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The Effects of Self-Talk on Flow and Performance in Elite Tae Kwon Do Athletes

By

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The author of this thesis had a remarkable amount of help from Dr. Antonis Hatzigeorgiadis.

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Abstract

The purpose of the present study was to investigate the effects of a self-talk intervention on flow and performance in elite Tae Kwon Do athletes. Originally, 28 Tae Kwon Do athletes were recruited. An 8-week intervention was implemented in-between two competitions where flow was assessed. Assessments of kick performance through measures of force and repetitions for both the dominant and the non-dominant leg, were obtained within a week following each competition in laboratory settings. Seventeen athletes participated in the two competitions before and after the intervention, whereas 18 athletes completed the two performance assessments. The results showed a notable increase for the experimental group in overall flow and the dimensions of challenge-skills balance, clear goals, unambiguous feedback, concentration on the task at hand and sense of control post-intervention, whereas no differences were found for the control group. The analyses regarding kick performance revealed a significant increase of peak force for the roundhouse kick and an increased number of kicks for the repetitive roundhouse kick in the experimental group for the non-dominant leg, whereas no differences were found for the dominant leg. No differences in kick performance were recorded for the control group. The findings based on biomechanical measures show support for positive effects of self-talk on performance and offer indications for self-talk mechanisms enhancing flow experience in competitive sports.

Keywords: optimal experience, self-talk mechanisms, intervention, biomechanics, kick force

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The Effects of Self-Talk on Flow and Performance in Elite Tae Kwon Do Athletes

Flow is the most studied optimal experience in sport (Swann et al., 2017) associated with high levels of performance (Jackson & Eklund, 2004). It is important to gain the understanding of subjective states of excellent performance, such as flow, in order to develop efficient mental preparation strategies for athletes entering important competitions (Swann et al., 2017). The nature of flow being brief, rare and unpredictable leads to the challenges of discovering optimal measures to assess it in sport (Swann, 2016). Research designs aimed to collect "experience-near" data on flow will enhance our understanding of how various factors influence the occurrence of flow, the necessary and sufficient conditions for flow, and the mechanisms and processes through which flow occurs. There has been a noticeable progress in research of flow in sport over the last three decades, however, there are still challenges that researchers need to address in order to help individuals flourish in sport and experience flow on a regular basis.

Flow is an optimal subjective experience characterized by intense concentration and absorption in a specific activity where an individual excludes irrelevant thoughts and emotions, indulging into the sensation of gratification, even in challenging situations (Csikszentmihalyi, 1990). There are nine essential psychological conditions according to the traditional flow theory. Those are challenge-skill balance, the merging of action and awareness, clear goals, unambiguous feedback, concentration on the task at hand, sense of control, loss of self-consciousness, transformation of time and autotelic experience (Jackson & Eklund, 2004). Those relevant to the current study are described below.

Challenge-skills balance represents a crucial psychological condition of flow as the phenomenon of flow occurs only when the individual goes beyond the average experience of challenge and skills and invests psychic energy in a task (Jackson & Eklund, 2004). A simple way to find challenges is to enter a competitive situation (Csikszentmihalyi, 1990). However,

Stavrou, Jackson, Zervas and Karteroliotis (2007) claim that perceived skills are even more important factors in achieving optimal mental states and suggest psychological-preparation programs that among other include positive thinking and self-talk in order to increase the athlete's self-confidence and perceived competence. It is important to mention that the perception of skills rather than objective skill levels is important for confidence and adds to the challenge-skills balance (Jackson & Eklund, 2004).

Concentration on the task at hand is the next important and one of the most mentioned dimension of flow (Csikszentmihalyi, 1990; Jackson & Eklund, 2004). It embraces an important aspect of flow which is being able to stay in the present moment (Jackson & Eklund, 2004). In a flow state the individual's mindset is void of irrelevant thoughts and distractions, enabling the individual to keep his mind on the task performed. This provides a certain level of satisfaction leading to all the benefits one can get from flow experiences.

Sense of control is another frequently mentioned characteristic of flow where fear of failure and failure relevant thoughts are absent, enabling the athlete to deal with the challenges at hand (Jackson & Eklund, 2004). Similar to the relationship between challenge and skills this component of flow is balanced. Absolute control could lead the individual towards relaxation or boredom while the perception of the possibility to keep things under control keeps the flow experience active. Therefore, the lack of sense of worry within this dimension does not represent a pure sense of control, but exercising the sense of control in challenging situations that produces enjoyment (Csikszentmihalyi, 1990)

Action-awareness merging can be defined as a state where people do not separate themselves from the actions they are performing (Csikszentmihalyi, 1990). This feature of optimal experience represents total absorption in the activity which is spontaneous and automatic. The feelings of automaticity are described by athletes who are able to focus

completely on the task, their performance protocol being well learnt and proceeding subconsciously (Jackson & Eklund, 2004).

Loss of self-consciousness relates to being aware of the external evaluations of our performance (Jackson & Eklund, 2004). When in flow, the individual is liberated from the awareness in mind that questions whether or not the perceived important standards are being reached. As Csikszentmihalyi, Latter and Duranso (2017) mentioned when describing the dimension of loss of self-consciousness: "With your attention firmly centered on the task at hand, no additional mental energy remains to entertain self-doubt or worry about others' perceptions of your performance" (p. 33).

There have been several debates on whether or not flow can be controlled. Despite that flow and most of its dimensions are considered as spontaneous (e.g. Jackson & Eklund, 2004) a recent study from Harris, Vine and Wilson (2017) shows that flow may require efficient attentional control. This is contrary to the traditional view that emphasizes reduced conscious attention and effort. In other words, regardless of the feeling of effortlessness it seems that traditional effortful focusing strategies can be a potential trigger of flow in competitive settings. Several studies show indications for self-talk as one of those strategies that can have a potential effect on athletes' flow experience.

Research from Jackman, Swann and Crust (2016) investigating athletes' perceptions of the relationship between mental toughness and dispositional flow in sport shows factors connected to dispositional flow that are intertwined with self-talk and its many purposes. Among the seven dimensions describing the psychological attributes related to dispositional flow in athletes with higher and lower mental toughness, concentration with themes such as "clearing the mind", "focus on the task" and "narrow concentration" emerged. The lower-order themes within this dimension were, e.g. "accept your thoughts and move on",

"focus on the next action", "focus on the task", "get in the zone". Other concepts evidently related to self-talk emerged within the dimensions of confidence, coping mechanisms, locus of control and optimism. Furthermore, the authors gave an example of one of the athletes using self-talk which lead to the initiation of flow: At half-time, I said to myself: "you're not having a bad day, the ball just isn't coming to you in the right way." In the second-half, I got on the ball and gave a great pass [that started the flow] (Jackman et al., 2016, p. 63). In the study from Swann et al. (2017) we can also spot the potential of self-talk to influence flow. The authors concluded based on information gathered from many different sports that the specific context in which flow occurred was a buildup of confidence. That is why the authors suggest focusing on confidence-enhancing strategies to facilitate flow. However, athletes in this study reported internal and external positive distractions that lead them away from the task at hand and helped them manage and maintain their flow states, which is contradictive with the credible hypothesis about the role of self-talk as a strategy that minimizes the occurrence and influence of internal and external distractions (Galanis, Hatzigeorgiadis, Zourbanos & Theodorakis, 2016). In a more specific sample of elite golfers Swann, Keegan, Crust and Piggott (2016) found the elements of confidence ("Had belief in myself.") and concentration ("Made myself focus more."). This is positively related to self-talk representing a technique that can enhance attentional focus (Hatzigeorgiadis & Galanis, 2017) and self-confidence (e.g., Perkos, Theodorakis & Chroni, 2002; Slimani et al., 2014; Zinsser, Bunker & Williams, 2010).

Attentional focus (Hatzigeorgiadis & Galanis, 2017; Landin & Hebert, 1999) and self-confidence (e.g., Chroni, Perkos & Theodorakis, 2007; Hatzigeorgiadis, Zourbanos, Mpoumpaki & Theodorakis 2009) are among the frequently mentioned self-talk functions that can be defined as mechanisms through which self-talk can be beneficial to performance (Hatzigeorgiadis, Zourbanos, Latinjak & Theodorakis, 2014). According to Galanis et al.

(2016) and the prospective model of self-talk mechanisms, attention represents one of the two main clusters of self-talk functions. Likewise Hatzigeorgiadis (2006) claims that the attention function is the most responsible for the effectiveness of both instructional and motivational self-talk. Landin (1994) reviewed the research on the role of verbal cues on attention and information processing functions and concluded that apart from attention being a critical stimuli for the benefits of self-talk, verbal cues have the ability to trigger motor patterns that once mastered can be performed automatically. This has been supported later on with a self-talk intervention where skilled tennis players reported that the cues facilitated the execution of the desired movement patterns (Landin & Hebert, 1999). As one of the participants stated (p. 277): "Sometimes when you say it, you don't have to worry about whether you're doing it or not because you say and automatically do it." This illustrates another potential mechanism of self-talk which is to trigger successful performance (Wilson, Peper & Schmid, 2006) with reducing the attention to only the most important perceptual and movement components of the skill (Magill, 2007). Additionally, regarding the attentional function Hatzigeorgiadis, Theodorakis and Zourbanos (2004) provided preliminary evidence that enhancing concentration could be the potential mechanism underlying the effectiveness of self-talk on performance which is in accordance with findings from Chroni et al. (2007). A more recent study from Galanis, Hatzigeorgiadis, Comoutos, Charachousi and Sanchez (2018) tested the effectiveness of self-talk on task conditions under external distractions in laboratory and field settings and found that self-talk lead to improvement in performance by countering the effects of distraction. Once again this provides support for attention as a viable mechanism of self-talk in enhancing performance.

Motivation is hypothesized to be another important aspect and the second main cluster according to a prospective model of self-talk mechanisms (Galanis et al., 2016). Studies indeed show that the increase in self-confidence (Chroni et al., 2007; Hatzigeorgiadis, 2006;

Hatzigeorgiadis et al., 2009; Landin & Hebert, 1999; Zetou, Vernadakis & Bebetsos, 2014) and self-efficacy (Hatzigeorgiadis, Zourbanos, Goltsios & Theodorakis, 2008) seem to facilitate the effects of self-talk on performance.

One of the studies involving self-talk mechanisms with regard to Tae Kwon Do investigated the effects of instructional self-talk on learning and performance of novice athletes and their perceptions of the skill (Zetou, Vernadakis, Bebetsos & Liadakis, 2014). They used an instrument for assessing the functions of self-talk in sports developed by Theodorakis, Hatzigeorgiadis and Chroni (2008).The results demonstrated that instructional self-talk was effective in learning and improving performance and also helped the athletes develop all five psychological dimensions of self-talk mechanisms (effort, automaticity, cognitive and emotional control, self-confidence and attention). Other than this study, there is a gap present in the existing literature on the subject of self-talk and Tae Kwon Do performance. Considering that athletes are involved in internal dialogue a lot of the time during training and competitions (Hatzigeorgiadis et al., 2014) and that research provides strong support for self-talk as an effective strategy of enhancing sport performance (e.g., Hatzigeorgiadis & Galanis, 2017), it would be valuable to add to this area of knowledge with findings from a competitive sport such as Tae Kwon Do.

Some of the existing studies used force impact platforms or other measurements systems to assess certain aspects of Tae Kwon Do performance (Chiodo et al., 2011; Čular, Miletić & Miletić, 2010), roundhouse kick in particular (Estevan, Álvarez, Falcó & Castillo, 2014; Estevan, Álvarez, Falcó, Molina-García & Castillo, 2011; Falcó et al., 2009; Falcó, Molina-García, Álvarez & Estevan, 2013; Thibordee & Prasartwuth, 2014; Wasik & Shan, 2015). Despite that roundhouse kick is one of the most frequently used kicks in Tae Kwon Do competitions (Falcó et al., 2009) other types of kicks should be addressed in research as well with the use of objective biomechanical measurement system which provides a solid mean for

obtaining valid performance measurements.

Similarly to the need for further research targeting the effects of self-talk on various aspects of performance in Tae Kwon Do, requirement for studies targeting the causes of flow instead of describing its associative factors persists (Swann, Keegan, Piggott & Crust, 2012; Swann, 2016). Even though qualitative research is acknowledged as the more appropriate approach to studying the flow phenomenon, a properly constructed experiment targeting the important factors of flow could provide us with new insights regarding the optimal human functioning and indications of causality. Focus and thoughts and/or emotions seem to be central to flow experience, consisting this indication of causality according to the literature review from Swan et al. (2012). This coincides with self-talk mechanisms (self-confidence, focus/attention/concentration and triggering automatic execution) that mediate the effects of self-talk on performance. Jackson, Thomas, Marsh and Smethrust (2001) have investigated the relationships between flow and psychological skill use and found that positive self-talk was one of the facilitators of flow. An even more recent study from Miller Taylor, Brinthaupt and Pennington (2018) focused on the relationship between self-talk and flow in competitive cross-country runners assessing their self-talk after a race. The results showed that motivational self-talk was a significant predictor during the race. Negative self-talk was negatively associated to flow while positive self-talk was positively related to flow which is in accordance with the previously mentioned study from Jackson et al. (2001). In both of the studies the authors recommended intervention studies in order to manipulate factors associated with flow or successful performance (Jackson et al., 2001) and test the causality between self-talk and flow (Miller et al., 2018).

In the light of the above, the first purpose of this study was to engage in a field experimental approach in order to investigate the effects of self-talk intervention on flow experience and specific flow dimensions in Tae Kwon Do. Our hypotheses were that the

self-talk intervention would influence aspects of flow, such as the dimensions of challenge-skill balance, concentration on the task at hand, action-awareness merging, sense of control and loss of self-consciousness, as well as the overall flow experience. The aim of the second part of the study was to investigate the effects of self-talk intervention on various aspects of performance in Tae Kwon Do using a biomechanical measurement system in lab settings. Our hypotheses were that self-talk intervention leads to performance enhancement in roundhouse kick (*Dollyeo Chagi*), side kick (*Yeop Chagi*) and repetitive roundhouse kick (repetitive *Dollyeo Chagi*) in elite Tae Kwon Do athletes.

Method

Participants

Tae Kwon Do athletes ($N = 28$; 11 males, 17 females) aged from 13 to 21 years from two Tae Kwon Do clubs were recruited. The mean age of participants was 15.64 ($SD = 2.41$) years and their mean competitive experience 5.10 ($SD = 1.95$) years. They were training for an average of 10.55 ($SD = 4.04$) hours per week. They were all competing at national or international level. The two clubs were assigned as experimental ($n = 15$) and control ($n = 13$) groups.

Measures

Competition data. The importance of the competition was assessed with two items asking how important and how crucial the match athletes were going to compete is on a 10-point scale from 1 (*not at all*) to 10 (*very much*). The official competition results were obtained by the organizers.

Flow. Flow experience was measured with the Greek version of the Flow State Scale-2 (Stavrou & Zervas, 2004), a self-report instrument designed to assess post-event flow experience in sport (Jackson & Eklund, 2002). It comprises 36 items assessing nine dimensions of flow (4 items per subscale): challenge-skills balance (e.g., “The challenge and

my skills were at an equally high level."), merging of action and awareness (e.g., "Things just seemed to be happening automatically."), clear goals (e.g., "I knew clearly what I wanted to do."), unambiguous feedback (e.g., "I was aware of how well I was performing."), concentration on the task at hand (e.g., "My attention was focused entirely on what I was doing."), sense of control (e.g., "I felt like I could control what I was doing."), loss of self-consciousness (e.g., "I was not concerned with what others may have been thinking of me."), transformation of time (e.g., "I lost my normal awareness of time.") and autotelic experience (e.g., "I found the experience extremely rewarding."). Participants completed the questionnaire within 30 minutes after the match. Responses were given on a 5-point Likert scale ranging from 1(*strongly disagree*) to 5 (*strongly agree*). The reliability for the different subscales in the first assessment ranged from .64 to .93 and for the second assessment from .77 to .96.

Performance. Performance measurements were held in an optimally-controlled environment. Each participant performed three types of kicks on a kicking pad stably placed on a force measuring plate located between two steel poles stretched from the floor to the ceiling. The measures were obtained with Digital Acquire 4 Bertec program designed to collect data from force measuring devices. The plate was wired with Bertec measurement system which was connected to a laptop. A black band was tied around the kicking pad marking the target for the trials of the first two types of kicks. One researcher led the performance protocol and was responsible for recording the data via Bertec program while the other researcher observed the kicks and recorded their accuracy, i.e., whether the kicks were applied within the designated zone of the kicking pad.

Manipulation check. A typical self-talk manipulation check was used to assess use of self-talk from experimental and control groups (Hatzigeorgiadis et al., 2009). For the training session, the use of self-talk was assessed for the experimental group only through an item

asking participants following each training session to report how frequently they used the self-talk cues on a 10-point scale ranging from 1 (*not at all*) to 10 (*all the time*). For the post-intervention competition and kick measures participants from the experimental group were asked (a) to indicate if they used their self-talk plan during the competition/kick measures; (b) if so, to write down which cues they used; and (c) if so, to report to what degree they used the cue words from 1 (*not at all*) to 10 (*all the time*). Participants of the control group were asked (a) whether there was something specific that they systematically told themselves during the competition/kick measures; (b) if so, to write down what that was; and (c) if so, to what degree from 1 (*not at all*) to 10 (*all the time*).

Procedures

The study was approved by the Ethics Committee of the institution. The coaches from two Tae Kwon Do clubs were contacted and informed about the study and its purpose. Once they gave their permission the participants were informed about the purpose of the program and their coaches' consent. They were also notified about their participation being voluntary and that at any point they could withdraw from the program without any consequences. Finally, before the inception of the program, informed consent was signed by participants' parents.

An 8-week intervention was implemented in-between 2 competitions agreed by the coaches of the two groups; the two competitions were described from the coaches as important for the athletes and the teams. Within a week following each competition the kick measures were obtained in laboratory settings. During the 8 weeks the two teams implemented a 10 minute routine with the same exercises after the warm-up and before the start of the main training program, in 3 training sessions per week at the presence of a person from the research team.

Intervention. Before the first intervention session an introductory presentation of

self-talk and its benefits took place with the purpose to familiarize the participants with the psychological technique of the experiment. They were all informed about the importance of attending their training sessions according to schedule and encouraged to use self-talk not only during intervention periods, but also during the rest of the practice, at all training sessions and competitions. Self-talk practice was implemented under supervision three times per week after warm up and before the main practice. At the beginning of each session the participants were gathered and informed about the purpose and the content of the self-talk plan for each set of exercises. They received information about what cue words to use, when and how often to use them as well as what purpose do the cues obtain. The plan was presented on a paper which was after the given instructions placed on the wall until the next plan replaced it (an example of a self-talk plan is displayed in the Appendix). As mentioned previously, after the execution of the sets of exercises the participants were individually asked to give an evaluation of how frequently they used the given self-talk cues on a scale from 1 to 10. The intervention plans were developed through the cooperation of the research team, the coach, and the athletes.

A weekly plan during the first two weeks and a daily plan thereafter were prepared for the whole group. The athletes practiced motivational self-talk during the first week and instructional self-talk during the second week. During this time exercises were developed connected with specific tactical aspects in Tae Kwon Do which were discussed with the coach of the team. Specific cues both instructional and motivational were assigned to those exercises forming daily plans for the third and the fourth week. All the exercises throughout the program were executed in pairs. Once familiarized with self-talk after the first four weeks each athlete was encouraged to prepare an individualized self-talk plan according to their needs and preference.

The participants of the control group were informed about the time and place of the

measurements and were equally encouraged to attend all the practices according to schedule.

Flow. Flow experience was assessed within 30 minutes after the first match of the competition from all the participants before the intervention period. The same procedure followed approximately two months later after the completion of the intervention.

Performance. Performance measurements were held twice within approximately two months for both control and experimental group. The performance assessment protocol began with a 20 minute warm-up. Afterwards the athletes were given instructions about the procedure of the measurements. All the participants performed three types of kicks: roundhouse kick (*Dollyeo Chagi*), side kick (*Yeop Chagi*) and repetitive roundhouse kick (*Dollyeo Chagi*). The first kick (*Dollyeo Chagi*) was executed three times with each leg. The participants performed the kick with the right leg in the first sequence of trials. In the second sequence they all performed the same kick with the left leg. This sequence was repeated two more times until we obtained three measurements from each leg. The same procedure followed for the second kick (*Yeop Chagi*). For the first two types of kicks the participants were instructed to kick as hard as possible aiming at the black band. The third type of kick represented a continuous sequence of the first kick (*Dollyeo Chagi*) lasting for 20 seconds. The participants were instructed to kick as fast and as hard as possible in the given time, starting with the non-dominant leg (left for 2 in the control group and no-one in the experimental group). The participants performed the third type of kick one time with each leg. Before the main measurements took place the participants were able to perform the roundhouse kick and side kick with each leg one time as part of the familiarization process of the data acquisition.

To allow adequate rest between the kicks, participants took turn performing a single kick at the time. For the first two sequences of trials one researcher was adjusting the black band according to the height of the participants and assessing the accuracy of the kicks while

the other researcher was in charge of leading the measurements. The latter made sure the participants were ready before each kick and gave a signal for kick execution ("Go" for the first two series of kicks and "Start" for the third type of kick) when the program was prepared according to the settings displayed on the screen. The "start" button was pressed at the same time as the signal was given followed by "stop" after the kick was performed. After each measurement was obtained the measurement system had to be reset to "zero" value as well as the program on the laptop. For the last kick additional settings were adjusted to collecting the data for the period of 20 seconds. When 20 seconds passed, the researcher gave a signal ("Stop!") to the participants to stop kicking the pad. The same protocol was applied in both experimental and control group.

Results

Performance in kick trials

Screening and control analyses. Eighteen participants completed the two performance assessments; eight from the experimental group and ten from the control group (*M* age: 15.78, *SD* = 1.66; *M* competitive experience: 5.06, *SD* = 1.83; *M* training days per week: 5.28, *SD* = 1.13; *M* training hours per week: 9.14, *SD* = 2.62). From the rest, two were injured during the period of the intervention and eight were not available during the week of the final assessment. Chi-square tests were conducted to test for differences in gender as a function of group. The analyses revealed no significant differences χ^2 (1) = 1.95, p = .28. T-tests were computed to test for differences in age, competitive experience, days and hours of weekly training between the two groups. The analysis showed that there were no significant differences in any of the tested variables; for age, t (16) = 1.74, p = .10, for competitive experience, t (16) = 1.49, p = .16, for days of training per week, t (16) = 0.09, p = .93, and for hours of training per week, t (16) = 0.37. p = .72.

Participants of the experimental group reported systematic use of self-talk during the

kicks (M = 8.14, SD = 1.21). With regard to the content of the personal self-talk plans (a) for the single kicks, most athletes used motivational cues (e.g., power, strong, let's go, push, you can do it) and only a few some sort of instruction or trigger (e.g., hands up, ready); (b) for the repetitive kick, most athletes used motivational cues but of different nature (e.g., hang on, keep going, a bit more) and one reported an instruction (pace it).

Hypothesis testing. Two-way analysis of variance with group as independent factor (control, experimental) and time as a dependent factor (pre-, post-intervention competition) were computed to test for differences in accuracy of kicks. For the dominant leg, the analysis showed a non-significant group by time interaction, F (2, 15) = 0.50, p = .95. For the non-dominant leg, the analysis showed a non-significant group by time interaction, F (2, 15) = 0.70, p = .94.

Two-way analysis of variance with group as independent factor (control, experimental) and time as a dependent factor (pre-, post-intervention competition) were computed to test for differences in the three types of kicks, one for the dominant leg and one for the non-dominant leg. For the dominant leg, the analysis yielded a non-significant multivariate group by time interaction, F (5, 12) = 1.40, p = .29. For the non-dominant leg, the analysis yielded a significant multivariate group by time interaction, F (5, 12) = 3.17, p < .05. Examination of the pairwise comparisons showed that for the experimental group force was increased for the roundhouse kick (p < .05) and also number of kicks was increased for the repetitive roundhouse kick (p < .05), whereas for the control group no changes were recorded in any of the kicks. Descriptive statistics for all kicks are presented in Table 1.

Table 1. *Descriptive Statistics for Performance*

	Experimental				Control			
	Pre		Post		Pre		Post	
Leg	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Dominant								
Roundhouse kick	2277.20	663.60	2647.88	1282.04	1587.09	235.22	1326.15	389.48
Side kick	1756.56	191.92	2163.89	1100.25	1614.01	222.85	1209.91	202.85
RRK	860.60	381.71	933.30	412.97	684.17	267.46	597.72	195.91
Number of RRK	37.88	2.23	38.75	2.05	36.10	2.02	36.60	2.27
Fatigue Index	205.95	177.39	200.16	310.83	165.32	194.74	144.65	110.96
Non-Dominant								
Roundhouse kick	2073.35	555.91	2514.81	853.02	1506.68	126.01	1254.19	250.54
Side kick	1584.71	307.10	1861.83	699.39	1516.89	253.20	1219.18	249.84
RRK	876.61	426.35	863.37	346.84	682.60	249.14	650.99	216.85
Number of RRK	36.88	1.46	39.00	2.39	35.50	2.12	36.00	1.83
Fatigue Index	389.20	258.15	284.27	186.68	97.39	137.73	152.09	171.31

Note. RRK = repetitive roundhouse kick. Fatigue Index = last five kicks – first five kicks in repetitive roundhouse kick exercise. Number of RRK = number of kicks in 20 seconds. All the values except from number of RKK are expressed in newtons (N).

Flow in competition

Screening and control analyses. Seventeen athletes participate in the two competitions before and after the intervention; seven from the experimental group and ten from the control group (*M* age: 15.18, *SD* = 1.42; *M* competitive experience: 4.88, *SD* = 1.80; *M* training days per week: 5.47, *SD* = 1.07; *M* training hours per week: 9.91, *SD* = 2.79). From the rest, two were injured during the period of the intervention and nine did not compete in both of the two competitions that were selected for the data collection. Chi-square tests were conducted to test for differences in gender as a function of group. The analyses revealed no significant differences χ^2 (1) = 4.41, p = .10. T-tests were computed to test for differences in age, competitive experience, days and hours of weekly training between the two groups. The analysis showed that there were no significant differences in any of the tested variables; for age, t (25) = 0.60, p = .56, for competitive experience, t (15) = 1.36, p = .20, for days of training per week, t (15) = 0.13, p = .90, and for hours of training per week, t (15) = 0.24. p = .82.

Hypothesis testing. T-tests were computed to test for difference in competition importance for the two groups across the two competitions. The analysis revealed a non-significant effect for the pre-intervention competition, t (15) = 0.35, p = .73, and a significant effect for the post-intervention competition, t (15) = 0.35, p = 2.57, $p < .05$, with the control group scoring higher than the experimental group. Subsequently, importance scores for post-intervention competition were used as a covariate in subsequent analyses. Chi-square tests were computed to test for differences in match outcome between the two groups for the pre- and post-intervention competition. The analysis showed there were no significant differences; for pre-intervention competition, χ^2 (1) = 0.49, p = .64, and for the post-intervention competition, χ^2 (1) = 1.25, p = .35.

Participants of the experimental group reported systematic use of their self-talk plans

during the competition (M = 8.20, SD = .84). With regard to the content of the personal self-talk plans athletes used a variety of cues including mostly technical and tactical triggers (e.g., head back, arms, cut, push, block) and motivational cues (e.g., ready, let's go, power).

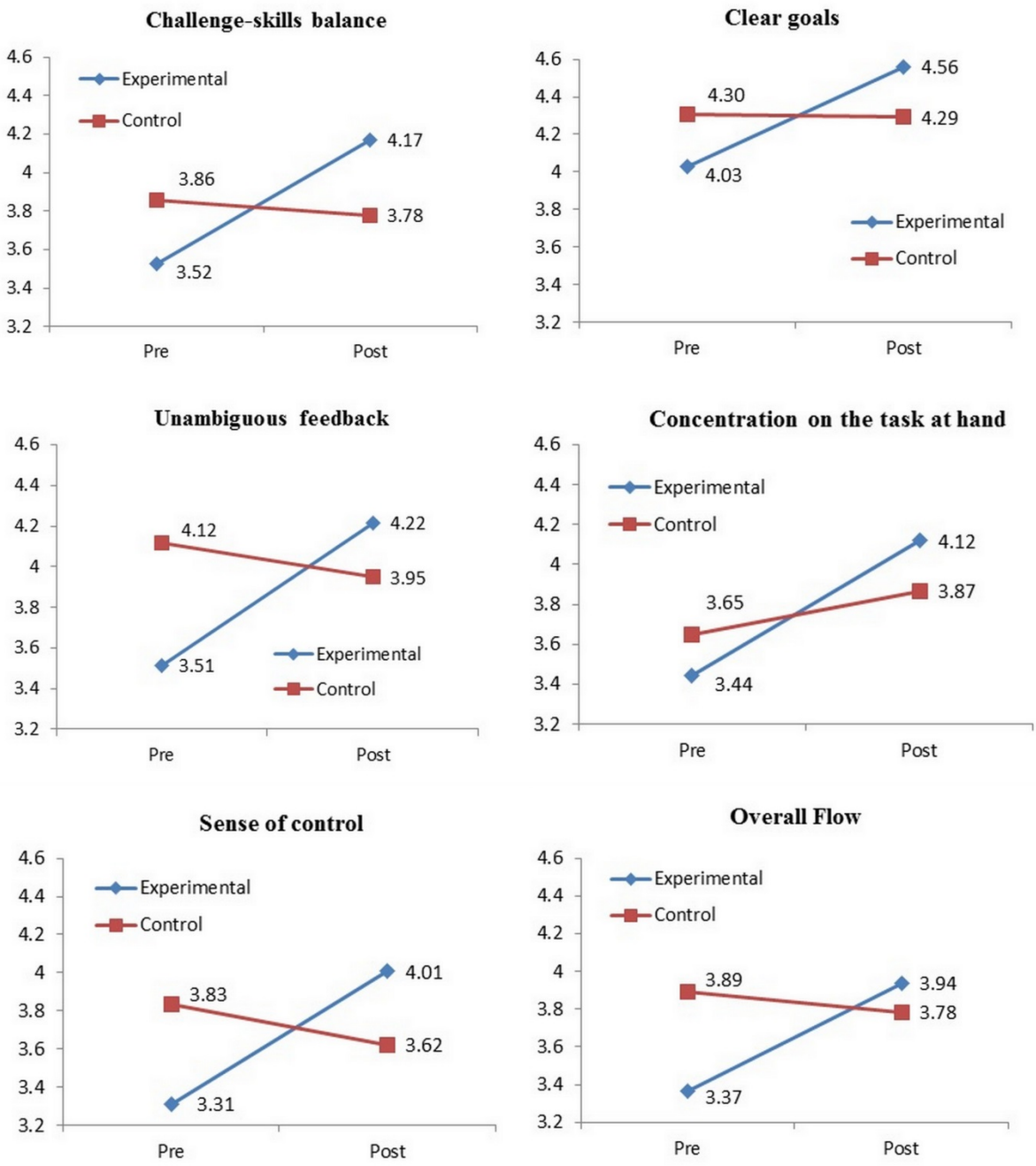
A multivariate analysis of covariance with group as independent factor (control, experimental), time as a dependent factor (pre-, post-intervention competition), and importance for post-intervention competition as covariate, was computed to test for differences in flow scores. The analysis revealed a non-significant multivariate effect, F (6, 9) = 0.62, p = .75, partial η^2 = .48. Nevertheless, examination of the pairwise comparisons showed that significant differences existed for several flow subscales when comparing changes across competitions for the two groups. In particular, changes that reached or approached significance with notable effect size were observed for challenge-skills balance (p < .05, partial η^2 = .21), clear goals (p < .05, partial η^2 = .16), unambiguous feedback (p < .05, partial η^2 = .30), concentration on the task at hand (p = .08, partial η^2 = .06), sense of control (p = .05, partial η^2 = .21), and overall flow (p < .05, partial η^2 = .27). For all of the above subscales scores and overall flow score the experimental group improved in the post-intervention competition (estimated means displayed in Figure 1), whereas scores for the control group did not change significantly. Considering the size of the effect reported above, and considering the implication of the sample size on statistical significance, it was deemed appropriate that these differences are noticed. Descriptive statistics for flow are presented in Table 2.

Table 2. *Descriptive Statistics for Flow (Observed means).*

	Experimental				Control			
	Pre		Post		Pre		Post	
Dimensions	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
CSB	3.71	.53	4.00	.79	3.73	.70	3.90	.67
MAA	3.18	.62	3.25	.82	3.65	.61	3.45	.87
Clear goals	4.18	.47	4.50	.46	4.20	.54	4.33	.61
UF	3.79	.59	4.29	.49	3.93	.65	3.90	.77
CTH	3.69	.57	3.96	.83	3.48	.89	3.98	1.06
Sense of control	3.61	.66	3.93	.83	3.63	1.08	3.68	1.11
LSC	3.54	.64	4.23	.97	4.13	.50	4.05	.96
TT	2.57	.81	3.07	.99	3.33	.69	3.15	.90
AE	3.93	.53	3.82	1.12	3.65	1.09	3.88	1.20
Overall flow	3.58	.44	3.89	.53	3.74	.60	3.81	.61

Note. CSB = challenge-skills balance, MAA = merging of action and awareness, UF = unambiguous feedback, CTH = concentration on the task at hand, LSC = loss of self-consciousness, TT = transformation of time, AE = autotelic experience.

Figure 1. Changes in flow: Estimated means controlled for competition importance



Discussion

The purpose of the current study was to investigate the effects of a self-talk intervention on flow and Tae Kwon Do kick performance. The results showed that some of the performance measures and aspects of flow seemed to improve for Tae Kwon Do athletes who took part in the intervention. The flow dimensions which were affected by the intervention were challenge-skills balance, sense of control, concentration on the task at hand, clear goals and unambiguous feedback as well as the overall flow. As for performance, the improvements were found in the first and the third type of kick performed with the non-dominant leg.

Firstly, we will discuss one of the aspects when analyzing the performance results, which was the significant difference in performance improvement between the dominant and non-dominant leg. One of the studies which addressed the effects of instructional and motivational self-talk on dominant and non-dominant arm performance on a handball task found that for the non-dominant arm instructional self-talk had a larger effect compared to motivational and that the effect sizes for both types of self-talk were more than twice as large for the non-dominant arm (Zourbanos, Hatzigeorgiadis, Bardas & Theodorakis, 2013). The latter can be related to the results from our study where performance measurements post-intervention showed significant improvement in the kicks executed by the non-dominant leg. In relation to these findings the importance of skill level in connection with self-talk can be considered. The results of a meta-analysis on self-talk and sports performance showed that self-talk can have a greater effect for less well-learned tasks (Hatzigeorgiadis, Zourbanos, Galanis & Theodorakis, 2011). Even in this sample of elite athletes the non-dominant leg probably has more space for improvement which justifies the effectiveness of self-talk training in our study. The results showed a positive, but not significant, trend for the dominant

leg as well. The proficiency of the dominant leg in high level athletes probably requires longer interventions in order to achieve the same substantial effect. Furthermore, the small sample size further justifies the lack of statistically significant results.

Apart from the promising performance results for the non-dominant leg overall, the improvement for the roundhouse kick is of particular importance. Roundhouse kick is a powerful (Thibordee & Prasartwuth, 2014) and one of the most commonly used kicks in Tae Kwon Do competitions (Falcó et al., 2009). Several studies have investigated roundhouse kick and variables related to it, such as effects of distance on impact force and execution time (Estevan et al., 2011; Falcó et al., 2009, 2013), kinematic and kinetic analyses (Thibordee & Prasartwuth, 2014), target effect (Wasik & Shan, 2015) and self-efficacy (Estevan et al., 2014). The topic of self-talk was addressed by Hanshaw and Sukal (2016) who investigated the effects of one motivational self-talk training session on the response time of trained martial artists performing rear-leg roundhouse kick. The improvement of response times in the self-talk group can be complemented with the improvement of peak force and stamina of the roundhouse kick from our study. The additional effects that evolved in our study may be attributed to the length of self-talk training. Despite self-talk being a strategy that gives immediate results and being easy to learn and apply, training seems to enhance its effectiveness, especially in high level athletes, and is therefore recommended (Hatzigeorgiadis et al., 2011).

No significant improvement for the side kick after the implementation of self-talk training was found in our study. In a study examining the influence of self-talk on side kick performance in Tae Kwon Do by measuring the impact force (Magnusson & Roon, 2013) it was found that personalized self-talk enhanced performance in elite Tae Kwon Do athletes while assigned self-talk turned out detrimental for their performance. Since our athletes chose their own cue words in the post-measurements we would expect improvement in the peak

force of the side kick. Once again the reason for not reaching significant results might be a consequence of small sample size, since the trend of impact force increase of the side kick was notable.

Hanshaw and Sukal (2016) recommended accuracy testing for kicks after psychological skills training. In our study the use of self-talk did not influence the accuracy of kicks. It should be noted that the participants in our study reported using self-talk related mostly to the impact of the kick (e.g. ready-power, power, let's go strong) rather than accuracy which probably reduced the effect of the intervention on the precision perspective. This could be improved by conducting an experiment with two separate tasks for power and accuracy which would provide the athletes the opportunity to use more specific self-talk for each task. Improvement is also needed in the assessment of accuracy of the kicks. The black band which represented the target in our study was manually moved in between the kicks according to the height of the participants and accuracy was thereafter recorded by the researcher. Instead of relying on data based on observation, other measurement systems could be used to objectively assess the effects of self-talk on accuracy of kicking performance.

Overall, our study adds to the broad existing literature of self-talk and its beneficial effects on performance (Hatzigeorgiadis et al., 2011), extending it to elite Tae Kwon Do based on biomechanical data. This provides indications for further applied use of self-talk. Chiodo et al. (2011) suggest training elite Tae Kwon Do athletes to maintain their upper limb strength during competition in order to improve their performance. Apart from physical training we suggest that mental training with regular self-talk use has the potential of helping to achieve such goals as well.

The findings for flow experience should be taken with caution due to the small sample size and hence the statistical analyses that provided non-significant multivariate, but significant univariate effects. According to expectations challenge-skills balance, sense of

control and concentration on the task at hand, as well as overall flow showed an increase pattern post-intervention, when taking into consideration the reported perceived importance of competition.

Challenge-skills balance represents the golden rule of flow (Jackson & Csikszentmihalyi, 1999). Not only do the challenges and skills have to match in order for flow to happen, but they both have to surpass the individual's average levels. When the challenge-skills balance is set the athlete's mind is focused on the task and clear from irrelevant thoughts and distractions (Jackson & Eklund, 2004). Likewise self-talk helps athletes increase attentional focus and counter detrimental effects of distraction (Hatzigeorgiadis & Galanis, 2017; Galanis et al., 2018). The current study shows support for the hypothesis that the dimension of challenge-skills balance develops after self-talk intervention. Self-talk increases self-confidence (e.g., Hatzigeorgiadis, 2006) and can therefore lead to perceiving challenges in a positive way with the use of facilitative and optimally chosen cues (Jackson & Csikszentmihalyi, 1999). Our findings also support those from Stavrou et al. (2007) who encourage among other the implementation of self-talk in psychological programs with the purpose to increase the athlete's self-confidence and perceived competence and therefore increase athlete's perceived skills.

Sense of control was the second dimension which was successfully improved with the self-talk intervention. Whether sense of control can be built up by self-talk through efficient attentional control (Harris et al., 2017) or automaticity (Landin & Hebert, 1999) is still debatable. One possible explanation is that the increase of attentional focus underlying the benefits of self-talk (Hatzigeorgiadis & Galanis, 2017) relieves athletes from fear of failure and enables them to focus on their performance (Jackson & Eklund, 2004). Another explanation would be that self-talk once used spontaneously triggers automatic execution of the desired movements (Landin & Hebert, 1999), enhancing the athletes self-confidence

(Hatzigeorgiadis, 2006) and therefore allowing them to feel in control and enjoy challenging situations (Csikszentmihalyi, 1990).

Another dimension that self-talk seems to have an impact on is concentration on the task at hand. Similarly to sense of control, we can associate the positive effect of the intervention on this dimension through the increase of attentional focus (Hatzigeorgiadis & Galanis, 2017). Athletes with high concentration on the task at hand are keeping their mind in the present with thoughts directed to the demands of the activity they are indulged in (Jackson & Csikszentmihalyi, 1999). The results on this dimension were very close to statistical significance, allowing us to speculate that with a higher number of participants our expectations would be reached and our hypothesis confirmed with confidence. On one hand, our findings are in accordance with those from Zetou et al. (2014b) claiming that self-talk leads to the development of attention when performing Tae Kwon Do skills. On the other hand they counter the possibility of internal and external positive distractions helping maintain the state of flow (Swann et al. 2017) as the concentration on the task at hand reflects the absence of irrelevant thoughts and distractions (Jackson & Eklund, 2004). More studies are required regarding the means of maintaining flow, our study offering support to the hypothesis that the development of self-talk and its mechanisms increases flow through enhanced attentional focus (Hatzigeorgiadis & Galanis, 2017) and countering the effects of distractions (Galanis et al., 2018).

Finally, throughout all the dimensions except from autotelic experience, the overall flow of the competitors in the experimental group significantly increased. Apart from challenge-skills balance, sense of control, concentration on the task at hand, clear goals and unambiguous feedback, the flow dimensions of merging of action and awareness, loss of self-consciousness and transformation of time, indicated a trend of increase post-intervention. However, with our limited sample they did not reach the criteria for statistical significance.

The increase of overall flow supports the previous findings of self-talk representing a psychological skill that facilitates flow experience (Jackson et al., 2001; Miller Taylor et al., 2018). It seems that the postulation about functions of self-talk inducing effect in flow state is meaningful. Considering the prospective model of self-talk mechanisms (Galanis et al., 2016) the impact self-talk has on performance through attentional and motivational functions (e.g. self-efficacy, confidence) could be the same route to the positive development of flow experience. Attentional functioning as an attainable mechanism of self-talk for improving task performance, enabling athletes to shift focus of attention depending on the skill they are performing, strengthening the quality of internal and/or external focus and protect against distractions (Galanis et al., 2016), is a plausible explanation for the increasing trend of flow in the current study. Self-efficacy (Hatzigeorgiadis et al., 2008) and self-confidence (Hatzigeorgiadis et al., 2009) as mechanisms of self-talk also add to this potential explanation as the concept of motivation is essential to flow experience (Jackson & Csikszentmihalyi, 1999).

There are two more dimensions of flow that reached a significant difference post intervention and that ought to be discussed. Clear goals and unambiguous feedback were not targeted with the intervention, however, knowing that the dimensions of flow even though exclusive in their nine categories, are also connected amongst each other in many different aspects (e.g. self-confidence, concentration and automaticity), we cannot decline the potential impact that self-talk could have on those two dimensions through the same functions. As sport provides clear goals and rules for athletes to follow, it is important for athletes to understand what it is they are striving to achieve (Jackson & Csikszentmihalyi, 1999). Performance preparation leads to clarity of focus on particular goals that form an integral component of flow experience (Jackson & Eklund, 2004). Based on the findings from our study we suggest that self-talk with its attentional effects (Hatzigeorgiadis et al., 2004) can also enhance the

focus on those particular goals and therefore add to enhancement of the clear goals dimension of flow. As for unambiguous feedback, it refers to receiving information about keeping track with the chosen goals in an effortless manner from various sources (Jackson & Eklund, 2004). Since self-talk is considered to enhance internal and external attentional focus (Galanis et al., 2016) and help maintain it under conditions such as distractions and fatigue (Hatzigeorgiadis & Galanis, 2017), it is possible that this enhances the athletes' chances for an effective and effortless gathering of unambiguous feedback from different sources. Experiments from Galanis, Hatzigeorgiadis, Sarampalis and Sanchez (2016) brought up the effortless attention effect as another potential mechanism of self-talk. This could also be associated with the rise of unambiguous feedback in our study.

Also contrary to our expectations the dimensions of merging with action and awareness and loss of self-consciousness did not show significant increase after self-talk intervention. Within the dimension of loss of self-consciousness athletes' minds are free from the worry of reaching other people's expectations and the standards they perceive as important (Jackson & Eklund, 2004), while within action-awareness merging they are completely absorbed in the activity in a spontaneous and automatic manner (Csikszentmihalyi, 1990). Since the two dimensions show a trend of enhancement, the most tenable explanation for not gaining the desired effects of self-talk post intervention would be the methodology of the study. This interpretation is likely considering the attentional function of self-talk (Hatzigeorgiadis & Galanis, 2017) and the important role of attentional focus in the dimension of loss of self-consciousness (Csikszentmihalyi et al., 2017) as well as in the merging of action and awareness (Jackson & Eklund, 2004).

The study contributes to the existing self-talk literature regarding performance, but also to relevant outcomes and mechanisms that may explain the facilitating effects of self-talk on performance and flow. Biomechanical data from performance measurements shows

improvement in certain Tae Kwon Do skills after self-talk intervention and therefore offers support to the knowledge of self-talk having the potential to contribute to the optimal performance of sports with power-based skills (Tod, Thatcher, McGuigan & Thatcher, 2009). With our study we also added to the existing literature of flow in elite sports using an experimental design. The study provides preliminary evidence suggesting that self-talk through its various functions may help the development of flow states during competition. Self-talk interventions proved to be successful also in reducing cognitive (Hatzigeorgiadis et al., 2009) and competitive anxiety (Georgakaki & Karakasidou, 2017) which together with the current study demonstrates and adds to the variety of benefits that self-talk interventions can provide in addition to performance enhancement. Conducting self-talk interventions can help discover, identify and develop an understanding of self-talk mechanisms underlying the benefits of self-talk in sports (e.g. Hatzigeorgiadis, 2006; Hatzigeorgiadis et al., 2009; Zetou et al., 2014a).

The current study represents the first research addressing the influence of self-talk on flow and investigating the effects of self-talk on performance of elite Tae Kwon Do athletes using an experimental method. Developing an understanding of psychological factors that are connected with optimal performance is a major field and priority in applied sport psychology (Jackson et al., 2001).

Limitations

The main limitation of the current study was the loss of participants due to injuries or absence at the post measurement competition leading to small final sample size and subsequently the lack of multivariate significance demanding caution with the interpretation. It is recommended to repeat this study on a larger sample and in other competitive sports, particularly for flow. As Swann et al. (2012) suggest, researchers should distribute questionnaires after events that are likely to be optimally-challenging, and therefore more

likely to facilitate flow than normal performances. One of the limitations of using questionnaires is that the participants may have high scores already at baseline. The ceiling effect can prevent the detection of significant changes caused by the independent variable in quantitative data analysis (Cramer & Howitt, 2004). This could be considered as the second limitation of our study as slightly elevated scores at baseline made identifiable increases statistically harder to achieve. A mixed method design combining questionnaires with interviews could be one way of providing plausible interpretations of flow results.

Finally, in the current study we used field assessment for flow and lab assessment for performance measurements. The latter was controllable to the higher extent with the use of objective biomechanical measurements. Field experiments involving psychological interventions that are conducted in a competitive environment are on the contrary difficult to control, thus lacking internal validity, and therefore not often employed by researchers (Martin, Vause & Schwartzman, 2005). Flow assessment in our study was held on the spot of two different competitions, lowering the internal, but adding to the external and ecological validity of the current research as a competition for elite Tae Kwon Do athletes is the most realistic setting for experiencing flow. This adds to the applied value of the findings and to studies investigating the effects of self-talk interventions in competitive sport performance using an experimental approach (Hatzigeorgiadis, Galanis, Zourbanos & Theodorakis, 2014). This study with the combination of field and lab experimental design integrates the advantages of both approaches and contributes to the existing knowledge of the psychological technique of self-talk as an effective strategy providing new research directions (Hatzigeorgiadis et al., 2011).

Conclusions

Findings from the study provide valuable indications for the effectiveness of self-talk intervention in increasing flow and performance in elite Tae Kwon Do athletes. Self-talk

seems to have a positive effect on the development of challenge-skills balance, clear goals, unambiguous feedback, concentration on the task at hand, sense of control and the overall flow in competitive settings, and on enhancing the peak force and stamina of roundhouse kicks, particularly for the non-dominant leg. Drawing final conclusions based on these results remains limited and demands future investigation with larger samples. Despite the limitations the study represents a novelty in its topic and contributes to the existing research with its experimental design and used biomechanical measures for investigating self-talk as a strategy to increase flow and performance.

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Appendix

Example of a self-talk training plan

Week 3 - instructional and motivational self talk		
What	When	Why
Streched leg	After the "push"	To keep the knee stretched after the "push"
Ready-back	During the defense	To be ready for my defense. To score with the back leg.