Effects of Cold Rainy Weather vs. Normal Warm Indoor Environment upon Cognitive Performances

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Abstract

In education we also have to consider the performances obtained and the conditions where they are obtained. 'Preparing for life' is about having knowledge and, sometimes, being able to use it in difficult conditions. Traditional classroom can be occasionally misguiding, but through sport it's possible to understand phenomena that can be transferred to education. The aim of our study was to investigate the influence of cold and rain in outdoor sports on the cognitive performances of amateur hikers. Cognitive performance of 40 amateur hikers was tested (arithmetical operations test) in a comfortable surrounding with mild temperature and outdoors on a rainy and mildly windy day. Significant differences in the time to solve the test was found in different environments ($p<0.0001$), taking longer outdoors, as well as the number of faults ($p<0.0001$). We can conclude that even a mild change in weather environment can influence the cognitive performance.

Keywords: Weather Conditions, Human Performance, Outdoor Activities, Expedition, Decision Making, Performance Control.

1. Introduction

In order to prepare and organize an expedition, for instance in the mountains or at sea (in a sailing context, in a kayak raid, etc.), it is important to understand how the performance of the participants will be influenced by the weather conditions in which they have to perform and make decisions. Rain and cold are, undoubtedly, obstacles that have to be surpassed when they occur. So it is important to know how much these conditions can delay decision making, finding solutions and performing to solve the faced problems. In expeditions we are sometimes near the limit, therefore even a decision that seems trivial can be fundamental and can modify how we conduct the expedition. It is known that cognitive performance plays a crucial role in some tasks of the expeditions features (e.g. orientation, safety, decision-making and reactions in emergency situations) (Giesbrecht, Arnett, Vela & Bristow, 1993). Several researchers have studied the relation between cognitive performance and the exposure to cold conditions (Palinkas, 2001; Pilcher, Nadler & Busch, 2002).

However, it is usually aimed for very complex processes that are not well representative of what we can find in simple expeditions performed by amateurs, an enormous market that has to be studied and developed. Thus, it is important to try to keep it simple and to do it with useful instruments, that are easy to use and cheap (in financial costs, in time, etc.), having although as a reference the knowledge from more sophisticated situations. Researchers found that a prolonged exposure to severe cold results in changes in the physiological aspects, i.e. Central Nervous System (CNS) decrements, such as amnesia and unconsciousness associated with hypothermia. Moreover some authors defend that even exposure to less severe cold may affect cognitive performance (Palinkas, 2001; Mäkinen, Palinkas, Dennis, Pääkkönen, Rintamäki, Leppäluoto & Hassi, 2006; Baddeley, Cuccaro, Egstrom, Weltman & Willis, 1975; Bowen, 1968).

Mäkinen et al. (2006) found that a rigorous enough cold exposure, causing whole body cooling, resulted in impaired cognitive performance. However, even exposure to less severe cold, which does not lower core temperature markedly, may result in cognitive decrements with decreased performance, health-related consequences and difficulties in the accuracy (Hoffman, 2001). Most of the investigation made over this topic used extreme cases (Paulus, Potterat, Taylor, Van Orden, Bauman, Momen, Padilla & Swain, 2009; Adam, Carter, Cheuvront, Merullo, Castellani, Lieberman & Sawka, 2008; Lieberman, Niro, Tharion, Nindl, Castellani, Montain & 2006; Hoffman, 2001). Those studies are important for “extreme” expeditions. However, there is a big and profound change in sports activities and in its’ market.

Nowadays outdoor sport mobilizes a huge amount of people in activities where they are exposed to cold conditions that are not extreme. Consequently it is important to know if and how cold can influence the performance in those activities. In high-risk sports this knowledge is even more important, as it is evident. And if we have an association between high-risk and a practice that is not so regular problems tend to increase.

According to the statistical accident tables from North American Mountaineering (American Alpine Club, 2010) the total number of accidents reported between 1951 and 2008 were of 7.403, resulting in a total of 6.153 injured and 1.720 fatalities. Yet most of those accidents was related to high-risk sports made by people with a low previous preparation, because it is not easy to distinguish (usually they even have the same name) amateur practices from extreme expeditions that have much bigger difficulties.

Therefore the aim of this study is to compare the influence of environment (cold, rainy weather vs. warm indoor) on the cognitive performances of amateur hikers, trying to understand what happens in many of these activities when amateurs perform them. In this study arithmetical operations were used to test the cognitive responses of the subjects. It was hypothesised that the cold rainy weather had a negative effect upon the cognitive performances, meaning longer time to conduct the test and making more faults. More detailed understanding about the influence of mild environmental on cognitive performances can help to increase awareness of people and thus their safety in different situations (Vogt, Leonhardt, Köper & Pennig, 2010; Brymer, 2009; Harris & Stanton, 2010; Griffin, Young & Stanton, 2010).

2. Methods

2.1. Participants

To understand how environmental conditions can modify the cognitive performance of the participants in expeditions and raids 40 subjects (between 20 and 27 years old with an average age of 24.5 years), amateurs hikers with some experience (about 10 weekends per year in the last 4 years), 17 females and 23 males, were tested in a comfortable surrounding with mild temperature and outdoors in a rainy and mildly windy day after a light walk in these conditions. The participants were fully informed about the protocol before participating in this study. Informed consent was obtained prior to all testing, in accordance with the recommendations of the local ethical committee and current ethical standards in sports and exercise research.

2.2. Procedures

Before starting the experiment participants were randomly divided in two equally sized groups (n=20). Then it was explained to everybody, together, that they should perform arithmetical operations having to do them with the following priority: firstly making no mistakes and secondly do them as quickly as possible. At the same time as group A answered the test, group B went to another room to get prepared for the walk and joined group A as soon as this group finished the test.

All participants went, at the same time, for a light walk on a rainy and windy day with temperatures between 5 and 7 degrees C, outdoors, for 50 minutes. The test was presented to the two groups, simultaneously, while sitting outdoors on a rock. Once the test was finished everybody returned to the shelter together, what took about 10 minutes. After this group A was dismissed and group B, after half an hour, the time participants had to took a hot shower, answered the same test in the same comfortable situation indoors.

The test (always the same test) was presented on a paper and had 60 arithmetical operations (additions, subtractions, divisions and multiplications), with numbers equal or inferior to 5, randomly distributed. In conclusion, group A answered the test, first comfortably sitting at a table, indoors, and then, went for a 50 minute walk in outdoor conditions. Group B did the same but in the reverse order. Everybody was relatively well equipped for rainy and cold conditions.

2.3. Instruments

To compare the effect of the environment the dependent variables, time used time to answer the test and the total number of errors, were measured. A Casio HS-3 digital stopwatch was used to measure the total time used by each participant to answer the test under each condition. The total number of errors committed by each participant under each condition was counted after the test and plotted in SPSS version 17.0 (SPSS, Inc., Chicago, IL) for further analysis.

2.4. Statistical Analysis

To compare the effect of environment on the time used to conduct the test, a 2-way ANOVA (test situation: indoor-outdoor x group: first indoor – first outdoor situation) for repeated measures was used. To compare mistakes made during the two situations a Mann Wittney test was conducted. The level for significance was set at $p \leq 0.05$. Statistical analysis was performed in SPSS version 17.0 (SPSS, Inc., Chicago, IL).

3. Results

A significant difference in time used to conduct the test in the different environments was found in both groups ($p<0.0001$), i.e. in the outdoors situation participants used significantly more time to solve the test than in the indoors situation (figure 1). However, no interaction between the groups was found (figure 1; $p=.258$). Also the total number of faults was significantly higher in the outdoors situation when compared with the indoors situation (figure 2; $p<0.0001$) once again with no differences between the groups ($p=0.145$).

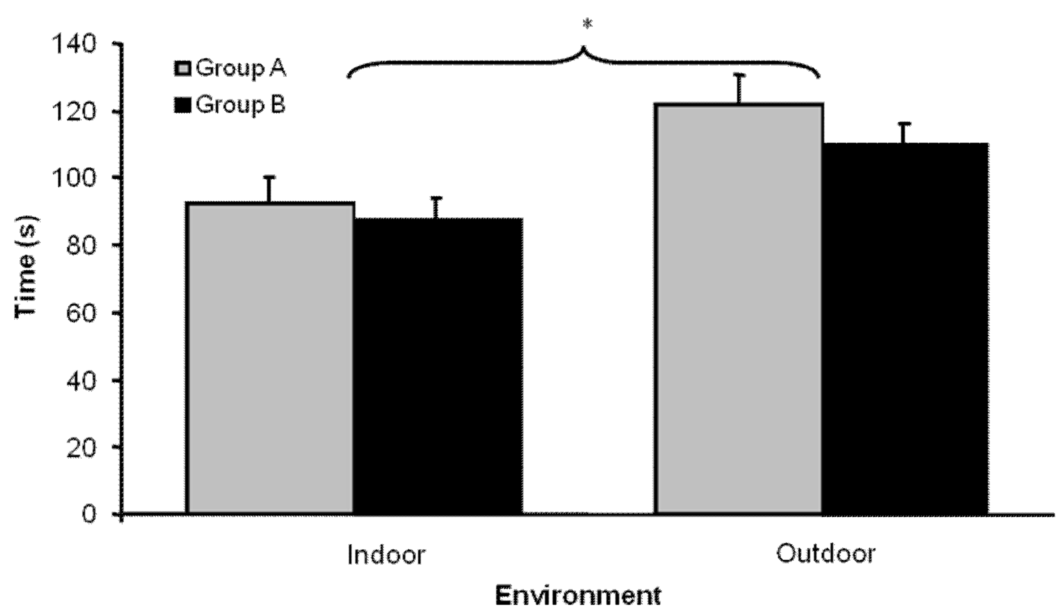

Figure 1. Total time (Mean ± SEM) used to conduct 60 arithmetical operations in cold rainy weather and indoors for group A (started first with the indoors situation) and group B (started first with the outdoors situation).
* indicates a significant difference ($p<0.001$) between the situations.

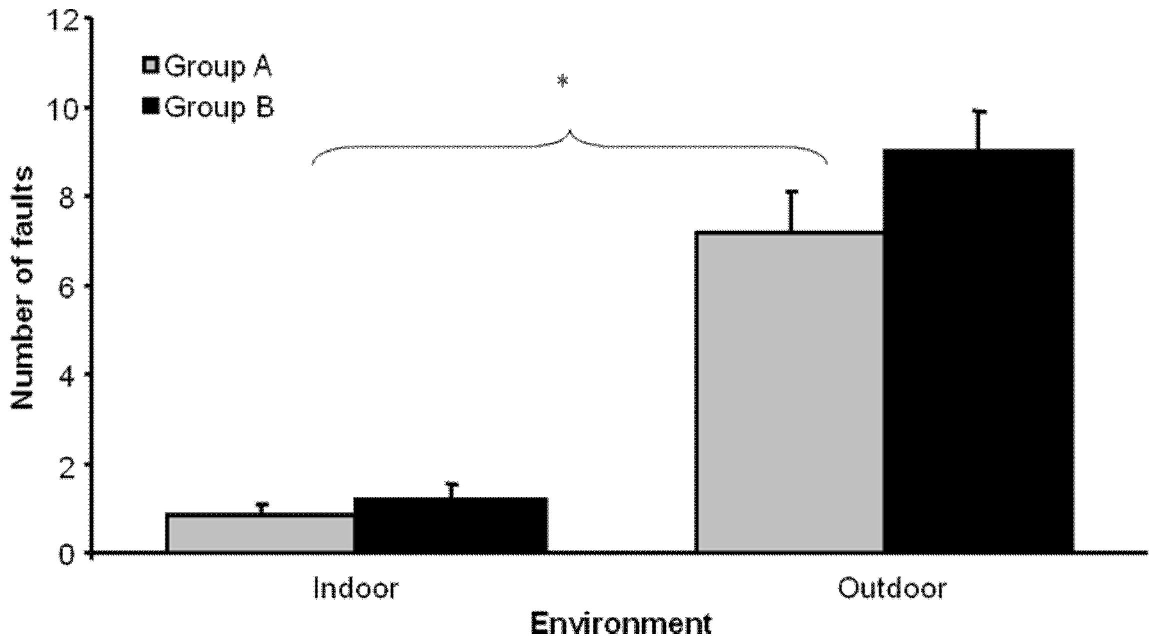

Figure 2. Total number of faults (Mean ± SEM) made of the 60 arithmetical operations in cold rainy weather and indoors for group A (started first with the indoors situation) and group B (started first with the outdoors situation). * Indicates a significant difference ($p<0.001$) between the situations

For group A, the average time in adverse conditions was 32% higher than in comfortable conditions indoors, and for group B the average time in adverse conditions was 26% higher than in comfortable conditions indoors with no significant differences between the groups. In cold rainy weather the faults increased about 13%.

4. Discussion

Cognitive performances in amateur hikers change when conducting the task in a light walk in a rainy and windy day or in an indoors situation. Most of the literature focuses mainly on extreme cold conditions (Paulus *et al*, 2009; Adam *et al*, 2008; Lieberman *et al*, 2006; Hoffman, 2001; Palinkas, 2001). However, sport is generating new motivations and new types of practice, allowing many people to do similar activities although in milder conditions. But risks and difficulties still exist and must be prevented. Those difficulties are confirmed by Mäkinen *et al* (2006), who analysed cold stress that may occur in everyday occupations, or have an effect on performance of psychomotor and cognitive tasks (Enander, 1987).

Our results are compatible with the ones found in literature. However we cannot make a direct correlation of the results (ours and from other authors) because there are differences that must not be ignored, such as the tests used, the temperatures that participants were exposed to, the duration of this exposure, the population type, and so on. Authors such as Coleshaw, Van Someren, Wolff, Davis & Keatinge (1983), using a divers sample with two-digits calculation tests speed of performance was impaired by 50% with a core temperature of 34-35º C. Even in these conditions differences in accuracy were not found when enough time was allowed for the task. In our tests results were different as we realized that in tests in cold rainy weather the faults increased in about 13%. This can result from the fact that our participants were amateur hikers with only some experience. Another reason could be the competitive context generated as everybody was answering at the same time.

Davis, Baddeley & Hancock (1975), in a similar test of 50 five-digit additions with a divers sample found a decrease of 13% in arithmetic test scores. Other study results of code substitution and code substitution delayed tests (Mäkinen et al, 2006) showed that exposure to cold is inversely associated with accuracy on the code substitution, code substitution delayed and efficiency. So, our results are compatible with the ones from most of the authors studying this matter, which indicates a reduction in the capabilities to respond to cold conditions reflected in a bigger response time.

The analyses of cold stress that may occur in everyday occupations, or have an effect on performance of psychomotor and cognitive tasks (Enander, 1987; Stang & Weiner, 1970; Coleshaw, Van Someren, Wolff, Davis & Keatinge, 1983) is another field of research where we can find results analogous to the ones we have found.

However, some authors (Ellis, 1982; Payne, 1959; Adam *et al*, 2008) showed the contrary and defended the idea that cold stress can improve the impact of dehydration. Ellis (1982) and Payne (1959) found that, in particular conditions, cold could even improve the initial performance before it results in a decrement of the same performance.

5. Conclusion

Knowing what to expect and the influence it can have on the activity is an essential instrument to organize and plan an expedition. It is not only the capability of doing a good performance that can be the problem. In an expedition, safety is the main concern and even small variations in environmental conditions can influence cognitive performance and decision making capacity. In outdoor sports when trouble occurs, even with little differences, it could become critical, unlike other situations where it would not even be taken into account.

We can conclude that even mild changes in weather environment influences cognitive performance. Therefore when practicing for an expedition we must not only consider the physical performance during the raid but also take into account the conditions that can occur and the difficulties that may result from them, especially for amateurs. But knowing what to expect and the influence it can have in the activities is also essential in education to create situations that can develop desirable behaviours.

6. References

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