

Checklist of psychological variables involved in climbing. Operationalizing expert's knowledge

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Abstract

In climbing both technical and physical skills have proven to be highly demanding and plenty of research has been done to prove so, but, coaches and climbers claim that psychological factors play a determining role and are key for high performance. It becomes necessary to develop new strategies to established empiric or theoretical base to support psychology to be applied to climbing. The aim of this study was to identify psychological variables needed to improve and excel as a climber and to operationalize implicit expert knowledge. To this end, using a mixed quantitative-qualitative method, four Spanish high-level coaches were interviewed and participated in a three-round focus group. Results found were organized and grouped according to the model of psychological dimensions proposed by Sánchez & Torregrosa in order to create an assessment tool that provides coaches information about climber's mental skills follow up. The final result was the creation of a Mobile APP checklist of psychological variables involved in climbing that can provide real time performance information, share individual climber's follow-up and comparison with other climbers. Future lines of research were proposed for the improvement of assessment tools for psychological skills in climbing that can help coaches and trainers to record, enhance and predict performance.

Keywords: climbing, mental skills, performance parameters, assessment tool, coaches.

1. Introduction

The spread of climbing practices has not ceased to increase over the last years (AAC, 2019; IFSC, 2021; Sheel, 2004). It also offers multiple options and possibilities both according to people's different abilities to climb (climbing rating systems allow climbers to know the route difficulty), location (indoors, rock climbing), competitive climbing (speed, lead, bouldering) or styles (onsight, flash, redpoint). In the past decades, climbing has become a highly professionalized sport, improving technical demands and physical needs necessary to stand out as a high performer athlete (Aubel & Ohl, 2004; Garrido-Palomino & España Romero, 2019; Monasterio & Brymer, 2021; Pociello, 1995; Sanchez et al., 2019; Serhii et al., 2020). The development of this sports modality has drawn increasing scientific interest (Holzschuh, 2016; Mermier et al., 2000; Watts et al., 2021).

It is known that climbing is both physically and psychologically demanding (Giles, Rhodes, & Taunton, 2006; Lee & Ewert, 2019; Monasterio & Brymer, 2021; Saul et al., 2019). Lines of research have been directed to address the physiological demands of this activity and the characteristics and parameters required for climbers from a physiological and anthropometric point of view.

Therefore, numbers of research studies have been published dealing with the variables and factors that influence climber's performance (Feldmann et al., 2021; Fryer et al., 2018; Fuss et al., 2020; Giles et al., 2006; Grant et al., 2001; MacKenzie et al., 2020; Macleod et al., 2007; Mermier et al., 2000; Rokowski et al., 2021; Seifert et al., 2020; Stien et al., 2021; Watts, 2004). However, there have been just less studies that focus on the importance of psychological factors during climbing, and even less which have been focused on the impact of psychological factors on climber's performance (Byrne & Mueller, 2014; Fanchini et al., 2013; Feher, Meyers, & Skelly, 1998; Garrido-Palomino & España Romero, 2019; Llewellyn & Sanchez, 2008; Magiera et al., 2013; Monasterio & Brymer, 2021; Sanchez et al., 2019; Saul et al., 2019; Zuckerman, 1983), and, how can these be assessed (Draper et al., 2011; Garrido-Palomino et al., 2020; Grushko & Leonov, 2014; Lee & Ewert, 2019; Montalbetti & Chamarro, 2010; Ordás, Hernández, & Sánchez, 2011; Oyague, Luser, & Cercos, 2005; Portela et al., 2013; Sánchez & Torregrossa, 2005; Santolaya, Rubio, & Barquín, 2019; Serhii et al., 2020).

Several years ago, Sánchez and Torregrossa (2005) developed the model of "psychological factors involved in sport climbing". According to this model, there are three main psychological dimensions involved in climbing:

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Basic processes to capture and process information, motivational aspects, and emotional mechanisms. Initially the aim of our study was to prove the model by interviewing coaches with vast experience in both, climbing and training, gather information about psychological variables needed to become a skilled climber, their impact in performance and talent detection. Growing in parallel, as a result of the experts focus groups (based on a mixed quantitative-qualitative methodology), knowledge detected was transformed and grouped into psychological variables and new contributions were made to the model. Final result was the design of a Mobile APP checklist of psychological variables involved in climbing which can be used by coaches a) to identify the psychological demands of their athletes through the different training and development processes and b) to tailored mental skills improvement programs in climbing. The design of this instrument could represent a break with the trend of psychological evaluation based on generic tests for multiple sports, allowing a more adjusted evaluation, and consequently, a later design of the more specific intervention.

2. Method

2.1 Participants

Four male climbing expert coaches with ages between 44 and 57 years and more than 20 years of experience participated in the study. The selection criteria for experts implied meeting a series of requisites: 1) holding the Climbing Sport official credentials and titles with more than five years of experience in training climbers. 2) having carried out longitudinal follow-ups of groups of students during more than 5 years of training. 3) having more than five years of experience in competitions either as a sport practitioner or trainer. 4) Having a degree in climbing at least "7a onsight", as per the French grading system of difficulty. Additionally, all of them were authors of several climbing manuals, coaching trainers in Spanish Federation, one was a national climbing referee and expert in mid-mountaineering and three of them held the title of mountain guide issued by the International Union of High Mountain Guide Associations (UIAGM), which is the highest title grade recognized by the Spanish Ministry of Education and Culture.

The sample inclusion criteria correspond to a fundamental criterion: a high or maximum level of "expertise" of the experts (Ericsson, Prietula, & Cokely, 2007; Lorenzo Calvo, 2000; Lorenzo Calvo et al., 2013; Ruíz, 2015). Although it is already considered that the number of experts in a very minority sport is very small, we dealt with four experts with the highest level of training as climbing sports technicians,

performance level of the athletes they train, and years of experience with climbers at the highest level. The criteria selected are compatible with the requirements of techniques based on focus groups and expert validation (Francés García, 2016; León & Montero, 2020).

2.2 Material

An "ad hoc" online questionnaire consisting of a total of 19 items referring psychological general abilities for sports and those likely to be important for climbing was used. The questionnaire was developed for participants to reply online on a five-point Likert scale and a free space for suggestions. A semi-structured script was prepared with the results of the questionnaire to conduct the expert focus group. Several PowerPoint presentations with the objectives of the research was prepared for the focus group. Meetings were audio-visually registered and notes were taken both in paper and computer support.

3. Procedure

Due to the scarce bibliography with respect to psychological variables in climbing performance a mixed qualitative-quantitative methodology was selected, using the expert judgment technique as a way to extract knowledge from a group of climbing experts. Mixed methods (León & Montero, 2020; Montero & León, 2007) are a widely recommended methodology, especially (among other situations) for tackling a new subject or conducting a novel investigation in a specific field with little previous research. The reason to use this method is its usefulness to research areas of knowledge where investigation is still scarce. Therefore, it presents itself as a rigorous option scientifically sound (Glaser & Strauss, 1967; Strauss & Corbin, 1990) and allows for a greater comprehension of the object under (Creswell, 2009, 2014) and them "represent the highest grade of integration or combination between qualitative and quantitative methods" (Hernández, Fernández, & Baptista, 2003).

To combine both methods during the investigation a strategy of sequencing was followed where qualitative and quantitative techniques can be combined at different stages during the research process (Flick, 2014). Making use of the possibilities offered by mixed methods (Onwuegbuzie & Leech, 2006), the quantitative method was only required during the first phase of the research. The remaining phases were developed using expert group judgments. Qualitative studies provide a series of benefits which include flexibility at the time of designing the research (Erlandson et al., 1993; Glaser, 1992), in this sense hypothesis can be formulated and developed before, during and after the access and analysis of data (Vallés, 1997). The focus group or discussion group technique (Francés García, 2016) is configured as a

technique to collect the maximum level of information from a series of experts in a very specific area (between 3 and 10 approximately). This technique allows the determination of the areas and contents to be evaluated in the design of the instrument to be used later. This way, throughout the investigation it was the analysis of data obtained by the focus group what permitted the design to grow in parallel with findings and results. Therefore, the "qualitative" part is was the generation of the factors and content areas to be assessed in the quantitative test that was designed a posteriori.

The procedure established 6 phases in line with the proposal from Pérez and Carretero-Dios (2005). Three meetings were held with the experts of approximately 2 to 3 hours each, with a space of 3 weeks between each session to transcribe the recordings and formalize the results. At the beginning of each meeting, a presentation of the objectives to be discussed was made, a summary of the topics covered in the previous sessions was presented and the results obtained from the information gathered in each of the sessions were shown.

First phase: Contact with experts, informed consent and online questionnaire. When dealing with laymen in psychology, a problem found is that they do not label in the same way or share the same definitions as psychologists do. Therefore, as a previous step to extract expert knowledge, an "ad hoc" 19 items online questionnaire referring psychological general abilities for sport was carried out to homogenize terminology. Individual results from the online questionnaire stand out those psychological aspects highlighted by the expert coaches and helped to create a semi-structured script used to conduct the first meeting with the focus group.

Second phase: Based on a Grounded Theory methodology, a focus group with expert coaches took place to answer the question on which are the psychological factors involved in climbing, their impact and how important they can be to improve performance. For the focus group a presentation was made available with the objectives of the research and clarification of the psychological concepts to be discussed during meetings. At the meeting the themes versed around trying to identify which basic psychological variables are common and necessary to become a good climber, their importance on sport performance and their impact on detection of young talents. There for, as a way of knowing the psychological qualities that a coach looks at when evaluating climbers (especially when detecting young talents) focus was on the practice of climbing sports without specifying competitive climbing (boulder, speed, lead) or style (onsight, flash, redpoint) attending to as a competitive sport and not only recreational. To facilitate the above a semi-structured script was prepared presenting

the key points to be discussed during the meeting in an open-ended question format that allowed for a wide range of replies given by the experts. The fact of making open questions to build dialogue (inductive process) had the objective of approaching the issues based on information obtained from experts, as the means to reach a theory (Grounded Theory) and develop new valid concepts to explain climber's behavior.

Third phase: Transcription and codification of the knowledge obtained from the focus group. With all the information gathered, expert knowledge was analyzed, grouped into three predetermined dimensions (deductive procedure) and transformed into psychological variables. Corroboration and new contributions to the model of psychological dimensions proposed by Sánchez and Torregrossa (2005).

Fourth phase: Second meeting with participants. Results from the focus group were presented in a checklist (18 items) format in order to know the content validity. Through expert judgment, the items to be included in the *climbing inventory mental and behavior characteristics* (C.L.I.M.B.) were individually assessed. A new meeting was convened for each expert to carry out individually the evaluation of C.L.I.M.B. Each item was evaluated using a 10-point Likert scale in relation to its degree of alignment with the object of the study (Martínez-Abellán et al., 2016; Toro et al., 2008; Wiersma, 2001), therefore, their degree of belonging to the checklist (quantitative assessment) as well as the degree of precision and comprehension in its definition (1 not understood to 10 well understood) and syntactic formulation (qualitative assessment). Each item was accompanied by examples as a result of the information gathered in the focal group and a glossary of terms was provided with definitions of the proposed variables. For each item an alternative drafting was provided so that the expert could consider rephrasing the item if necessary. The evaluation criteria of the content validity (Bulger & Housner, 2007) contemplated that all those variables punctuated below 7 were to be discarded. Those between 7 and 8 could be reformulated for a better understanding and subsequent re-evaluation. Psychological variables above 8 were considered approved and therefore not subject to modifications.

Fifth phase: After individual evaluation of replies by experts to the revised checklist, results were made subject to group discussion. Opportunity to add or modify their replies was given but no expert considered it necessary. The final result was the creation of the definite C.L.I.M.B.

Sixth phase: A third meeting with the expert group was convened to present the definitive C.L.I.M.B. and instruct it's use and application. At last instance experts were required to perform a global evaluation (usefulness, applicability) results

were discussed and conclusions reached. The participation in the work of the expert group was voluntary, and no economic or similar incentive was implemented. Given the existence of multiple evaluation phases during the process, it was reported that all those experts who for different reasons wanted to abandon participation in the study could do so at any time. Likewise, the most absolute confidentiality of the data obtained was guaranteed.

4. Results

Coaches usually claim that psychological variables are key to become an expert climber. Once you have mastered the technical aspect of the sport and maintain a competitive physical base, it is the mental abilities that make the difference both in performance and the need to excel. However, coach's

estimations about the psychological faculties of climbers are mainly based on implicit knowledge and the attributions they can make of their pupils to predict sports performance. The results obtained after the experts focus group meetings have been organized according to the procedures used to extract the information.

Questionnaire of General psychological skills for sport

The results obtained from the online questionnaire show the psychological variables highlighted by the experts. Of the 19 variables presented (and an optional open question to include suggestions), 11 were considered important for climbing performance. The selection criterion was that at least two experts gave the variable a score equal to or greater than 4 on a 5-point Likert scale. The highlighted variables are shown in [Table 1](#).

Table 1

Results of the online questionnaire of general psychological skills for sport

Highlighted variables by the experts

1. Imagination 2. Response time 3. Decision making 4. Sustained attention
5. Self-control 6. Attention 7. Self-regulation 8. Frustration tolerance
9. Self-confidence 10. Learning ability 11. Achievement motivation

Note: 19 items were presented To be selected at least two experts needed to give the item a score equal to or higher than 4 in a 5-point Likert scale. The final result was 11 variables that were used to generate a semi-structured script for the focus groups.

Table 2

Frequency table of the online questionnaire of general psychological skills for sport

Ítems	Expert 1	Expert 2	Expert 3	Expert 4	M item	SD item
i1	1.00	4.00	5.00	2.00	3.00	1.83
i2	5.00	2.00	4.00	4.00	3.75	1.26
i3	4.00	3.00	4.00	4.00	3.75	.500
i4	5.00	3.00	3.00	5.00	4.00	1.16
i5	5.00	4.00	5.00	4.00	4.50	.58
i6	5.00	5.00	4.00	5.00	4.75	.500
i7	5.00	5.00	5.00	5.00	5.00	.000
i8	4.00	5.00	5.00	4.00	4.50	.58
i9	5.00	5.00	4.00	4.00	4.50	.58
i10	5.00	4.00	4.00	3.00	4.00	.82
i11	5.00	5.00	4.00	3.00	4.25	.96
i12	5.00	4.00	3.00	3.00	3.75	.96
i13	4.00	5.00	5.00	4.00	4.50	.58
i14	1.00	3.00	3.00	2.00	2.25	.96
i15	3.00	2.00	3.00	2.00	2.50	.58
i16	4.00	2.00	4.00	5.00	3.75	1.26
i17	5.00	5.00	5.00	5.00	5.00	.00
i18	4.00	2.00	4.00	4.00	3.50	1.00
i19	4.00	4.00	5.00	4.00	4.25	.50
M exp.	4.17	3.78	4.11	3.78		
SD exp.	1.29	1.22	.76	1.06		

Note: The table shows the ratings given by each expert to each of the items of the online questionnaire of general psychological skills for sport as well as the mean and standard deviation of each item.

Only one expert made a suggestion: "Ability to perceive the real possibilities of our actions according to the difficulty of the tasks." Subsequently, reference was made to the suggestion given in the first meeting with the focus group and after reaching consensus with the rest of the experts, the variable Self-efficacy was stated. The results obtained from the online questionnaire were used for the elaboration of the semi-structured script used during the first meeting with the focus group, being able to mention the variables as a suggestion if necessary.

Contents of the checklist, its dimensions and items.

After the first meeting with the focus group, the knowledge obtained from the experts was analyzed and reformulated

in the format of psychological variables adapted for its understanding within the sport of climbing. The variables were classified according to their belonging to each of the three preset dimensions according to the model proposed by Sánchez and Torregrossa (2005). As a result of information provided by coaches, we highlight the coincidence of the results obtained in the focus groups with the model developed by Sánchez and Torregrossa (2005) and we bring new data that can add consistency to findings. Clusters resulting for each dimension are shown below (Figure 1). The variables marked in bold are new contributions to the model.

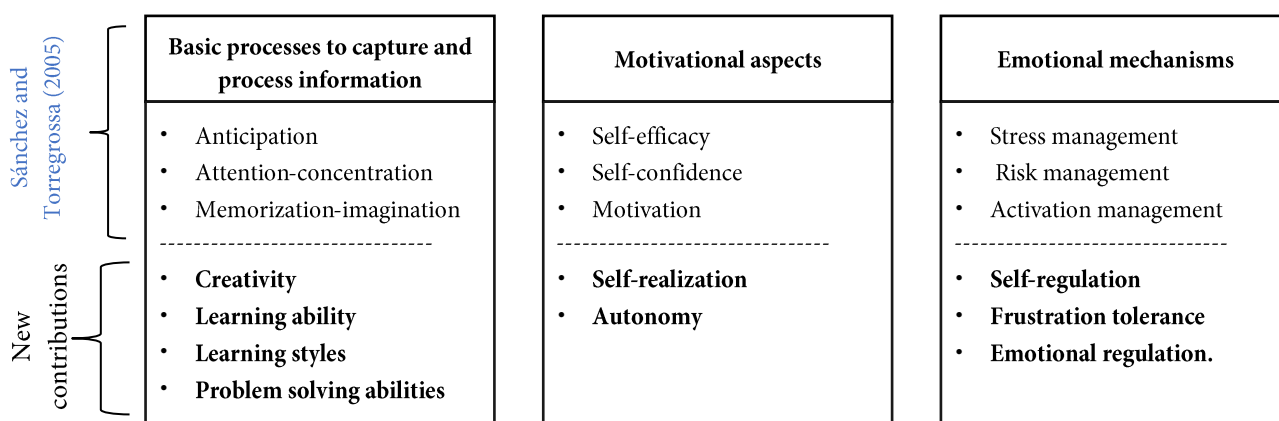


Figure 1. Grouping of psychological variables

Note: New contributions to Sánchez & Torregrossa's (2005) model of psychological variables involved in climbing are shown in bold. As a result of the focus groups each variable was then transformed into a checklist item.

Discussion of results with experts.

As a result of the information obtained from the experts, a total of 19 psychological variables were presented in item format for evaluation. Considering the pre-established content validity criterion, no item was discarded from the list as it did not have a lower score of 7 out of 10 (Bulger & Housner, 2007). After the individual assessment of the relevance of each item and the comprehensibility of the

wording, none of the four experts offered an alternative proposal, considering the wording of the items to be correct and comprehensible. It is worth noting the score of 8 points given by three of the four experts to item15. *Item15: Arousal Management: The climber is able to regulate and adapt his activation level appropriately to the difficulty / novelty of the route and the circumstances that arise. Example: "Get regulated; it is activated enough but it controls the desire to surpass itself and to surpass the others".*

<p>1. Anticipation: By reading the route, the climber is able to anticipate and prepare movements, manage the effort and anticipate the action. Example: "Manages the center of gravity anticipating the circumstances of the climb". Not relevant 1 2 3 4 5 6 7 8 9 10 Very relevant Not understood 1 2 3 4 5 6 7 8 9 10 Well understood Alternative writing:</p> <p>2. Memorization and Imagination: As the climber memorizes the route, he is able to imagine the difficulty of movements / holds and energy management. Example: "Immediately he is able to visualize and memorize the route." Not relevant 1 2 3 4 5 6 7 8 9 10 Very relevant Not understood 1 2 3 4 5 6 7 8 9 10 Well understood Alternative writing:</p>

Figure 2. Example of valued items by experts

Note: Example of the evaluation system used by each expert to individually assess the relevance and comprehensibility of each of the 19 items on the checklist.

	Basic processes to capture and process information
Anticipation	Those responses that occur prior to the appearance of the main stimulus.
	Motivational aspects
Self-effectivene	The perception that a person has about their ability to successfully perform a task.
	Emotional mechanisms
Stress Control	Stress occurs when there is an imbalance between what the person perceives to be their abilities and what the environment demands of them

Figure 3. Example of glossary of terms

Note: Example of the glossary of terms provided to the experts to assist in the evaluation of each item.

When individually asking the three experts who had assigned this score, they all agreed on the difficulty of understanding the term Arousal. In the words of one of the experts "If I have to read something twice, it's because it's hard to understand". Once the results had been analyzed individually, the scores obtained and the possible modifications were discussed as a group. By unanimous decision, it was decided to modify the term

Arousal by Activation in item15. It should be noted that the term "Activation management" coincides with the one formulated in the same way by [Sánchez and Torregrossa \(2005\)](#). Regarding this study, the terms imagery was also replaced by imagination and (re) concentration by concentration. The result of the individual evaluations of the experts can be seen in the [Table 3](#).

Table 3

Result of the content validity assessment

• N°	Ítems	Expert 1		Expert 2		Expert 3		Expert 4	
		R	C	R	C	R	C	R	C
1.	Anticipation	10	10	10	10	10	10	*8	9
2.	Attention-Concentration	10	10	10	10	10	10	10	10
3.	Memorization-Imagination	10	10	10	10	10	10	9	10
4.	Creativity	10	10	9	9	10	10	9	10
5.	Learning ability	10	10	10	10	10	10	10	10
6.	Learning styles	10	9	10	10	10	9	9	10
7.	Problem solving abilites	10	10	10	10	10	10	10	10
8.	Self-efficacy	10	10	10	9	10	10	9	10
9.	Self-confidence	10	10	10	10	10	10	10	10
10.	Motivation	10	10	10	10	10	10	10	10
11.	Self-realization	10	10	10	10	9	10	10	10
12.	Autonomy	10	10	10	10	10	10	10	10
13.	Stress management	10	10	10	10	10	10	10	10
14.	Risk management	10	10	10	10	10	10	*8	10
15.	Arousal management	10	8	10	10	10	8	8	10
16.	Selfregulation	10	9	10	10	10	10	*8	10
17.	Frustration tolerance	10	10	10	10	10	10	10	10
18.	Emotional regulation	10	10	10	10	10	10	9	10

Note: Results given by experts for the content validity of the eighteen items to be included in the checklist of psychological variables involved in climbing. R = content relevance. C = Writing comprehension

* The final grade once reevaluated is 10 points.

In relation to scores given by Expert 4 in items1 *Anticipation*, item14 *Risk management* and item16 *Self-regulation*, when asked about the ratings given (all with a score of 8), the expert refers to the fact that he considers them somewhat less important variables than other variables that are part of the group. Once the importance of scoring according to the relevance and importance of

belonging to the group (and not of comparison) of the psychological variables necessary to be a good climber was clarified again, Expert 4 re-scored the variables and items1, item14, and item16 getting a maximum score. Finally, scores given by each expert were discussed as group and they were urged to modify, omit or include any aspect that they considered necessary. No modification was necessary.

Global assessment and applicability of the questionnaire

A final focus group session with experts tested comprehension, acceptance, and usability of the checklist, showing this tool may become a helpful instrument for climbing coaches to systematically and consistently assess pupil's mental skills. Results are presented in the following Table 4.

Table 4

Usefulness, applicability and global evaluation results

Nº	Ítems	Expert 1	Expert 2	Expert 3	Expert 4
1.	Usefulness	10	10	10	10
2.	Applicability	10	10	10	10
3.	Global	10	10	9	10

Note: Results given by experts from de evaluation of comprehension, acceptance, and usability of the checklist of psychological variables involved in climbing

As alternatives to the original format, three different application models were presented (with and without examples, boxed or non-boxed items). The four experts agreed that they preferred the original format proposed in first instance (boxed items and with examples). The assessment corresponding to expert 3 does not obtain the maximum score since it is considered to be "a great work tool, the 9 in the global assessment responds to the future evaluative improvement. Now it is the best", referring to the time to leave a door open to modifications once it is put into practice. After individual assessment, ratings were pooled and experts were encouraged to comment on the pros and cons of both the design and ease of application. In the words of one of the experts, all agreed that it was an "easy-to-apply and very useful tool for coaches". It is worth noting the importance that the experts give to the fact of being able to "offer something to your sportsmen so that they realize their progression, since the training sessions are based mainly on physical and technical aspects, but almost no attention is paid to psychological factors, which for me are basic needs". Although it is a tool designed to help coaches assess psychological aspects of their pupils, it makes sense to be able to provide athletes some feedback on their performance.

The final result was the creation of a checklist of psychological variables for climbing (C.L.I.M.B.) with which coaches can evaluate climber's mental skills. As a final point to the meeting, a proposal was made for the development of Mobile APP. All experts agreed with the fact of being able to use both formats, both on paper and digital.

5. Discussion

According to experts, climbers are not always aware of their progress, as they sometimes identify progress with the result rather than with performance. Providing athletes

with a tool that allows them to visualize their progress on different timelines can help them to be aware of their improvement and, on the other hand, show those aspects that need to be addressed in order to increase their performance. In the same sense, the results of the evaluations could help coaches to structure training sessions in a more personalized way, modifying them according to the needs detected. The information obtained from the focus group showed the more relevant psychological aspects drawn by coaches (Figure 1). In agreement with Sánchez and Torregrossa (2005), three main dimensions were proposed. Firstly, those that refer to preparation for climbing, memorization and mental replication, and the capacity to maintain concentration while solving climbing tasks (basic processes to capture and process information); secondly, those variables that encourage climbers to improve while having fun and pursuing continuous improvement of skills in climbing (motivational aspects); and thirdly, those related to the need to be able to manage emotions and arousal levels when facing frustrating and uncertain difficulties (motivational aspects).

Results coincide with the previously established model and new variables are proposed that can help improve the model in the identification of psychological variables that influence on climbing performance. The comparison between the variables of the model and the expert knowledge extracted may contribute to validate Sánchez & Torregrossa's (2005) model:

A. Basic processes to capture and process information:

- Anticipation: The way in which the climber prepares to do an action, preview movements and anticipate climbing circumstances.
- Attention-Concentration: Climber's must be capable of what to be aware of during the reading of the route, avoid distractions and maintain concentration during its execution. Experts coincide with Sánchez and Torregrossa (2005) in that paying sustained attention could have a consequence on the activity including optimal focus.
- Memorization-Imagination: Memorization can be a prior activity. But it also happens during execution since it is required to identify and remember the sequence of movements during the action itself. In this sense memorization is intrinsically linked with the capacity to imagine since it is not always possible to access the planned route depending on the modality of the sport (*onsight* or *flash*). Experts coincide with Sánchez and Torregrossa (2005), where imagining plays a higher role than mere visualization as it implies not only imagining the route, holding points and difficulty, but also movements and energy use. To memorize you must *read* the route, know what to memorize and how it is memorized.

- Creativity: The capacity to perform new movements becomes indispensable at times of facing challenges due to the route or sequence of movements especially if they need to be resolved instantly and without prior work. Experts agree with Wang (2012) and Watts (2004), on the importance of being creative and contributing with novelties in movements, including style, problem-solving and therefore performance.
- Learning ability: Climber's need to be able to understand and assimilate necessary information to solve a movement or complete a route, transfer what they have learnt and understand and assimilate information quickly (Seifert et al., 2015; Seifert et al., 2018), because when in competition, the environment is always changing, (the routes are never the same), and time is limited.
- Learning styles: The way to achieve necessary skills to be effective during climbing is the determination to acquire knowledge on the impact of psychological factors such as frustration tolerance, motivation, autonomy and self-confidence. As in dancing, the way to learn can strongly condition the execution styles, the aesthetics of movements and the progression style are important factors to be taken into account regardless of the result, there is a moral code and a style that is much appreciated in the climbing community (de Léséleuc, Gleyse, & Marcellini, 2002).
- Problem solving ability: Climbers must quickly identify, analyze and interpret problems posed by the route to put in practice learnt dexterities efficiently, additionally be open to new possibilities, manage effort effectively and execute successfully a sequence of movements to resolve the climb (Özen, 2015).

B. Motivational aspects:

- Self-effectiveness: A climber's perception on his capacity to successfully execute a task. Experts, as in Sánchez and Torregrossa (2005) confirm that the perception over own capacity to resolve a series of movements or believe that they can reach the top are indispensable conditions for optimum performance (Krüger & Seng, 2019).
- Self-confidence: The belief a climber has over its capabilities to confront a particular task. Already Schlossberg (1981) marked that feeling sure and confident can change the way to behave and interact with the environment depending the success or failure in doing a task (Aras & Ewert, 2016; Coco, Casolo, & Fiorucci, 2021; Hardiyono et al., 2019; Hodgson et al., 2009), especially when a single failure can cause elimination.
- Motivation: The mental state or process that allows climbers to maintain a positive attitude, learn and enjoy climbing. A climber must have fun by the fact of climbing. In agreement with the studies realized in this respect (Byrne & Mueller, 2014; Csikszentmihalyi, 1975; Ewert & Hollenhorst, 1989; Louková & Vomáčko, 2009; McIntyre, 1992), motivation is what makes one enjoy while learning, wishing to improve and to maintain over time the willingness to continue. Among climbers, the reward is usually the experience of the activity itself, existing a positive relationship between levels of commitment and intrinsic motives.
- Self-realization: The impulse to become what one is capable of being. As in Ewert (1994), experts speak about the need for continuous improvement and sense of satisfaction after completing a climb. The reward in achieving the objective seems to be greater than the effort put in doing so. Since climbing is subjected to a degree of difficulty, the climber is not only comforted by solving a problem but once solved he searches how to increase the difficulty and thus improve his performance, pushed by the need for personal development (Levenhagen, 2010).
- Autonomy: The capacity to regulate one-self and to take decisions without external influences or interventions. The nature of climbing demands to be firm and constant in the search for improvement to consolidate a level of difficulty handled in an ever-changing environment before increasing to a higher level. Experts agreed in the need to generate self-management in climbers as they make progress, gradually unlinking them from external directives (Draper et al., 2011; Llewellyn et al., 2008).

C. Emotional mechanisms

- Stress control: Stress is generated when there is an imbalance between the climber's perception of his capabilities and the demands from the environment. Climbers must know how to interpret those situations where uncertainty can be stressful, such as being observed when doing a difficult movement during a competition. However, the reaction to psychologically stressful situations is not always the same as it depends on the perceptions of each person. For instance, some climbers reached optimum performances under stress when they were faced with situations that, a priori, may produce fear, this puts the investigation by Hošek (1994), cited in Chaloupsky (2014) in correlation with results obtained by the focal group. Experts coincide with Watts (2004) and Draper et al. (2008) in addressing the importance of interpreting these situations to minimize their impact on climbers since proper management of stress can directly influence in their performance.

- Activation management: Climbers need to understand how to regulate themselves to adapt their activation level to the demands of the situation (at times new and difficult) without extra-limiting themselves (Caber & Albayrak, 2016). As in Sánchez and Torregrossa (2005), experts expressed that being able to manage fear of falling, not being able to reach the top or getting tired are situations which climbers must know how to calibrate in order to perform successfully. Therefore, knowledge on how to manage activation levels implies maximizing performance.
 - Risk management: Climbers must be capable of effectively interpret the difficulty of movements, manage their resources and minimize excess efforts and risk of falling. They have to be aware of and assess potential dangers and what control over them they can exercise (West & Allin, 2010). Coinciding with Llewellyn and Sanchez (2008), experts insist on the fact that the ability of the climber depends on assuming risky decisions based on their capabilities and risk perception since when they feel confident to pursue additional risks. This way the expert findings can be related to research by Fave, Bassi, and Massimini (2003), where the difference between objective risk and subjective perception turns around the abilities of the climber himself.
 - Self-regulation: If a climber wishes to achieve his personal targets, he has to self-generate thoughts, feelings and actions to allow him to carry out actions to solve the challenge. Experts gave due importance to how a climber prepares himself during training and competition, how he manages effort and generates positive attitudes towards climbing. Experts coincided with investigations in this field (Castanier, Le Scanff, & Woodman, 2011; Fave et al., 2003; Llewellyn & Sanchez, 2008; Robinson, 1985), where self-regulation strategies play a key role in decision making during climbing.
 - Frustration tolerance: Not always things turn right during climbing. The way in which a climber persists in answering a task, although he is aware that reinforcement is very low, influences learning and achievement of success. According to experts, to know how to manage errors is a basic competency, contrary to other sports, in climbing a single mistake or wrong execution of a movement is enough to be disqualified without even having the chance to complete the exercise. Thus, when things go wrong, it becomes necessary to maintain a good attitude, motivation and persistence to continue trying (Brunik, Jug, & Tušák, 2002).
 - Emotional regulation: It is necessary to manage emotions in a way that they do not interfere with the ability to climb. According to experts one of the most common variables for climbers is emotional regulation (Oyague et al., 2005; Savage et al., 2020; Trifu & Trifu, 2019). Being able to control emotions appropriately avoids interference to concentrate in resolving a movement and finish a route.
- In summary, attending to the basic mechanisms to capture and to process information, coaches underlined the importance of being prepared and anticipate each and every move previous to any action and during climbing. In fact, according to experts, being creative and having a high capacity to resolve problems and being able to mentally recreate movements and maintain concentration will impact in climbing performance. Having the capacity to read the route, memorize and mentally reproduce movements will increase possibilities of success, since in climbing both memories and experience are closely related (Pezzulo et al., 2010; Smyth & Waller, 1998).
- Additionally, experts highlight the need to learn adequately and quickly to be able to extrapolate what known to ever changing environments since in competition routes are never the same and the capacity to generate new and creative movements can determine final results. In this respect climbing shares many peculiarities with other individual and team sports (Feher et al., 1998). A mistake in execution may produce a fall and be disqualified, but from a different perspective climbing is not a sport subject to routines such as those in rhythm gymnastics or similar sports. This is a discipline where in spite of time and effort restrictions or route limitations, the capacity to resolve problems in new ways may drive success. Considering motivation, climbing shares same similarities to most of sports. As a young practitioner, the athlete should enjoy when learning to climb; as an elite sportsperson, the athlete must maintain a great amount of motivation to continue improving. Climbers are continually exposed to uncertainties and must adapt their performance to new routines and to new challenging outcomes. Therefore, strengthening self-confidence and self-esteem plays a determining role in climbing (Coco et al., 2021; Iso-Ahola, La Verde, & Graefe, 1989; Krüger & Seng, 2019; Levenhagen, 2010; Marco, 2003), and personal challenges and increased difficulties in climbing are linked to personal development (Ewert, 1994). Regarding emotional mechanisms, it is necessary to be able to self-regulate oneself when facing potentially highly stressful situations with a risky component that can determine the decision making. Coaches found essential to be capable of

properly manage arousal levels, self-regulate and manage the correct amount of physical and mental energy to face uncertainties without falling into frustration. In this respect appropriate management of emotions can influence on the mechanisms to process information and therefore have repercussions in performance.

Based on findings (Figure 1), a Mobile APP checklist of psychological variables for climbing was created to help coaches evaluate climbers during training development processes, track their psychological abilities over time, compare with other climbers and share with other coaches. The results found contrast with authors who speak of the importance of psychological variables such as self-efficacy in predicting behaviours such as risky decision-making or risk exposure (Llewellyn & Sanchez, 2008; Llewellyn et al., 2008) and their relationship with emotional stability, impulsivity and extraversion as regulators of mood and risk reduction (Monasterio, Alamri, & Mei-Dan, 2014; Savage et al., 2020). On the other hand, as climbing has become a competitive sport, pre-performance psychological states have been shown to influence sport performance (Sanchez et al., 2019), increasing levels of stress management and higher levels of introversion in the athlete (Brymer et al., 2020). Strategic management in relation to the effort made on the route (energy management) and the effects of anxiety on the narrowing of the field of vision influence the emotional states of climbers (Brymer et al., 2020). Hence the importance of further research in the field of emotional mechanisms, information processing and motivational aspects involved in sport performance in climbing (Garrido-Palomino & España Romero, 2019; Lee & Ewert, 2019; Sanchez et al., 2019).

6. Conclusions

A specific psychological instrument has been designed for climbing. The designed instrument is based on a theoretical framework, where at the methodological level, a combined quantitative and qualitative methodology is used to extract knowledge from a group of four expert coaches through several rounds of focus groups. The implications of the instrument used in a practical level helps coaches to make their knowledge more explicit by following a checklist of psychological variables involved in the process of evaluation and psychological intervention of

References

- AAC. (2019). *State of Climbing*. American Alpine Club Report. https://aac-publications.s3.amazonaws.com/articles/State_of_Climbing_Report_2019_Web.pdf
- Aras, D., & Ewert, A. W. (2016). The effects of eight weeks sport rock climbing training on anxiety. *Acta Medica Mediterranea*, 32(1), 223-230. http://dx.doi.org/10.19193/393-6384_2016_1_35

climbers (especially at a competitive level) and unifies work methods in order to: highlight climbers' strengths and areas for improvement, provide feedback, share with other coaches, compare follow-up, the evolution between athletes and track their psychological abilities over time highlighting its possible use for the detection, selection and promotion of sport talents.

7. Strength, limitations & Future lines of research

The fact that the aim of this study focuses on the design of the checklist, does not show quantitative results derived from administration to climbers. In future studies it would be advisable to collect quality data at sample level to allow for more accurate quantitative analysis. However, it would have been difficult to present both the design of the instrument and the empirical data derived from it in a single article. Taking into account the constraints, the following lines of research are proposed for future studies: a) to apply the checklist with a representative sample of climbers belonging to different submodalities of competitive climbing in order to empirically validate the instrument. b) To empirically test the level of precision and applicability in specific psychological intervention processes, with case follow-up being advisable.

Further lines based on these achievements could help to establish mental skill climbing specific programs to improve performance, since within the sport itself, climbers attend to specific peculiarities depending on the modality practiced, whether it be speed, lead or boulder (Levernier & Laffaye, 2021; Stien et al., 2019). It seems essential to carry out detailed longitudinal monitoring, since, unlike the observation of physical abilities, there are psychological variables that must be analysed in detail (Ruíz, 2015). To this end, studies could be carried out with grassroots climbers, thus being able to calibrate the applicability of the checklist in the processes of detection, selection, promotion and development of sporting talent.

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- Aubel, O., & Ohl, F. (2004). The denegation of the economy: the example of climbing in France. *International Review for the Sociology of Sport*, 39(2), 123-137. <https://doi.org/10.1177/1012690204043457>
- Brunik, S., Jug, S., & Tušak, M. (2002). Personality traits of Slovenian female and male mountain climbers. *Kinesiology*, 34(2.), 153-162. <https://hrcak.srce.hr/225432>
- Brymer, E., Feletti, F., Monasterio, E., & Schweitzer, R. D. (2020). *Understanding Extreme Sports: A Psychological Perspective*. Lausanne: Frontiers Media SA. <https://eprints.qut.edu.au/206462>
- Bulger, S. M., & Housner, L. D. (2007). Modified Delphi investigation of exercise science in physical education teacher education. *Journal of Teaching in Physical Education*, 26(1), 57-80. <https://doi.org/10.1123/jtpe.26.1.57>
- Byrne, R., & Mueller, F. F. (2014). Designing digital climbing experiences through understanding rock climbing motivation. In Y. Pisan, N. M. Sgouros, & T. Marsh (Eds.), *Entertainment Computing-ICEC 2014: 13th International Conference, ICEC 2014, Sydney, Australia, October 1-3, 2014. Proceedings 13* (pp. 92-99). Springer. https://doi.org/10.1007/978-3-662-45212-7_12
- Caber, M., & Albayrak, T. (2016). Push or pull? Identifying rock climbing tourists' motivations. *Tourism Management*, 55, 74-84. <https://doi.org/10.1016/j.tourman.2016.02.003>
- Castanier, C., Le Scanff, C., & Woodman, T. (2011). Mountaineering as affect regulation: The moderating role of self-regulation strategies. *Anxiety, Stress, & Coping*, 24(1), 75-89. <https://doi.org/10.1080/10615801003774210>
- Chaloupsky, D. (2014). The acceptable level of risk-taking for traditional rock climbers. *Journal of Human Sport and Exercise*, 9(1), 263-269. <http://dx.doi.org/10.14198/jhse.2014.9.Proc1.08>
- Coco, D., Casolo, F., & Fiorucci, M. (2021). Challenging play and motor experiences in the natural environment, adventure, and the perception of risk in outdoor didactic-educational places. *Journal of Physical Education and Sport*, 21, 650-656. <https://dx.doi.org/10.7752/jpes.2021.s1077>
- Creswell, J. (2009). *Research design: Qualitative, quantitative and mixed approaches*. Thousand Oaks, CA, EE. UU.: SAGE Publications.
- Creswell, J. (2014). *A concise introduction to mixed methods research*. Thousand Oaks, CA, EE. UU.: SAGE Publications.
- Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. San Francisco, EE. UU.: Jossey-Bass Inc.
- de Léséleuc, E., Gleyse, J., & Marcellini, A. (2002). The practice of sport as political expression? Rock climbing at Claret, France. *International sociology*, 17(1), 73-90. <https://doi.org/10.1177/0268580902017001004>
- Draper, N., Dickson, T., Blackwell, G., Fryer, S., Priestley, S., Winter, D., & Ellis, G. (2011). Self-reported ability assessment in rock climbing. *Journal of sports sciences*, 29(8), 851-858. <https://doi.org/10.1080/02640414.2011.565362>
- Draper, N., Jones, G. A., Fryer, S., Hodgson, C., & Blackwell, G. (2008). Effect of an on-sight lead on the physiological and psychological responses to rock climbing. *Journal of sports science & medicine*, 7(4), 492-498. <https://pubmed.ncbi.nlm.nih.gov/24149956>
- Ericsson, K. A., Prietula, M. J., & Cokely, E. T. (2007). La formación de un experto. *Harvard Business Review*, 85(8), 113-120. https://www.academia.edu/download/51220431/Articulo_n_1.pdf
- Erlandson, D., Harris, E., Skipper, B., & Allen, S. (1993). *Doing naturalistic inquiry: A guide to methods*. Newbury Park, CA, EE. UU.: Sage Publications.
- Ewert, A., & Hollenhorst, S. (1989). Testing the adventure model: Empirical support for a model of risk recreation participation. *Journal of leisure research*, 21(2), 124-139. <https://doi.org/10.1080/00222216.1989.11969794>
- Ewert, A. W. (1994). Playing the edge: Motivation and risk taking in a high-altitude wilderness like environment. *Environment and Behavior*, 26(1), 3-24. <https://doi.org/10.1177/0013916594261001>
- Fanchini, M., Violette, F., Impellizzeri, F. M., & Maffiuletti, N. A. (2013). Differences in climbing-specific strength between boulder and lead rock climbers. *The Journal of Strength & Conditioning Research*, 27(2), 310-314. <https://doi.org/10.1519/jsc.0b013e3182577026>
- Fave, A. D., Bassi, M., & Massimini, F. (2003). Quality of experience and risk perception in high-altitude rock climbing. *Journal of Applied Sport Psychology*, 15(1), 82-98. <https://doi.org/10.1080/10413200305402>
- Feher, P., Meyers, M. C., & Skelly, W. A. (1998). Psychological profile of rock climbers: state and trait attributes. *Journal of Sport Behavior*, 21(2), 167-180. <https://www.proquest.com/openview/bb344a4907c5c0354247351b2c3b52bd>
- Feldmann, A., Lehmann, R., Wittmann, F., Wolf, P., Baláš, J., & Erlacher, D. (2021). Acute effect of high-intensity climbing on performance and muscle oxygenation in elite climbers. *Journal of Science in Sport and Exercise*, 4(2), 145-155. <https://doi.org/10.1007/s42978-021-00139-9>
- Flick, U. (2014). *La gestión de la calidad en la investigación cualitativa*. Madrid, España: Morata, SL.

- Francés García, F. J. (2016). *Metodologías participativas para la investigación y la intervención social*. Alicante: Universidad de Alicante. https://publicaciones.ua.es/libro/metodologias-participativas-para-la-investigacion-y-la-intervencion-social_112743
- Fryer, S. M., Giles, D., Palomino, I. G., de la O Puerta, A., & España-Romero, V. (2018). Hemodynamic and cardiorespiratory predictors of sport rock climbing performance. *The Journal of Strength & Conditioning Research*, 32(12), 3534-3541. <https://doi.org/10.1519/jsc.0000000000001860>
- Fuss, F. K., Tan, A. M., Pichler, S., Niegl, G., & Weizman, Y. (2020). Heart rate behavior in speed climbing. *Frontiers in Psychology*, 11, 1364. <https://doi.org/10.3389/fpsyg.2020.01364>
- Garrido-Palomino, I., & España Romero, V. (2019). Role of emotional intelligence on rock climbing performance. *Revista Internacional de Ciencias del Deporte*, 15(57), 284-294. <https://doi.org/10.5232/ricyde2019.05706>
- Garrido-Palomino, I., Fryer, S., Giles, D., González-Rosa, J. J., & España-Romero, V. (2020). Attentional differences as a function of rock climbing performance. *Frontiers in Psychology*, 11, 1550. <https://doi.org/10.3389/fpsyg.2020.01550>
- Giles, L. V., Rhodes, E. C., & Taunton, J. E. (2006). The physiology of rock climbing. *Sports medicine*, 36, 529-545. <https://doi.org/10.2165/00007256-200636060-00006>
- Glaser, B. (1992). *Basics of grounded theory analysis: Emergence versus forcing*. Mill Valley CA, EE. UU.: Sociology Press.
- Glaser, B., & Strauss, A. (1967). *The Discovery of Grounded Theory. Strategies for Qualitative Research* (4th ed.). New Brunswick, Canada: Aldine Transaction.
- Grant, S., Hasler, T., Davies, C., Aitchison, T. C., Wilson, J., & Whittaker, A. (2001). A comparison of the anthropometric, strength, endurance and flexibility characteristics of female elite and recreational climbers and non-climbers. *Journal of sports sciences*, 19(7), 499-505. <https://doi.org/10.1080/026404101750238953>
- Grushko, A. I., & Leonov, S. V. (2014). The usage of eye-tracking technologies in rock-climbing. *Procedia-Social and Behavioral Sciences*, 146, 169-174. <https://doi.org/10.1016/j.sbspro.2014.08.075>
- Hardiyono, B., Nurkadri, N., Pratama, B. A., & Laksana, A. A. N. P. (2019). The effect of the dominant muscle strength and self confidence on the results climb of the rock climbing's athlete. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, 5(1), 124-139. https://doi.org/10.29407/js_unpgr.v5i1.12857
- Hernández, R., Fernández, C., & Baptista, M. (2003). *Metodología de la investigación*. México DF, México: McGraw Hill. <https://www.uca.ac.cr/wp-content/uploads/2017/10/Investigacion.pdf>
- Hodgson, C. I., Draper, N., McMorris, T., Jones, G., Fryer, S., & Coleman, I. (2009). Perceived anxiety and plasma cortisol concentrations following rock climbing with differing safety rope protocols. *British Journal of Sports Medicine*, 43(7), 531-535. <http://dx.doi.org/10.1136/bjism.2007.046011>
- Holzschuh, A. (2016). Does rock climbing threaten cliff biodiversity?-A critical review. *Biological Conservation*, 204, 153-162. <https://doi.org/10.1016/j.biocon.2016.10.010>
- Hošek, V. (1994). *Psychologie odolnosti*. Praha: Karolinum.
- IFSC. (2021). *Annual reports*. International Federation of Sport climbing. <https://www.ifsc-climbing.org/index.php/news/2-uncategorised/282-annual-reports>
- Iso-Ahola, S. E., La Verde, D., & Graefe, A. R. (1989). Perceived competence as a mediator of the relationship between high risk sports participation and self-esteem. *Journal of leisure research*, 21(1), 32-39. <https://doi.org/10.1080/00222216.1989.11969788>
- Krüger, M., & Seng, C. (2019). Effects of Short Practice of Climbing on Barriers Self-Efficacy within a Physical Education and Sport Intervention in Germany. *Sports*, 7(4), 81. <https://doi.org/10.3390/sports7040081>
- Lee, K., & Ewert, A. (2019). Understanding the motivations of serious leisure participation: A self-determination approach. *Annals of Leisure Research*, 22(1), 76-96. <https://doi.org/10.1080/11745398.2018.1469420>
- León, O., & Montero, I. (2020). *Métodos de Investigación en Psicología y Educación*. McGraw-Hill. <https://www.casadellibro.com/libro-metodos-de-investigacion-psicologia-y-educacion-4-ed/9788448620509/11561875>
- Levenhagen, M. (2010). A stage model of why climbers climb and how it frames the discussions of recent climbing controversies. *Journal of Mountaineering*, 1192, 16-33. <https://www.researchgate.net/profile/Mike-Levenhagen/publication/228865482>
- Levernier, G., & Laffaye, G. (2021). Rate of force development and maximal force: reliability and difference between non-climbers, skilled and international climbers. *Sports Biomechanics*, 20(4), 495-506. <https://doi.org/10.1080/14763141.2019.1584236>
- Llewellyn, D. J., & Sanchez, X. (2008). Individual differences and risk taking in rock climbing. *Psychology of Sport and Exercise*, 9(4), 413-426. <https://doi.org/10.1016/j.psychsport.2007.07.003>
- Llewellyn, D. J., Sanchez, X., Asghar, A., & Jones, G. (2008). Self-efficacy, risk taking and performance in rock climbing. *Personality and Individual Differences*, 45(1), 75-81. <https://doi.org/10.1016/j.paid.2008.03.001>

- Lorenzo Calvo, A. (2000). *Búsqueda de nuevas variables en la detección de talentos en los deportes colectivos. Una aplicación al baloncesto*. (Doctoral dissertation). Ciencias. [https://oa.upm.es/98/1/ALBERTO LORENZO CALVO.pdf](https://oa.upm.es/98/1/ALBERTO_LORENZO_CALVO.pdf)
- Lorenzo Calvo, A., Jiménez Saíz, S., Gómez Ruano, M. Á., & Calleja González, J. (2013). Detección y Desarrollo del Talento Deportivo: El estado del arte. In *Congreso Internacional en Ciencias de la Actividad Física y del Deporte. Investigación, Desarrollo e Innovación en el ámbito del Deporte* (pp. 1-29). UPV-EHU Vitoria-Gasteiz. [https://oa.upm.es/29623/8/INVE MEM 2013 170668.pdf](https://oa.upm.es/29623/8/INVE_MEM_2013_170668.pdf)
- Louková, T., & Vomáčko, L. (2009). Motivation for climbing and mountaineering. In T. I. & M. Andy (Eds.), *Outdoor Activities in Educational and Recreational Programmes* (1st ed., pp. 135-139). Praha: IYNF, Praha. <https://is.muni.cz/publication/856612>
- MacKenzie, R., Monaghan, L., Masson, R. A., Werner, A. K., Caprez, T. S., Johnston, L., & Kemi, O. J. (2020). Physical and physiological determinants of rock climbing. *International journal of sports physiology and performance*, 15(2), 168-179. <https://doi.org/10.1123/ijsp.2018-0901>
- Macleod, D., Sutherland, D., Buntin, L., Whitaker, A., Aitchison, T., Watt, I., Bradley, J., & Grant, S. (2007). Physiological determinants of climbing-specific finger endurance and sport rock climbing performance. *Journal of sports sciences*, 25(12), 1433-1443. <https://doi.org/10.1080/02640410600944550>
- Magiera, A., Rocznik, R., Maszczyk, A., Czuba, M., Kantyka, J., & Kurek, P. (2013). The structure of performance of a sport rock climber. *Journal of human kinetics*, 36(1), 107-117. <https://doi.org/10.2478/hukin-2013-0011>
- Marco, J. (2003). *Psicosociología: influencias en el rendimiento deportivo*. Madrid, España: Gymnos.
- Martínez-Abellán, A., Conesa-Ros, E., Morán-Navarro, R., García-Pallarés, J., De la Cruz, E., Ortega, E., & López-Gullón, J. (2016). Diseño y validación de contenido de un cuestionario sobre Pérdida de Peso en Deportes de Combate (PPDC). *Cuadernos de Psicología del Deporte*, 16(3), 113-122. <https://revistas.um.es/cpd/article/view/278521>
- McIntyre, N. (1992). Involvement in risk recreation: A comparison of objective and subjective measures of engagement. *Journal of leisure research*, 24(1), 64-71. <https://doi.org/10.1080/00222216.1992.11969872>
- Mermier, C. M., Janot, J. M., Parker, D. L., & Swan, J. G. (2000). Physiological and anthropometric determinants of sport climbing performance. *British Journal of Sports Medicine*, 34(5), 359-365. <http://dx.doi.org/10.1136/bjism.34.5.359>
- Monasterio, E., Alamri, Y. A., & Mei-Dan, O. (2014). Personality characteristics in a population of mountain climbers. *Wilderness & Environmental Medicine*, 25(2), 214-219. <https://doi.org/10.1016/j.wem.2013.12.028>
- Monasterio, E., & Brymer, E. (2021). Feeding Time at the Zoo: Psychological aspects of a serious rock climbing accident. *Journal of Adventure Education and Outdoor Learning*, 21(4), 323-335. <https://doi.org/10.1080/14729679.2020.1829494>
- Montalbetti, T., & Chamarro, A. (2010). Construction and validation of the rock climbing risk perception questionnaire. *Sport Psychology Notebooks*, 10(2), 43-56. <https://revistas.um.es/cpd/article/view/113061>
- Montero, I., & León, O. G. (2007). A guide for naming research studies in Psychology. *International Journal of clinical and health psychology*, 7(3), 847-862. <https://www.redalyc.org/pdf/337/33770318.pdf>
- Onwuegbuzie, A. J., & Leech, N. L. (2006). Linking research questions to mixed methods data analysis procedures. *The qualitative report*, 11(3), 474-498. <https://doi.org/10.46743/2160-3715/2006.1663>
- Ordás, R. P., Hernández, E. H., & Sánchez, I. G. (2011). Relación entre el nivel de habilidad motriz y la ansiedad percibida antes y después de una práctica de escalada en niños de Educación Primaria. *RETOS. Nuevas Tendencias en Educación Física, Deporte y Recreación*, (19), 25-29. <https://www.redalyc.org/pdf/3457/345732285005.pdf>
- Oyague, G. P., Lusar, A. C., & Cercos, J. F. (2005). Psychometric properties of the sport climbing psychological skills questionnaire. *Cuadernos de Psicología del Deporte*, 5(1), 9-18. <https://revistas.um.es/cpd/article/view/93361>
- Özen, G. (2015). Examining the effect of artificial wall climbing as a leisure time activity on children's problem-solving skills. *Pegem Journal of Education and Instruction*, 5(2), 221-236. <https://doi.org/10.14527/pegegog.2015.012>
- Pérez, C., & Carretero-Dios, H. (2005). Normas para el desarrollo y revisión de estudios instrumentales. *International Journal of clinical and health psychology*, 5(3), 521-551. <https://www.redalyc.org/pdf/337/33705307.pdf>
- Pezzulo, G., Barca, L., Bocconi, A. L., & Borghi, A. M. (2010). When affordances climb into your mind: Advantages of motor simulation in a memory task performed by novice and expert rock climbers. *Brain and Cognition*, 73(1), 68-73. <https://doi.org/10.1016/j.bandc.2010.03.002>
- Pociello, C. (1995). *Les cultures sportives: pratiques, représentations et mythes sportifs*. Paris, France: Presses Universitaires. <https://www.cairn.info/les-cultures-sportives--9782130503545.htm>
- Portela, P. M., Rico, S. R., Extremera, A. B., León, M. T. M., & Marín, M. M. (2013). Analysis of the sociodemographic, sports and psychological profile in a sport climbing practice of university students. *Retos: nuevas tendencias en educación física, deporte y recreación*, (24), 9-15. <https://dialnet.unirioja.es/descarga/articulo/4473504.pdf>

- Robinson, D. W. (1985). Stress seeking: Selected behavioral characteristics of elite rock climbers. *Journal of Sport and Exercise Psychology*, 7(4), 400-404. <https://doi.org/10.1123/jsp.7.4.400>
- Rokowski, R., Michailov, M., Maciejczyk, M., Więcek, M., Szymura, J., Draga, P., Trendafilov, P., & Szygula, Z. (2021). Muscle strength and endurance in high-level rock climbers. *Sports Biomechanics*, 1-16. <https://doi.org/10.1080/14763141.2021.1916577>
- Ruiz, -. B., R. (2015). La detección y selección de talentos deportivos desde una perspectiva psicológica. In A. García-Naveira & L. Locatelli (Eds.), *Avances en psicología del deporte* (pp. 245-283). Madrid, España: Paidotribo.
- Sánchez, X., & Torregrossa, M. (2005). El papel de los factores psicológicos en la escalada deportiva: un análisis cualitativo. *Revista de psicología del deporte*, 14(2), 177-194. <https://archives.rpd-online.com/article/view/180.html>
- Sanchez, X., Torregrossa, M., Woodman, T., Jones, G., & Llewellyn, D. J. (2019). Identification of parameters that predict sport climbing performance. *Frontiers in Psychology*, 10, 1294. <https://doi.org/10.3389/fpsyg.2019.01294>
- Santolaya, M., Rubio, V., & Barquín, R. R. (2019). Desarrollo de una lista de verificación de habilidades mentales y características de comportamiento en la escalada. *Actividad física y deporte: ciencia y profesión*, (30), 246-247. <http://colecfafev.com/wp-content/uploads/2019/07/Revista30.pdf>
- Saul, D., Steinmetz, G., Lehmann, W., & Schilling, A. F. (2019). Determinants for success in climbing: A systematic review. *Journal of Exercise Science & Fitness*, 17(3), 91-100. <https://doi.org/10.1016/j.jesf.2019.04.002>
- Savage, D., Chan, H. F., Moy, N., Schaffner, M., & Torgler, B. (2020). Personality and individual characteristics as indicators of lifetime climbing success among Everest mountaineers. *Personality and Individual Differences*, 162, 110044. <https://doi.org/10.1016/j.paid.2020.110044>
- Schlossberg, N. K. (1981). A model for analyzing human adaptation to transition. *The counseling psychologist*, 9(2), 2-18. <https://doi.org/10.1177/001100008100900202>
- Seifert, L., Boulanger, J., Orth, D., & Davids, K. (2015). Environmental design shapes perceptual-motor exploration, learning, and transfer in climbing. *Frontiers in Psychology*, 6, 1819. <https://doi.org/10.3389/fpsyg.2015.01819>
- Seifert, L., Hacques, G., Rivet, R., & Legreneur, P. (2020). Assessment of fluency dynamics in climbing. *Sports Biomechanics*, 1-12. <https://doi.org/10.1080/14763141.2020.1830161>
- Seifert, L., Orth, D., Mantel, B., Boulanger, J., Héroult, R., & Dicks, M. (2018). Affordance realization in climbing: Learning and transfer. *Frontiers in Psychology*, 9, 820. <https://doi.org/10.3389/fpsyg.2018.00820>
- Serhii, T., Olena, D., Van Den Tol, A., Anastasiia, R., Svitlana, F., Daryna, I., Oksana, S., Lolita, D., Vitaly, U., & Olena, I. (2020). Individual psychological determinants of stress resistance in rock climbers. *Journal of Physical Education and Sport*, 20(Suppl. 1), 469-476. <http://reposit.uni-sport.edu.ua/handle/787878787/2668>
- Sheel, A. (2004). Physiology of sport rock climbing. *British Journal of Sports Medicine*, 38(3), 355-359. <http://dx.doi.org/10.1136/bjism.2003.008169>
- Smyth, M. M., & Waller, A. (1998). Movement imagery in rock climbing: Patterns of interference from visual, spatial and kinaesthetic secondary tasks. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, 12(2), 145-157. [https://doi.org/10.1002/\(SICI\)1099-0720\(199804\)12:2<145::AID-ACP505>3.0.CO;2-Z](https://doi.org/10.1002/(SICI)1099-0720(199804)12:2<145::AID-ACP505>3.0.CO;2-Z)
- Stien, N., Frøysaker, T. F., Hermans, E., Vereide, V. A., Andersen, V., & Saeterbakken, A. H. (2021). The effects of prioritizing lead or boulder climbing among intermediate climbers. *Frontiers in Sports and Active Living*, 3, 661167. <https://doi.org/10.3389/fspor.2021.661167>
- Stien, N., Saeterbakken, A. H., Hermans, E., Vereide, V. A., Olsen, E., & Andersen, V. (2019). Comparison of climbing-specific strength and endurance between lead and boulder climbers. *PloS one*, 14(9), e0222529. <https://doi.org/10.1371/journal.pone.0222529>
- Strauss, A., & Corbin, J. (1990). *Basics of Qualitative Research: Theory, procedures and techniques*. Newbury Park, CA, EE. UU.: Sage Publications.
- Toro, E. O., Egido, J. M. J., Andrés, J. M. P., & de Barranda, P. S. (2008). Diseño y validación de un cuestionario para valorar las preferencias y satisfacciones en jóvenes jugadores de baloncesto. *Cuadernos de Psicología del Deporte*, 8(2), 39-58. <https://revistas.um.es/cpd/article/view/54281>
- Trifu, S., & Trifu, A. I. (2019). The state of preparation in performance climbing. *bioRxiv*, 631838. <https://doi.org/10.1101/631838>
- Vallés, M. (1997). *Técnicas cualitativas de investigación social: reflexión metodológica y práctica profesional*. Madrid, España: Síntesis.

- Wang, C.-C. (2012). *Exploring the relationship among rock climbing engagement, sensation-seeking, and creativity: A multi-method approach to understanding the adventure seeking creativity model*. (Doctoral dissertation). Indiana University. <https://www.proquest.com/openview/bf12e33e851a1d8a164a092981d92f9b>
- Watts, P. B. (2004). Physiology of difficult rock climbing. *European journal of applied physiology*, 91, 361-372. <https://doi.org/10.1007/s00421-003-1036-7>
- Watts, P. B., España-Romero, V., Ostrowski, M. L., & Jensen, R. L. (2021). Change in geometric entropy with repeated ascents in rock climbing. *Sports Biomechanics*, 20(8), 1031-1040. <https://doi.org/10.1080/14763141.2019.1635636>
- West, A., & Allin, L. (2010). Chancing your arm: The meaning of risk in rock climbing. *Sport in Society*, 13(7-8), 1234-1248. <https://doi.org/10.1080/17430431003780245>
- Wiersma, L. D. (2001). Conceptualization and development of the sources of enjoyment in youth sport questionnaire. *Measurement in Physical Education and Exercise Science*, 5(3), 153-177. https://doi.org/10.1207/S15327841MPEE0503_3
- Zuckerman, M. (1983). Sensation seeking and sports. *Personality and Individual differences*, 4(3), 285-292. [https://doi.org/10.1016/0191-8869\(83\)90150-2](https://doi.org/10.1016/0191-8869(83)90150-2)