The role of dual-task, self-efficacy and sensation seeking in high and low risk climbing sports

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Abstract

High-risk sports are influenced by contextual features and by personality traits such as self-efficacy and sensation seeking. The aim of this study was to investigate if dual-task, self-efficacy and sensation seeking influence sport performance in high and low-risk climbing disciplines. Sixty-nine climbers who practice low-risk (N = 34) and high-risk climbing (N =35) completed questionnaires on generalized self-efficacy and sensation seeking. The subjects carried out respectively the low or the high-risk tasks twice: with and without dual-task demands. The parameters of sport performance were: the total length covered and the number of mistakes. Results showed that climbers with high levels of sensation seeking demonstrated also high levels of self-efficacy, nevertheless, these personality traits do not affect directly the sport performance. Moreover, dual-task condition influences sport performance by worsening it. Results were discussed in light of the interference that concurrent demands may have on sport performance.

1. Introduction

The concept of risky sport has been defined by Breivik as a sport in which participants accept the possibility of injury or death as intrinsically characteristic of the activity (Breivik, 1995). Therefore, sports such as skydiving, alpine skiing, snowboarding, mountaineering and rock climbing, can be considered high-risk sports since they are characterized by the presence of dangerous elements, for instance high speed (Shealy, Ettlinger, & Johnson, 2005).

The implementation of risky behaviour could be associated with sensation seeking that is a personality trait characterized by tendencies to undertake novel and intense experiences, to pursue feelings and sensations, with the availability of taking risks for the pleasure of such an experience (Zuckerman, 1994). Several studies have shown that subjects who perform high-risk sports have higher levels of sensation seeking than those who perform low-risk ones (Baretta, Greco, & Steca, 2017; Jack & Ronan, 1998; Freixanet, 1991). Moreover, when there is the guarantee of maintaining high levels of excitement, athletes are willing to undertake different activities; for example, Franken (1998) showed that expert mountaineers have a greater predisposition to try risky climbs despite non-expert ones.

In high-risk sports, several studies have shown that participants have high levels of self-efficacy (Bandura, 1997) that is the individual's belief in their own ability to organize and execute the course of action required to produce certain results (Brody, Hatfield & Spalding, 1988). Llewellyn and Sanchez (2008) have shown how climbers with high levels of self-efficacy are more likely to take risks than those with low levels of self-efficacy; furthermore, the results of Baretta, Greco and Steca (2017) demonstrated that sensation seeking and self-efficacy represent predictors of the performance in other sports like the high-risk free-diving discipline.

Moreover, the level of expertise can be a predictor of sport performance. It is known that systematic and regular participation in exercise enhances sport performance (Billat, 2001). Savelsbergh, Cañal-Bruland,

and van der Kamp (2012) examined the benefits of months of sport practice on the reduction of the number of errors; in particular the authors demonstrated that the increase in duration, intensity and structure of training played a major role in improving performance.

So far, we have seen individual factors that can affect sport performance. Other factors can be related to contextual features.

With respect to contextual features, athletes need to respond efficiently to different environmental stimuli, and in time, well-learned motor skills exploit a lesser amount of cognitive load leaving resources available to process external stimuli (Abernethy et al., 2007; Beilock, Wierenga, & Carr, 2002). Contextual features can be manipulated through the dual-task paradigm. The dual-task paradigm involves a primary task (sport related) and a secondary task (e.g., focusing attention and memorizing items in a cognitive task). Dual-task demands are very common in sport, and the literature demonstrates the interference of a secondary task on performance due to the limitation of cognitive resources (Kahneman, 1973; Fabio & Towey, in press). In fact, the secondary task causes a greater effort in terms of cognitive load and attentional resources related to working memory (WM) and, consequently, may affect the performance in the primary task (Beilock, Wierenga, et al., 2002; Fabio & Towey, in press).

To analyse the role of cognitive load in this study the dual-task paradigm was used. In sport performance a double activity can be useful to verify the levels of the reached performance automatization. Beilock, Carr et al. (2002) examined the effects of interference in dual-task paradigm on soccer players. The authors evaluated the differences in a group of experts and beginners during a dribbling task while simultaneously performing an auditory control task; the results demonstrated higher levels of interference for the beginners, while expert performance was damaged only when using the non-dominant foot (Beilock, Carr, et al. 2002).

In recent years, despite the high prevalence of injuries, high-risk sports such as rock climbing, became more popular (Langseth & Salvesen; 2018; Jones, Asghar & Llewellyn, 2008; Pain & Pain, 2005). All the factors here analysed can be important in climbing sports; as well as other sport disciplines, rock climbing presents physical and psychological effort (Saul, Steinmetz, Lehmann & Schilling, 2019). Practitioners are required to face continuous choices (e.g., choosing the footholds and supports to use), need great planning skills, and have to manage the feelings that may arise (e.g., the fear of flying, the desire to give up, etc.). Different types of climbing can present different degrees of risk: a) in the "roped-party leader" climb, subjects are secured by the second roped-party through specific safety measures. Anchorage points are used during the climb, and the rope is needed reduce the weight in case of a fall. The climbers who perform this type of climb, in case of mistakes can "fly" 2–8 meters, going against injuries such as spraining an ankle or breaking a leg (Martha, Sanchez & Goma`i-Freixanet, 2008; Hohlrieder, Lutz, Schubert, Eschertzhuber, & Mair, 2007). This type of climb is considered as a "high-risk activity"; b) in the "Top rope", as “a second” or “*moulinette*”, the rope is positioned previously from the roped-party leader, which secures it from above. The subjects are secured with the top rope system by

using a Gri-gri, that is a self-locking delay device. This type of climb is less risky than the first and is often used by beginners.

According to the previous results regarding risk-taking in extreme sports, the role played by self-efficacy and by contextual features, the present study has investigated these factors in sport performance. More in detail, three hypotheses were suggested: a) by considering that self-efficacy influences sport performance in different disciplines, it is assumed that even in climbing, self-efficacy determines the performance of the subjects, both in low-risk and high-risk tasks; b) considering that climbing as a roped-party leader is characterized by greater risks, it is expected that sensation seeking influences performance in the high-risk discipline but not in the low-risk one; c) with reference to the contextual features, in this study the dual-task was used. Since cognitive resources are engaged for the performance of the secondary task it is hypothesized that the presence of interference worsens performance for both groups.

2. Method

2.1. Participants

Participants are climbers (n = 67; average age, M = 27.37; DS = 7.54). The athletes who climbed as “roped-party leader” (n = 35, 26 men and 9 women), are categorized as “high-risk group”; while the remaining ones, id est those who climbed as *moulinette*, are categorized as “low-risk group” (n = 34; 18 men and 16 women). Table 1 reports the characteristics of the participants.

Table 1 Characteristics of the two groups participating in the experiment

Group	Measures	Value
High-Risk	n, boys/girls	26/9
	Age, M (SD)	28.41(6.01)
	M. practice, M (SD)	73.17 (50.22)
Low-Risk	n, boys/girls	18/16
	Age, M (SD)	26.30(8.81)
	M practice, M (SD)	18.69 (20,16)

The Human Ethics Committee of the of Cognitive Sciences, Psychology, Education and Cultural Studies, approved the study protocol; all participants volunteered willingly (without remuneration) in the research after being informed that the study was an investigation of the role of contextual features, self-efficacy and sensation seeking in high and low-risk climbing sport, therefore they gave a written consent. After

explaining the procedure, the two groups completed a series of tests administrated individually in isolated areas.

2.2.1 Instruments

The administered questionnaires were: a) The Italian version of the Brief Sensation Seeking Scale (BSSS; Primi, Narducci, Benedetti, Donati, & Chiesi, 2011). The scale evaluates the dimensions of Boredom Susceptibility (BS), Thrill and Adventure Seeking (TAS), Disinhibition (DIS) and Experience Seeking (ES). The BSSS is a reduction of Zuckerman's Sensation Seeking Scale (SSS-V; Zuckerman, Eysenck, & Eysenck, 1978) and it is composed of 8 items with 5-point likert scale response. The test has a good internal consistency; the reliability index through the Cronbach alpha is .73 (95% C.I.=.70-.75). b) The Italian version of the General Self-Efficacy Scale (Sibilia, Schwarzer, & Jerusalem,1995), that is composed of 10 items designed to evaluate positive self-beliefs, and how the subject addresses a series of difficult requests that may arise in everyday life. Differently from other scales that evaluate self-efficacy, this test refers specially to personal action, in particular to the belief that one's actions are the cause of the positive results that the subject can obtain. The Cronbach alpha is .76 (95% C.I.=.76-.90). c) A brief demographic interview, that required: age, number of months of practise, usual types of climb: "roped-party leader" or "*moulinette*".

2.2.2 Experimental set-up and tasks

The sport performance was evaluated by asking each participant to climb outdoor the previously selected climbing route. The route was classified by a universal scale, the IRCRA scale, (Draper et al., 2015) for the conversion of local/national climbing grades to a uniform/standardised number system for statistical analysis, (IRCRA 10; 14.42 mt.).

With reference to the contextual features, each participant took part in two different conditions: single-task and dual-task conditions. In the first of these, participants were asked to climb the route above and no dual-task was requested. In the second condition, the same sport task was simultaneously associated with an auditory monitoring task; the participants were previously informed that during the climb they would listen to an audio recording (presented trough headphones) in which they had to identify specific words (ball – white) and report how many times they were repeated in the same recording.

In both conditions the sport performance was evaluated through two parameters: a) length covered in the track (obtained dividing the time spent for the climb by the meters climbed), and b) accuracy, measured by the number of mistakes (slides and resting). In the dual-task condition, the added parameter was referred to the number of correct words that were identified in the secondary task.

2.3 Procedure

A brief interview was administered to assign the participants to the different groups. Subjects filled out the demographic information and gave the specific data that was required, such as: age, number of months of practise and their usual types of climbs: "roped-party leader" or "*moulinette*". The personality

questionnaire administration followed in a quiet area near the climbing site. After this evaluation participants were informed that they would be completing different sport-skill tasks.

Each participant was asked to climb the previously selected climbing route (the same for all the subjects involved); nevertheless, it should to be noted that not all participants were able to climb 14.42 meters, some of them stopped before the top. Two independent observers followed the performance by timing the subject during the climb and scoring the committed mistakes (eg. slides or resting). The concordance rate between two observers was 95%, any disagreement was verbally discussed. In the dual-task condition, auditory activity began at the same time that the subjects started to climb and stopped when the sport task ended. In this task, the participants listened to a recording in which random words were repeated, and had to identify the presence of two different targets, that is two words among a series of distractors.

2.4 Statistical Analysis

The data analysis was completed using the IBM SPSS Statistics, Version 24.0.

Repeated-measures ANOVAs were performed, assigning groups as independent variables and each of the measured parameters as dependent variables. Since two subjects did not attend the secondary task, they were excluded from the analysis.

Pearson's correlation test was used to assess the association between cognitive load, personality factors and sport performance. The *alpha* level was set to $p < .05$ for all statistical tests. In case of significant effects, the effect size of the test was reported. The effect sizes were computed and categorized according to Cohen (1988).

3. Results

The first part of the results refers to the differences in the sport performance by all groups, that is: the covered length of the track and accuracy (in terms of the number of mistakes). A preliminary analysis was conducted in order to verify the attention to the secondary task. All participants that correctly execute the auditory monitoring task (they had to identify, at least 85%, how many times the specific words, ball and white, appear) were included in the analysis.

Repeated-measures ANOVA 2 (groups: high-risk vs low-risk) X 2 (conditions: single-task vs dual-task) was performed, with Groups as a between-subjects factor and Conditions as a within-subjects factor. Table 2 shows means and standard deviations of the sport performance.

Table 2 Means and standard deviations referred to the sport performance for the two groups

	High risk (n = 35)		Low risk(n = 34)	
	M	DS	M	DS
Total length covered				
Single-task	14.18	1.37	12.19	3.41
Dual-Task	13.94	1.94	12.00	3.65
Number of mistakes				
Single- task	.23	.5	.64	.65
Dual -Task	.12	.41	.45	.67

Concerning the covered length of the track, Groups show a significant effect, $F(1, 65) = 9.92$, $p < .002$, $d = .85$, while no significant effect emerges for Conditions. This means that high-risk group (experts) covered a longer length than low-risk group, however the dual-task does not influence performance.

With reference to the accuracy, groups showed significant effect, $F(1, 65) = 11.74$, $p < 0.001$, $d = .90$. This means that there is a difference between the two groups with a higher number of mistakes for the low-risk group. With reference to condition factor, results showed significant effects, $F(1, 65) = 3.27$, $p < 0.5$, $d = .65$, this means that the cognitive load affected the accuracy of the performance. In summary, results demonstrate that cognitive load affects only the accuracy but not the covered length.

The second part of the results refers to correlations between individual factors (sensation seeking and self-efficacy) and sport performance (number of mistakes and the total length covered). With reference to the high-risk group (experts), the correlations demonstrate a positive association between sensation seeking and self-efficacy ($r = .47$, $p = .005$).

With reference to the low-risk group, a different pattern emerges; in particular, there is an overall absence of correlations between personality parameters and performance, while a positive association emerged between the number of mistakes and the total length covered ($r = .48$, $p < .005$). This result may be due to the lower level of risk taking which may influence the relationship between accuracy and covered length, causing a drop down in execution during the task.

4. Discussion

The purpose of the present study was to investigate the influence of cognitive load, self-efficacy and sensation seeking on climbing performance. We used two different groups exposed to different conditions: with and without dual-task. In line with the hypothesis the findings showed that the accuracy of the performance is affected by the interference of the dual-task. Similar studies have been conducted in different sport environments (Beilock, Carr, et al. 2002; Fabio & Towey, in press) and this result is in line with the findings in other sport fields. Leavitt (1979), Beilock, Carr, et al. (2002), Fabio and Towey (in press), examined the effects of cognitive load (e.g. discrimination task and auditory monitoring

task) while participants performing skilled sport related tasks. Fabio and Towey (in press) demonstrated interfering effects that varied in accordance to the difficulty of the secondary task and the amount of cognitive load.

In the present study we found that subjects that belong to high and low-risk groups show differences in the climbing performance. In particular, results demonstrate a better performance for the high-risk group, as indicated by the higher length that was covered on the track and the lower number of mistakes. This result is in line with previous research that find this effect (Baretta, Greco & Steca, 2017).

With reference to the individual factors no correlation was found between the personality factors (sensation seeking and self-efficacy) and the sport performance (neither with the length nor with the accuracy). This absence of correlation in both groups (with high and low-risk) is not in line with previous studies that showed a positive correlation between self-efficacy and performance (Moritz, Feltz, Fahrbach, & Mack, 2000) and provided evidence that self-efficacy is a significant predictor of sport performance (Bandura, 1997; Fabio & Towey, 2018a; 2018b; Feltz, Short, & Sullivan, 2008). The different results may be due to the type of control group that previous research used. Most of the studies compared subjects who practice high-risk sports with a control group not involved in any activity (e.g. Freixanet, 1991; Goma` -i-Freixanet, 1991). The explanation may be related to the fact that high and low-risk groups do not differ with reference to individual factors. May be that both athletes (high and low-risk groups) that choose the climbing activity are much more inclined to risk-taking than a control group not involved in any risk activity, but they do not differ between themselves. Thus, while differences emerge between high and low-risk in terms of sport performance, the absence of a relationship with the individual factors could be explained by the homogeneity of these within the groups.

When considering the correlation between sensation seeking and self-efficacy, the high-risk group shows a positive association between the two parameters. Similar results were found in Llewellyn and Sanchez (2008) and Llewellyn, Sanchez, Sanchez and Jones (2008) studies, in which the authors demonstrated an association between high levels of self-efficacy and risk taking in climbing performance. In fact, authors affirm that climbers who feel confident in their abilities, that is high in self-efficacy, take greater calculated risks and attempt harder climbs.

5. Conclusion

The main aim of the present research was to investigate the influence of cognitive load, self-efficacy and sensation seeking on climbing performance. Previous studies have analyzed the factors that underlie the participation in risky sports (Jack & Ronan, 1998; Freixanet, 1991) and the elements that influence performance (Savelsbergh, Cañal-Bruland, & van der Kamp, 2012) in different levels of risk (Baretta, Greco & Steca, 2017). For this purpose, the present research aimed to determine the variables that may affect performance in risky sports (Jones, Asghar, & Llewellyn, 2007). The main result is related to the importance of cognitive load on the accuracy of performance.

Even though the current research focused on such a specific risky sport, it provided some interesting insights that deserve to be tested in other contexts.

Some limitations of the study should be noted. One of these is the dimension of the sample, so it is wise to adopt some caution in generalizing the present findings; future research should address this limitation by increasing the number of participants. Another limit of the study refers to the sampling method, in particular the role of gender differences between the two groups (high and low-risk). Indeed, in the present study there may be significantly more boys than girls in the high-risk group than in the low-risk group; it is known that gender differences may influence both sensation seeking and self-efficacy (Cross, Cyrenne, & Brown, 2013). For example, men may have scored higher than women in self-efficacy, because they take greater risks due to the stronger beliefs in their capability to manage the risks in the climb; future research should balance the number of females and males in two groups. To study the risk factor, it would be important to plan more control groups: high, low and no-risk. Furthermore, the explanation of the climbing performance obviously involves further factors beyond those investigated by the present study. Therefore, it would be interesting to study other variables such as stress, planning, attention, coordinative components, strength and resistance in relationship with the respective self-efficacy beliefs. Finally, further research is required to verify the generalizability of current results and extend the analysis to other risky and competitive sports (e.g., alpine skiing or motocross races).

Declarations

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Credit authorship contribution statement:

Giulia Emma Towey: Conceptualization, Data curation, formal analysis. **Federica Andricciola:** conceptualization, Investigation, Writing. **Rosa Angela Fabio:** Methodology, Writing – Reviewing

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