and field events and found that coaches frequently use internal instructions despite their negative effects. The results also provide context for future feedback research to be conducted with a greater degree of ecological validity. Importantly, given the design of the present study, it is not valid to draw causal conclusions. Thus, further experimental research should attempt to mimic more ecologically valid environments when manipulating feedback and examine the effects on performance.

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