Goal-directed, spontaneous and stimulus-independent thoughts and mindwandering in a competitive context

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The aim of this study was to analyse the functions of goal-directed thoughts and the content of spontaneous and stimulus-independent thoughts and mindwandering in a competitive setting and to explore links between different types of thoughts. Therefore, seventeen young sport science students competed in a card-sorting task, while their recorded thoughts were collected between trials. Afterwards, the participants classified their own transcripts into different types of thoughts. The results indicated that goal-directed thinking serves a variety of functions, spontaneous thought content might reflect a series of psychological states and processes relevant for performance, and that the content of mindwandering was idiosyncratic. Moreover, goal-directed thinking increased during competition, whereas mindwandering diminished. Lastly, mindwandering was rarely connected to other types of thinking, whereas the most recurrent connection between thoughts was found between goal-directed and spontaneous thinking.

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Thoughts influence performance and behaviour in sports (see, Hardy & Oliver, 2014). Hence, it is not surprising that numerous studies in sport sciences have focused on a series of cognitive processes, such as decision making (Travassos et al., 2013), visualization (Cumming & Williams, 2014) or self-talk (Hatzigeorgiadis, Zourbanos, Galanis, & Theodorakis, 2011). Yet most of these cognitive concepts are related to several distinct thought processes, such as intuitive or rational decision making (Bar-Eli, Plessner, & Raab, 2011), or intuitive or rational self-talk (Van Raalte, Vincent, & Brewer, 2016). In line with these examples, researchers distinguished between automatic processes, pertaining to System I cognitive processing, which lack effort, intention, or awareness; and controlled cognitive processes, pertaining to System II cognitive processing (Kahneman, 2011), which typically involve effort, intention, and awareness. Initially, these differences were described, theoretically, by researchers (e.g., Schneider & Shiffrin, 1977) and tested, empirically, in metacognitive studies (e.g., Klinger, 1978). During the past decade, the differences between controlled and automatic thought processes were corroborated by studying neurological patterns in the human brain (Lieberman, 2007).

Classifications of thoughts in neuropsychology

A plethora of neuropsychological studies have focused on different thought processes and the brain regions associated to them (Christoff, 2013). One important contemporary classification differentiates between goal-directed thinking, which refers to controlled processes, and spontaneous thinking, stimulus-independent thinking and mindwandering (Fox, Spreng, Ellamil, Andrews-Hanna, & Christoff, 2015), which all refer to automatic processes. With regard to the former, Christoff, Gordon and Smith (2011) described goal-directed thinking as a mental process deliberately employed towards solving a problem or making progress on a task. Goal-directed thinking usually occurs during reasoning, problem solving and decision making. When considering specific neurological systems involved in controlled, goal-directed, thought processes, authors have reported that prefrontal and frontal cortical regions were activated while reasoning, whereas automatic processes are associated with the default network of the brain (see, Andrews-Hanna, Reidler, Huang, & Buckner, 2010).

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In relation to automatic thought processes, Christoff et al. (2011) further distinguished three types: mind-wandering, stimulus-independent thoughts and spontaneous thoughts. According to Klinger (2009), mind-wandering would include any thought that is unrelated to the ongoing task or activity, thus unrelated to the thought-eliciting situation; stimulus-independent thoughts would be related to the context of the activity, yet unrelated to the ongoing stimuli a person receives; and spontaneous thoughts are unintended, non-working, non-instrumental thoughts that come to mind unbidden and effortlessly, which are, however, linked to the task or activity at hand and to relevant contextual stimuli. During a corner kick in soccer, for instance, a defender could think *I'm stronger than him* (spontaneous thought), *I like soccer* (stimulus-independent thought) or *I'll go to the cinema tomorrow* (mindwandering). According to a revision undertaken by Christoff (2012), investigators have identified a number of brain regions linked to spontaneous thought: the posterior cingulate cortex and the anterior medial prefrontal cortex (PFC), temporopolar cortex and medial temporal lobe structures, and the rostrolateral prefrontal cortex. Furthermore, in studies on stimulus-independent thoughts the PFC has received the most attention within the literature (Mason et al., 2007). Lastly, one brain network that has been linked to mind wandering is the default network of brain regions (Raichle et al., 2001), which includes, most prominently, the medial PFC, posterior cingulate/precuneus region, and the temporoparietal junction.

Yet, as Christoff (2012) recognized, almost all neuroscientific investigations have used rest as an experimental paradigm to investigate automatic thought processes. During rest, subjects are simply instructed to do nothing, as no experimental task is given to them. To overcome this limitation, during the past years several studies have used experimental designs to study thought processes (e.g., Andrews-Hanna et al, 2010). However, the motor demands in the experimental tasks are usually limited to pressing a button on a computer (e.g., Gilbert, Simons, Frith, & Burgess, 2006). Consequently, it would seem that we are still far from studying thought processes in sport from a neuropsychological perspective.

The study of thought in sport sciences

Most studies on thoughts in sport were carried out from a metacognitive perspective (e.g., Zourbanos, Hatzigeorgiadis, Chroni, Theodorakis, & Papaiannou, 2009), based on the athletes' abilities to reflect on their own thoughts and actions (Fox & Christoff, 2014). With regard to sport based metacognitive studies on different thought processes, authors have focused on goal-directed thoughts such as gathering information and planning (Calmeiro & Tenenbaum, 2011) or providing self-instructions (Hatzigeorgiadis, Zourbanos, Goltsios, & Theodorakis, 2008), on spontaneous thoughts such as irrational beliefs (Turner & Barker,

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2014) or casual attributions (Cantón & Checa, 2010), and on stimulus-independent thoughts and mindwandering, which in sport have been referred to as task-irrelevant thoughts (Hatzigeorgiadis & Biddle, 2000) or attentional dissociation (Jones, Karageorghis, & Ekkekakis, 2014). In spite of the advances made in many research areas related to thought processes, it should be acknowledged that studying thoughts from a metacognitive perspective has important limitations (Latinjak, Hatzigeorgiadis, & Zourbanos, 2016). Nisbett and Wilson (1977) postulated that all thought-sampling procedures, including distant memory recall strategies (see, Latinjak, Hatzigeorgiadis et al., 2016), concurrent verbal protocols (see, Calmeiro & Tenenbaum, 2011) or self-caught measurement approaches (see, Garcia, Razon, Hristovski, Balagué, & Tenenbaum, 2015), have limitations as they rely on conscious awareness and memory. Yet such procedures provide access to cognitive activation and metacognitive knowledge that cannot be obtained through other methods (Guerrero, 2005), such as observational (e.g., Zourbanos et al., 2015) or neuropsychological (e.g., Andrews-Hanna et al, 2010) methodologies.

Spontaneous and goal-directed self-talk. From a metacognitive perspective, one way to examine thoughts is by studying self-talk (Hatzigeorgiadis & Biddle, 2000). Self-talk consists of verbalized thoughts, with a recognizable syntax (Van Raalte et al., 2016), directed, overtly or covertly (Hardy, 2006), to the self. Therefore, self-talk has been regarded as a window into thought (Hinzen, 2013). Yet researchers have also identified two distinct research perspectives in sport self-talk: the *strategic self-talk* perspective considers the use of self-talk as a mental strategy, whereby self-talk cues or self-talk plans are deliberately employed to enhance performance or achieve other related outcomes; and the *automatic self-talk* perspective, that views self-talk as inherent thoughts and self-statements athletes address to themselves, mostly during sport performance, and that focuses on the occurrence and the frequency, as well as on the antecedents and the consequences, of such statements (Theodorakis, Hatzigeorgiadis, & Zourbanos, 2012). The study of thought processes clearly falls into the automatic self-talk perspective, which has received, to date, less research attention compared to the strategic self-talk perspective (see two reviews on strategic self-talk: Hatzigeorgiadis et al., 2011; Tod, Hardy, & Oliver, 2011).

One line of research in the automatic self-talk perspective that has adapted the general distinction between controlled and automatic thought processes (Schneider & Shiffrin, 1977), as well as Christoff's (2012) classification of automatic thoughts, and that uses metacognitive memory recall procedures, focuses on the content of spontaneous self-talk and the functions of goal-directed self-talk (Latinjak, Font-Lladó, Zourbanos, &

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Hatzigeorgiadis, 2016; Latinjak, Hatzigeorgiadis et al., 2016; Latinjak, Zourbanos, López-Ros, & Hatzigeorgiadis 2014). On the one hand, these studies (Latinjak et al., 2014; Latinjak, Hatzigeorgiadis et al., 2016) have evidenced that spontaneous self-talk is predominantly anticipatory and positive ("I want to play/ I will win), anticipatory and negative ("Let's stop/ I will make a fool out of myself"), retrospective and positive ("I did it, I am the best/ I could hug the world") and retrospective and negative ("I messed up/ I let everyone down"). On the other, these studies have evidenced that goal-directed self-talk can aim at several functions: cognitive reappraisal ("It was not your fault"), cognitive and behavioural control ("Focus on the game"), positive predictions and goal management ("You can defeat them"), emotional control ("Don't be angry") and effort regulation ("Come on! / Relax").

In regard to the methodological limitations, Latinjak and colleagues argued that the consistency between different studies and the concordance between the results of these studies and previous studies on the content of spontaneous self-talk (e.g., Zourbanos et al., 2009) and the functions of goal-directed self-talk (e.g., Theodorakis, Hatzigeorgiadis, & Chroni, 2008) offers indirect support for their procedures. In spite of the advances made, the authors in this line of research recurrently underlined that different thought-sampling procedures ought to be used to replicate the findings, given the limitations of any thought-sampling procedure (Nisbett & Wilson, 1977). Moreover, the authors suggested that using concurrent thought-sampling procedures (Calmeiro & Tenenbaum, 2011), future studies could inquire into mindwandering. To the best of the authors' knowledge, mindwandering has not been studied in the context of sport.

The present study

The purpose of this study was to describe goal-directed, spontaneous and stimulus-independent thoughts and mindwandering. The study consisted of a laboratory-based competitive task, experienced by athletes as similar to sports practice in terms of cognitive, motivational and emotional factors. The task represented a head-to-head competition with prospects and threats to the ego and needs for emotional self-regulation, dealing with uncertainty, success and/or failure. In this competitive task comparisons between the performance of athletes were fundamental. Accordingly in this study, performance (in terms of wins and losses) was considered a dependent variable and its relation to the appearance of specific thought processes would be explored. Moreover, a concurrent thought-sampling procedure would be used to explore athletes' thoughts. Since introducing advances from neuropsychology into sport psychology has been recommended (Abreu & Duarte, 2015), a coding scheme based on the framework of Christoff (2012) would be used in this study.

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Specifically in this, study thought processes, defined in research using brain scans, were investigated from a metacognitive perspective. As such this would afford us the opportunity to observe whether distinctions made on a neurological level correspond to distinctions made on a conceptual level.

Furthermore, we asked three specific questions: (1) what are the functions of goal-directed thoughts, and what is the content of spontaneous and stimulus-independent thoughts and mindwandering; (2) how does the percentage of these thoughts change from pre-competition, to competition and post-competition scenarios; and (3) are there specific bonds between different types of thoughts, that is, are some thoughts more likely than others to emerge before or after a specific thought type?

On the one hand, we were convinced that advances in our understanding about spontaneous thoughts and mindwandering, would help us to gain insight into the affective, motivational and cognitive processes the athlete expresses through their self-dialogue. On the other hand, we believed that studies on the autonomous attempts athletes undertake to confront diverse competitive situations, through the use of goal-directed thinking, could lay some foundations for the interventions of sport psychology practitioners.

Method

Participants

A total of 17 young adult athletes, who were at that time studying sport science (10 males and 7 females, M_{age} = 19.35, *SD* = 1.46), agreed to participate in this study. They were competing in soccer (*n* = 8), basketball (*n* = 5), tennis (*n* = 2), water polo (*n* = 1) and handball (*n* = 1) on a national level. Another female participant took part in the first part of the experimental session, but had to withdraw for personal reasons unrelated to this study. Ethical approval was granted from the authors' university ethics board and all participants signed the informed consent form.

Procedure and data collection

Participants were informed that the study consisted of a two-hour session, which included a short seminar about thoughts in sport. Once all potential participants had signed up for the study, three sessions were planned for six participants each session. The sessions were carried out in a 45 square metre laboratory, at a local sport science faculty, equipped with a large round table in its centre. On arrival, the athletes were randomly seated around the table and the experimental procedures were explained. Afterwards, participants signed the informed consent form and answered personal descriptive questions.

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The session was divided into three parts. First, the participants completed a card-sorting task in a competitive setting. In parallel to the competition, the data regarding thoughts were collected after the practice trial, between all trials and after the final trial. Once the competition had finished, a lesson was given to the participants on goal-directed thinking and the different types of undirected thinking. Lastly, after a twenty-minute break, the participants were asked to classify their thoughts into goal-directed and undirected thoughts and their subtypes.

The experimental task. Competitive sport settings make application of concurrent thought-sampling procedures difficult. Therefore, in a pilot study with two groups of six participants, similar to the participants of the present study, two laboratory-based experimental tasks were tested: dart throwing and card sorting. After the pilot trials, all twelve participants and one researcher participated in a group discussion in which they were asked to discuss: the thought-sampling procedure, how they perceived the competitive task and to what degree their motivation, thoughts and emotions in the competitive task resembled those in their sport. The participants agreed that (a) the card-sorting task was better for thought sampling because they could start reporting thoughts immediately without sitting down and until seconds before the next trial started; and (b) emotions were perceived as more realistic in the card-sorting task because all participants could compete head-to-head at the same time. Moreover, all participants acknowledged that the competitive card-sorting task precipitated a series of situations they experienced as similar to real sport competition: specifically, they pointed towards emotions, such as anxiety (“I was really nervous, no idea why. Just like in some matches”), anger (“I thought I wouldn’t care, but then I got really annoyed”) and relief (“I just hoped I would pass to the next round, and when I saw that she lost, it took a huge weight off my shoulders”), performance beliefs, either positive (“I always thought I’d win …”) or negative (“There was no chance for me to win”), and goal orientations, both task (“…at that point I only tried to make fewer mistakes and feel comfortable with the task”) and ego (“…so there was no way a guy like him could beat me, no way”). Hence, the card-sorting task was chosen.

The task consisted of separating a total of 52 cards into red and black cards as quickly as possible. After explaining the task, we ran one practice trial. Afterwards we started the competition. After each trial during the competition, the slowest participant was eliminated, until only one participant was left. The competitive element was underlined by several measures: all participants competed head-to-head next to each other, the slowest participant

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in each trial was eliminated, and the participants eliminated in previous trials remained at the table to watch and support or criticize the other participants.

The thought-sampling procedure. In parallel to the competition, the data regarding thoughts were collected after the practice trial, between all trials and after the final trial. All participants, who had competed in the previous trial and/or who would compete in the next trial, were asked to write down anything that came to their minds, regardless of the content, on a blank sheet.

The time between trials was approximately six minutes. After four minutes the participants were informed that the next trial was imminent. However, they were told to keep writing until the researcher gave the signal to start sorting. Hence, all participants were still writing when the next trial started, and, consequently, their thoughts were recorded right up to the very last instant before competing.

Participant ratings of thoughts. In this study we took into consideration participant ratings of thoughts. Studying spontaneous self-talk, Van Raalte, Cornelius, Copeskey and Brewer (2014) evidenced that self-talk ratings made by participants in their study could be distinguished from those made by researchers. Similarly, Latinjak, Hatzigeorgiadis et al. (2016) calculated participant-rater agreement and concluded that agreement between participants and the judges was acceptable, but modest. In order to teach the participants about the different types of thought processes, a lesson was prepared for the participants.

The lesson contained the following topics: a brief description of the conceptualization of thoughts and self-talk in general and sport psychology; definitions of goal-directed and spontaneous self-talk; the structure and functions of goal-directed self-talk; and the structure and content of spontaneous self-talk. Language and expression were adapted to the language commonly used by the participants. After the lesson on goal-directed thinking and the different types of undirected thinking, each participant was assigned a research assistant, who would help them organize their answers in elementary meaning units (EMUs, Strauss & Corbin, 1998), group the EMUs into temporal sequences, and classify the EMUs into goal-directed and undirected EMUs and their subtypes. The research assistants instructed the participants to group EMUs if the different EMUs pertained to a temporal sequence of thoughts. If a participant could not remember whether two EMUs were related, then a new temporal sequence was opened. In this study, a EMU was defined as a raw-data quote that had a common meaning and captured a distinct concept (Tesch, 1990), and a temporal sequence was quite simply the beginning of a new line in the text-processing program.

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The research assistants were, at that time, not familiar with the purpose of the study. In order not to bias the decisions of the participants, the research assistants were instructed to use only hints or cues (e.g., "thought about the codification would be spontaneous, thoughts about the experiment we did earlier would be stimulus-independent, and thoughts about what you will do later at home, are mindwandering"). The research assistants' feedback was used as a scaffold, and the scaffolding (Bransford, Brown, & Cocking, 2000) was gradually removed as the participants progressively gained an understanding of the tasks they were instructed to carry out.

Data analyses

First, one independent judge, a sport science lecturer in subjects related to cognitive concepts such as attention, tactics and decision making, with expertise in qualitative analysis, and the first author categorized each EMU into goal-directed, spontaneous, stimulus-independent thoughts and mindwandering. Inter-rater agreement between the two judges was calculated, and, in case of disagreement, both convened to discuss until agreement was reached. Second, inter-rater agreement between the participants' ratings and the judges' ratings was calculated. In case of disagreement, the two judges critically considered the participants' option and deliberated until final agreement was reached. Upon completion of the categorization procedure, the content of each category was explored.

Third, since participants who advanced far in the competition reported more thoughts than participants who lost early in the competition, the number of goal-directed, spontaneous, and stimulus-independent thoughts and mindwandering were compared for each trial. Fourth, regardless of the trial, temporal sequences of thoughts were examined. The percentage of antecedent and subsequent meaning units were calculated for each category.

Results

Categorization process

A total of 577 separate EMUs were collected. The participants categorized 129 as goal-directed, 307 as spontaneous, 19 as stimulus-independent thoughts and 122 as mindwandering. The judges categorized 121 EMUs as goal-directed, 319 as spontaneous, 29 as stimulus-independent thoughts and 108 as mindwandering. Inter-rater agreement, calculated by dividing the number of agreements by the total number of EMUs, multiplied by 100 (O'Neill, McDonnell, Billingsley, & Jenson, 2011), was 96%. Subsequent participant-rater agreement was 90%. Since self-statements have interpretive elements associated to their content (Hardy, 2006) which the judges cannot account for, the judges agreed on keeping to the participants' ratings.

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Frequency and content

Goal-directed thoughts. An examination of goal-directed thoughts revealed a considerably wide range of purposes. Many goal-directed thoughts aimed at regulating concentration and thought content ("Start to concentrate. There is not much time left.") and action ("Do I use the best way to separate the cards? I don't think so, but neither do I know a better way. If I just try to do it differently, I might just lose more time"). Other goal-directed thoughts aimed at regulating activation, either promoting effort ("Come on! Wake up!") or tranquillity ("I have to calm down"). Cognitive reappraisal also seemed to be a target of goal-directed thought; sometimes in regard to past events ("Still, it could have been worse"), sometimes in regard to ongoing or upcoming tasks ("You don't play for your life"). Lastly, some EMUs indicated that goal-directed thoughts might be used to prompt self-efficacy and confidence ("I'll be as fast as I can be, like lightening"). In regard to frequencies, our results indicate that goal-directed thinking was most frequent during competition, less frequent before competition and least frequent after competition. Moreover, inspection of the percentages suggests that as competition advances, goal-directed thinking becomes more frequent (Table 1).

Spontaneous thoughts. Spontaneous thoughts were mostly a mixture of anticipatory or retrospective and positive or negative content. First, anticipatory-negative thinking included negative predictions ("Now I really am on edge, something weird has to happen for me to pass, like Getafe beating Barcelona in the Camp Nou"), nervousness ("I can't stand being nervous; the same thing happens to me in matches. They shouldn't let me play when the score is even"/ "I can feel my heart racing and my hands are not responding well"); and a certain wish to disengage ("I want to finish this test, so I can go home"). Second, anticipatory-positive thoughts were related to the desire to win or the belief in victory ("But since he won each time, he might just get too full of himself and that could be bad for him… we'll see."). Third, retrospective-negative thinking related to loss ("I lost concentration and so I didn't win. I felt that the guy in front of me no longer had any cards and I looked up. That's how I lost my concentration. I got confused with the cards and I couldn't concentrate again"). Lastly, retrospective-positive thinking related to success ("I'm in the final round/ I thought she would win, but I don't know how and why I won"). As to the number of EMUs classified as spontaneous, this category was the most numerous one throughout all trials (Table 1). Yet the percentage of spontaneous thought increased throughout the competition.

Stimulus-independent thoughts.

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In regard to stimulus-independent thinking, these thoughts were mostly directed towards the task settings (“The desk is cold”), other competitors (“Andre, why are you laughing”) and the consequences of the competition (“I wonder if it is true that the winner gets points in the exam”). The limited number of stimulus-independent thoughts lessens our confidence in the results of the comparison among trials. Nonetheless, the results suggest that stimulus-independent thinking is most frequent before and after the competition.

Mindwandering. In regard to mindwandering, the content of these EMUs was remarkably idiosyncratic. The participants thought about both the past (“What was Patrick’s mother doing in the restaurant? I don't understand. And how did it occur to me to talk to her about him? I'm a disaster”) and the future (“This weekend I'll buy my tickets to Paris for Christmas, they’re still cheap but prices will be going up soon”). Yet the content was always unrelated to the task at hand. In regard to frequency, mindwandering was frequent in practice and at the beginning of the competition, but decreased as the competition advanced (Table 1).

Table 1. Comparisons between goal-directed and undirected thoughts in each trial: frequencies, percentages and chi-squared analysis

	N participants			*N*	Goal-directed		Spontaneous		Stimulus-independent		Mind-wandering	
Trial	Playing[a]	L/W [b]	Out [c]	EMUs	*n*	% (row)	*n*	% (row)	*n*	% (row)	*n*	% (row)
Comparison between trials (X^2 = 56.845; p < .001)												
After practice	17	0	0	138	21	15%	66	48%	8	6%	43	31%
After Trial 1	14	3	0	135	30	22%	58	43%	2	1%	45	33%
After Trial 2	11	3	3	94	25	27%	53	56%	2	2%	14	15%
After Trial 3	8	3	6	94	26	28%	52	55%	3	3%	13	14%
After Trial 4	5	3	9	81	24	30%	51	63%	2	2%	4	5%
After Trial 5	0	5	12	35	3	9%	27	77%	2	6%	3	9%

Note. [a] participants still in play register thought prior to performing; [b] participants who lost (L) or won (W) register thoughts after competition; [c] participants who are out do not register thoughts.

Temporal sequences

An exploration of the EMUs that precede or follow a specific thought category (see, Figure 1), revealed that EMUs of one category are often preceded and followed by EMUs of the same category: goal-directed (35%; “I shouldn’t be nervous – I have to calm down”); spontaneous (50%; “This girl will not beat me, I know she won’t – In this concentration task she might have a chance. I don’t know. Maybe yes. Maybe no – The worst thing is to come second – She was first in all the previous trials – I hope she won’t be this time”); stimulus-independent (32%; “Oh! My mobile phone is charging… I think the sound is turned on. – Did the scientist see it? I'm a disaster”); and mindwandering (54%; “I’m lucky not to work today. Just imagine 8 hours on my feet – Yes, but Sunday I won't be able to see the other game because I'll have to work – Well, better Sunday than Saturday, when I play. – I hope I'll play well, because since my injury I haven’t had much luck”).

All categories have EMUs that stand in isolation (as a unique EMU of a temporal sequence), commence a temporal sequence or terminate it. Goal-directed thoughts emerged

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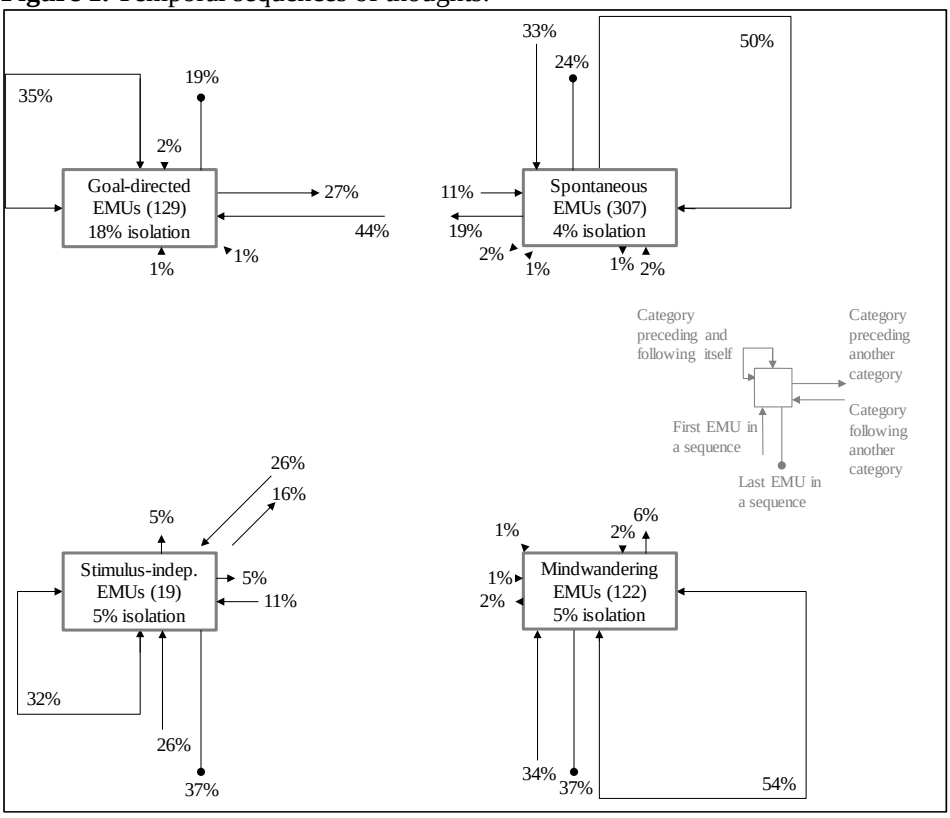
much more often in isolation (18%) than any other undirected thought (4-5%). Similarly, all three types of undirected thought commence a temporal sequence far more frequently (26-34%) than goal-directed thoughts (2%). The difference in percentages of EMUs terminating temporal sequences was less pronounced between thought categories.

Figure 1. Temporal sequences of thoughts.



The strongest link between two different types of thought categories was encountered from spontaneous thinking to goal-directed thinking ("I was very slow – I could try to do it quicker, and if I make a mistake it might not matter. I don't believe they will check for mistakes"). Nonetheless, the link in the opposite direction, from goal-directed to spontaneous thinking, was the second most recurrent bond ("Calm down. Your life isn't at stake here – But it would still be cool to win"). Less powerful links represent thought changes from spontaneous to stimulus-independent thoughts, and vice versa, from stimulus-independent to spontaneous thoughts, from mindwandering to spontaneous and stimulus-independent thoughts, and from stimulus-independent to goal-directed thoughts (for percentages see, Figure 1).

Discussion

In this study we inquired into the functions of goal-directed thoughts and the content of spontaneous and stimulus-independent thoughts and mindwandering, examined the

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proportion of these thoughts before, during and after competition, and explored links between different types of thoughts.

Content and Functions

According to our results, goal-directed thinking serves a variety of functions. Previous studies on self-talk in sport psychology described two main functions of goal-directed thoughts or self-talk: motivational and instructional (e.g., Hardy, 2006). Later on, researchers explored specific motivational functions, such as effort regulation (Theodorakis et al., 2008), psyching-up (Hardy, Hall & Hardy, 2005; Zourbanos et al., 2009), self-efficacy and confidence boosting (Hatzigeorgiadis et al., 2008) and facilitating relaxation (Hardy et al., 2005); and specific instructional functions such as enhancing concentration (Latinjak, Torregrosa, & Renom, 2011), providing feedback (Cutton & Landin, 2007), directing and redirecting focus of attention (Ziegler, 1987), and triggering automatic responses (Theodorakis et al., 2008). Our results support that, to some degree it appears that athletes have their own set of psychological interventions already embedded in their minds: cognitive reappraisal, focus of attention and performance instructions, self-efficacy promotion, and effort and emotion regulation. Yet in the studies in which the effects of both instructional and motivational self-talk on diverse outcome variables have been confirmed, all of them manipulated the athletes' self-talk and thoughts through strategic self-talk interventions (for a review of strategic self-talk procedures see, Zourbanos, Hatzigeorgiadis, Kolovelonis, Latinjak, & Theodorakis, 2016). Hence, there is a dearth of studies in the sport psychology literature (Latinjak, Hatzigeorgiadis et al., 2016) examining the effects of athletes' autonomous attempts to regulate and solve problems through the use of goal-directed self-talk.

Regarding undirected thoughts, our results support a hypothesis presented by Van Raalte et al. (2016) stating that System I self-talk, which is conceptually very similar to spontaneous self-talk, would represent the intuitive cognitive reaction of the athlete to a given situation. After making a mistake, for instance, an athlete might experience uncontrolled and unintentional thoughts such as: *it's my mistake*, *I let everyone down* or *it's over.* On the one hand, these type of thoughts are effortless and do not tend to interfere with other cognitive processes (Lieberman, 2007), yet on the other, these thoughts could reflect a series of psychological states and processes relevant for performance. Anticipatory-negative thoughts could be irrational beliefs (Turner & Barker, 2014) or performance worries typical in sport anxiety (Conroy & Metzler, 2004). Anticipatory-positive thinking could express performance or mastery approaches (Elliot & McGregor, 2001). Lastly, retrospective thinking might

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include attributions of success or failure (Allen, Jones, & Sheffield, 2010). Each of these categories has proven important in sport and, therefore, knowing the content of spontaneous thought could lay important foundations for successful psychological interventions. For instance, re-attributional training has been shown to be effective in changing athletes' original attributions and increasing, thereby, self-efficacy in following tasks (Allen et al., 2010), and rational emotive behaviour therapy (REBT; Ellis, 1957) applied to sport contexts has been shown to substitute irrational beliefs with rational ones (Turner & Barker, 2014).

The content of mindwandering was idiosyncratic. In regard to the frequency of mindwandering, our results suggest that the athlete's mind spends a considerable time wondering in conjunction with the practice context. Other studies on mindwandering in everyday life have claimed that we spend about a third of our waking life mindwandering (Christoff, 2012; Klinger, 2009; Mason et al., 2007). Mindwandering has been described in the literature as a sort of off-line processing of the brain (Peigneux, Schmitz, & Willems, 2007), which occurs in parallel with task-related thought and, thus, could lead to the experience of a frustrating distraction or a sudden insight (Christoff, 2012). Moreover, mindwandering is related to the consolidation and re-consolidation of memory, just the way dreaming is (Smallwood & Schooler, 2006), and therefore, it could be related to the acquisition of skills and experience in sports. To the best of the authors' knowledge, mindwandering has not been explicitly studied in sports. Implicitly, however, irrelevant thoughts have recurrently been related to poor performance (Hatzigeorgiadis & Biddle, 2000), whereas dissociative strategies in which athletes focus on task-unrelated stimuli, have shown to help overcome fatigue and pain (Birrer & Morgan, 2010).

Overall, our results were consistent, first with the general distinction between controlled, rational or operant thoughts and automatic or uncontrolled thoughts (Lieberman, 2007; Schneider & Shiffrin, 1977), and second with the subdivisions of automatic thoughts used by Christoff (2012). In regard to the latter, the data enabled us to describe with considerable detail spontaneous thoughts and mindwandering, but not stimulus-independent thoughts. Since mindwandering and stimulus-independent thoughts both share communalities, as they are both unintentional and unrelated with the ongoing task, it is not surprising that both have been used interchangeably (Mason et al., 2007). Still, the two are conceptually different (Klinger, 2009). Stimulus-independent thought is dissociated from current sensory input, similar to mind wandering (Mason et al., 2007), but it can also occur in the form of complex task-related thought that goes beyond the current sensory information (Gilbert et al., 2006). Moreover, Christoff (2012) herself recognized that because the

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neuroscience research regarding undirected thinking is underdeveloped, there is some terminological fluidity; definitions of different terms vary among different researchers and sometimes even across different publications by the same researchers. To conclude, all three types of undirected thoughts are conceptually different (Christoff, 2012), and different activation patterns associated to them have been reported by neuropsychological studies (Mason et al., 2007), but with regard to metacognitive investigations in sport science, further studies are required to better describe each category and possible overlaps between them.

Changes during the competition

According to our results, thought patterns change from before to after the competition. Specifically, our results show changes from before to during the competition, and changes during the competition. Goal-directed thinking is more frequent during competition than before. Moreover, mindwandering was more frequent in association with practice, with no likelihood of losing, and during the first trial, with few chances of losing; whereas towards the end, with high chances of losing, the frequency of mindwandering diminished. Similarly, a series of studies found that task difficulty was positively related to goal-directed thinking, mostly accessed in the form of private speech (Duncan & Cheyne, 2002; Ferneyhough & Fradley, 2005), whereas mindwandering was found to be more frequent in easy, compared to difficult, tasks (Smallwood, Obonsawin, & Reid, 2003). In regard to the latter, Smallwood and Schooler (2006) have proposed an executive-resource hypothesis, which posits that both goal-directed and undirected thoughts compete for limited executive resources. If greater chances of losing represents greater threat for the athletes and therefore increase competitive anxiety (see, Hammermeister & Burton, 2001), then attention control theory (Eysenck, Derakshan, Santos, & Calvo, 2007) could be another means to explain the results of this study. According to the attention control theory, anxiety increases the extent to which processing is influenced by the stimulus-driven attentional system, which would imply a decrease in task-unrelated processes such as mindwandering.

Temporal sequences

Mindwandering was rarely connected to other types of thinking. These results support the idea of mindwandering as a process that consists of the mind flitting from one unrelated thought to the next with fluidity (Mason et al., 2007). Goal-directed thinking rarely started a temporal sequence, compared to other undirected thought types. These results support the idea that undirected thoughts represent the immediate, emotionally-charged reaction to a situation and that goal-directed thinking is a response to the emotionally-charged and bias-driven intuitive thought processes (Van Raalte et al., 2016). Likewise, the strongest link of

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thought types was found between spontaneous and goal-directed thoughts. Hence, these results stand in agreement with the suggestion that intuitive thought processes, which include spontaneous thinking, occur temporally before rational processes, which include goal-directed thinking (Kahneman, 2011; Van Raalte et al., 2016). Conversely, frequent paths that led from goal-directed to spontaneous thinking indicated that goal-directed thinking might represent reason, although the voice of intuition might talk back.

Methodological considerations

All thought-sampling procedures have limitations, as they rely on conscious awareness and memory (Nisbett & Wilson, 1977). In this study, a written verbal-report protocol was chosen. Verbal protocols have been used repeatedly in sport so as to assess a wide variety of phenomena, such as emotions, decision making and thought processes (Calmeiro & Tenenbaum, 2011). These verbal protocols have been seen as valuable since they allow us to provide insight into athletes' experiences, unbiased by the limitations of retrospective introspection (Van Raalte et al., 2016). When designing this study, we considered audio-taping our participants, similar to immediate recall interviews (McPherson & Kernodle, 2007) or thinking-aloud procedures (Nichols & Polman, 2008). However, we asked the participants to write down their thoughts because, according to Cacioppo and Petty (1981), the written listing procedures are relatively private and non-threatening and can be administered easily in group settings.

Other methodological decisions should also be acknowledged, since they represent potential limitations of this study. The competitive task was designed to elicit experiences similar to those athletes encounter in their sports. Some of the participants' thoughts offer support for this assumption: "I can't stand being nervous; the same thing happens to me in matches". Similarly, the measures taken to emphasize the competitive elements also received indirect support by the participants' statements: the task made participants competed head-to-head ("…I felt that the guy in front of me no longer had any cards and I looked up. That's how I lost my concentration…"), the slowest participant in each trial was eliminated ("Ok, another one is out. Will I be next?"), and the participants eliminated in previous trials remained at the table to watch and support or criticize the other participants ("I feel intimidated by the others who have already been disqualified and who won't stop looking at me"). In spite of all that, the task the participants performed was no sport task.

A final issue deserving consideration is performance. In this study performance was only assessed by the outcomes in the competition. Considering the various studies that have shed light on the relation between performance and goal-directed (e.g., Hatzigeorgiadis et al.,

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2011), spontaneous (e.g., Zourbanos et al., 2015) and task-unrelated thoughts (e.g., Hatzigeorgiadis & Biddle, 2000), future studies should use precise performance measures to inquire into the relationship between these different thought processes and athletes' sport performance.

Conclusions

This study focused on athletes' thoughts in a competitive task. To this end, a connection between neuroscience and sport sciences was established by analysing goal-directed, spontaneous and stimulus-independent thoughts and mindwandering. First, important differences in the content were observed, especially between goal-directed and spontaneous thoughts and mindwandering. Simply put, spontaneous thoughts open up a window into the current state of the athlete. What the athlete thinks has not to be taken literally (e.g., "I want to kill the referee"). The content has to be translated into affective and cognitive processes, such as attributions (e.g., uncontrolled) or emotions (e.g., anger). In regard to goal-directed thinking, athletes self-regulate on various levels: affective ("Don't be angry"), motivational ("Try to have fun") and cognitive ("Focus on the task"). Lastly, mindwandering is idiosyncratic. In a shared context, like a competitive task, goal-directed and spontaneous thoughts connect each athlete to the task and his/her peers, whereas mindwandering singles out each individual as unique; as each life story is.

From an applied perspective, each type of thoughts is relevant for learning and performance. Listening to, and understanding, spontaneous thoughts allows for insight into relevant processes, such as emotions and appraisals and, therefore, may lay the grounds for successful psychological interventions. Goal-directed thoughts are relevant for self-regulation, and self-regulation is relevant for performance. Increasing our understanding of goal-directed thinking allows us to help the athlete develop and empower the coach within, the voice accompanying them throughout their life. Taking into account the frequency of mindwandering reported in this study, a final remark about mindwandering is also in order. According to previous studies (Chrsitoff, 2012; Smallwood & Schooler, 2006), mindwandering can affect performance in several ways: it may distract, dysfunctionally, from task-relevant stimuli, or, functionally, from fatigue and pain; and it could be linked to memory, just as dreaming is. Accordingly, when to interrupt mindwandering, when to leave athletes' minds to wander around, and when and how to teach athletes to use mindwandering in their favour, could be a relevant question in applied sport psychology.

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