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ORIGINAL ARTICLE

THE EFFECT OF ATTENTIONAL INTERFERENCE ON A ROCK CLIMBING TASK: A PILOT STUDY

Abstract

Preparatory behavior has been identified as being beneficial (i.e., achieving optimal emotional states, focused attention, etc.) to performance within various sport domains. Participants of risk sport (i.e., rock climbing, surfing, skydiving, among others) have been reported to engage in this behavior (i.e., preparatory routines, plans, strategies, etc.) in an attempt to reduce the degree of uncertainty within their domains. The ability to employ this type of behavior however requires cognitive resources and attentional focus. The present pilot study examined the effect of decreased cognitive resources (i.e., through interference tasks)on performance in a risk sport activity (i.e., rock climbing). Rock climbers (N = 18), whose attentional focus was manipulated through a series of resource-depleting tasks, climbed significantly slower,t (16) = -2.34, p< .03, than climbers who were uninhibited. The necessity of cognitive resources in preparing for a risk sport task and how the depletion of such resources may impair performance in such a task is discussed.

Key Words: *Risk sport, cognitive interference, planning, performance*

Introduction

Risk sport activities such as skydiving and rock climbing, have increased in popularity and participation (Cazenave, Le Scanff, & Woodman, 2007; Llewellyn & Sanchez, 2008; Llewellyn, Sanchez, Asghar, & Jones, 2008). Research on these activities has predominately focused on their sensation and arousal inducing elements (Heyman& Rose, 1980; Hymbaugh& Garrett, 1974; Straub, 1982). To date, no research has attempted to manipulate performance within a specific risk sport activity. The present pilot study examined the effect of attentional interference on performance within the risk sport activity of rock climbing.

Sport environments contain uncertain events that can be hazardous to those who participate. As a result, a potential for risk exists for each sport participant. The most serious sport risk regards personal safety (i.e., injury). Sports that pose a continued risk of serious physical injury or death are referred to as risk sports (Cogan & Brown, 1999; Kerr, 1991). These sports include, but are not limited to: skydiving (Celsi, Rose, & Leigh, 1993; Hymbaugh& Garrett, 1994), hang-gliding (Straub, 1982), surfing (Diehm&Armatas, 2004), rock climbing (Ewert, 1994) and scuba diving (Heyman& Rose, 1980), among others.

The ability to maintain attentional focus on a task is a prerequisite for any type of organized cognitive function (Lavie, 2005). However, one's capacity of cognitive processing is limited (Paas, Tuovinen, Tabbers, & Van Gerven, 2003). This is especially the case within a complex risk sport environment. Risk sport participants are often susceptible to the distractions of irrelevant environmental stimuli (Jackson, 2003), as these activities primarily occur in naturalistic, public forums. Focusing on irrelevant distractions can decrease one's attention from his or her primary task, and result in decreased accuracy for task completion (Ward, 2004).

The effect of limitedattentional focus on task performance has been examined within sport, as well as other domains of psychology (e.g., intelligence, education, driving performance, etc.) (Consiglio, Driscoll, Witte, & Berg, 2003; Hatzigeorgiadis& Biddle, 1999; 2001; Strayer, Drews, & Johnston, 2003). One manner in which attentional focus can be disrupted is through an increased degree of cognitive interference. Cognitive interference has been referred to as "thoughts individuals experience while performing a task but which are not related to the execution of the task" (Hatzigeorgiadis& Biddle, 2001, p. 412). This type of attentionaldisruption occurs when an individual attempts to process the features of one stimulus, while simultaneously attempting to process the unique features of another stimulus (Bush et al., 1998).As one's degree of cognitive interference increases, it can divert his or her attentional focus away from task-relevant cues, and towards task-irrelevant cues.The resultant decreased attentional focus could increase risk within the athletic activity, and subsequently increase one's susceptibility to injury.

Attending to multiple cues occupies valuable cognitive resources (i.e., general-purpose processing units) (Hockey, 1997), and subsequently may reduce one's ability to selectively attend to the priority task (Lavie, Hirst, de Fockert, & Viding, 2004). As such, a negative relationship tends to exist between disrupted attentional focus and task performance. In regards to risk sport activities, the inability to focus on task-relevant cues may interfere with an individual's ability to adequately process important contextual information. This type of information is often necessary for a risk sport participant to prepare, either mentally or behaviorally, for his or her task. Therefore, attentional disruption, in the form of cognitive interference, may lead to a measurable decrease in task performance within a risk sport.

Task performance is often affected by one's ability to prepare for the target behavior. Pre-task preparation in sport can be used to reduce physical elements of risk, as well as technical expenses (e.g., energy expenditure) (Eccles, Walsh, &Ingledew, 2002). Risk sport participants have been reported to engage in planning-related behavior to a similar degree to that of non-risk sport participants (Kerr, 1991; Kerr &Svebak, 1989). Within risk sports, preparing, which commonly takes the form of rehearsing pre-determined task-relevant behavioral responses and visually scanning the sport environment, can aid in the anticipation or avoidance of negative stimuli within the surroundings.

Preparations can also aid in reducing, to a degree, the amount of uncertainty (or unpredictability), which may accompany a risk sport. Uncertainty in sport can often lead to increased perceptions of risk by the participant. Preparing and or rehearsing behavioral responses to anticipate unpredictable stimuli (e.g., weather, equipment malfunction, etc.) can, to some degree, prepare participants for uncertainty. However, preparation requires time (Sangals&Sommer, 2010), as well as cognitive resources. While the appropriate allocation of cognitive resources can maximize attention, and subsequently enhance performance ona task, a reduction of attention, due to distracting stimuli,can result in decreased performance (Cohn, Rotella, & Lloyd, 1990).

The purpose of the present pilot study was to investigate the effect of cognitive interference on performance within a rock climbing task. Within a risk sport domain, increasing a participant's degree of cognitive interference may negatively affect his or her ability to successfully focus on task-relevant cues, which may prohibit any pre-task preparations. This inability to prepare may be detrimental to task performance. Therefore, it was hypothesized that rock climbers who were cognitively interfered with, prior to a climbing task, would subsequently climb slower on average, than rock climbers who were not cognitively interfered with.

Methods

Participants

Participants (*N* = 18) were rock climbers, whoseages ranged from 18-31 (*M* age = 22.33, *SD* = 3.76). Level of climbing experience ranged from novice (*n* = 4), to advanced beginner (*n* = 4) to competent (*n* = 10). Climbing experience was obtained via participants' responses to a self-report demographic questionnaire. There were eight female and ten male participants. Participants were recruited from an indoor rock climbing facility located in a southeastern state.

Instrumentation

Three instruments were employed to obtain data: a demographic questionnaire, a manipulation measurement, and a one item measure of preparatory behavior.

Demographic questionnaire. This questionnaire consisted of demographic details such as, age and sex. Participants also reported their current skill level within risk sports in general, and rock climbing in particular (i.e., novice, advanced beginner, competent, proficient, expert).

Manipulation measurement. Each participant responded to three 10-point Likert-type scale questions that assessed his or her motivation to climb efficiently, safely, and quickly. Response choices ranged from 1 (*not motivated at all*) to 10 (*extremely motivated*).

*Preparatory behavior measure.*A one item 10-point Likert-typed scale question was administered to experimental participants to assess the degree to which the completion of the cognitive tasks affected participants' ability to engage in preparatory behavior prior to engagement in the climbing task. Response choices ranged from 1(*my ability to prepare was not effected at all*) to 10(*my ability to prepare was extremely effected*).

Climbing facility. The study was conducted at an indoor rock climbing facility. The facility contained 11 rope stations for top-roping (i.e., vertical climbing) of up to three stories high and a bouldering area that allowed individuals to climb at low heights and primarily side to side (i.e., bouldering), without the use of protective ropes or harnesses.

Experimental Conditions

Experimental condition. Participants were informed that they would be participating in a timed vertical climbing task to the top of one of the facility's three vertical climbing walls. After participants had secured their climbing apparatus, yet prior to beginning the climb, participants were administered five cognitive tasks. The objective of these tasks was to induce a degree of cognitive interference (i.e., interfere with participants' ability to cognitively plan for the task).

Participants were first asked to verbally indicate the answer to 20 four-digit number subtraction problems (e.g., 1358-3). Mental arithmetic requires cognitive effort on the part of the participant (Berntson, Cacioppo, & Fieldstone, 1996). Participants were then administered a condensed version of the Stroop test (Stroop, 1935). This test required participants to verbally recite words that were color-coded. Participants were instructed to recite the word and not the color (e.g., blue, green, red, purple, or brown) that the word was in. Performance within the Stroop test necessitates a heightened degree of attention and is believed to require higher-order decision processing (Braun-LaTour, Puccinelli, & Mast, 2007).

Participants were then asked to correctly answer ten mathematical equations (i.e., addition, subtraction, multiplication) within a 20 second time period. Participants were also required to mentally determine the number of syllables in a group of phrases within a 45 second time period. There were two groups of phrases, each consisting of three sentences, that the participants were required to complete.

Finally, participants were asked to complete a mental puzzle (i.e., the Dot Problem). The Dot Problem is part of the Stanford-Binet Intelligence Scales, Fifth Edition (SB5), and is often used to place individuals into specialized educational programs (Mayer, 1992). This puzzle required participants to pierce a series of nine dots, with only four straight lines, without lifting their pencil from the paper. Upon completion of the tasks, participants were instructed to begin climbing and prompted to complete the task as quickly as possible.

Control condition. Participants were informed that they would be participating in a timed vertical climbing task. Once participants had secured their climbing apparatus, they were instructed to begin climbing. They too were prompted to complete the task as quickly as possible.

Climbing Task

Participants performed a timed vertical climbing task (i.e., top-roping) on an indoor rock climbing wall. Timing of the climb was monitored with a stopwatch by the researcher. The addition of the timing element was done in an attempt to motivate participants to complete the task as quickly as possible. Timing of each participant's task began with his or her first contact with the climbing wall and ended with any bodily contact with the top of the climbing wall.

Procedure

Participants were approached and recruited at an indoor rock climbing facility. Each participant was required to read and sign an insurance waiver, which detailed the potential risk and danger that accompanies rock climbing at the facility. After receiving written informed consent, each participant was instructed to complete the demographic questionnaire. After completing the questionnaire, participants were randomly assigned to either the control or experimental condition, regardless of climbing experience. Participants were then instructed to comply with the climbing facility's safety requirements (e.g., attachment of safety harness, wearing of protective equipment, etc.).

Once safety requirements were met, control participants were instructed that they would be performing a timed vertical climbing task. Participants were then instructed to begin their task, and were prompted to climb as quickly as possible. Experimental participants were also instructed that they would be performing a timed vertical climbing task. However, prior to beginning their climb, they were administered five cognitive tasks. Immediately upon completion of the tasks, participants were instructed to begin the climbing task, and were prompted to climb as quickly as possible.

Upon the completion of the climb, participants in both conditions were administered the manipulation measure, while only the experimental condition received the preparatory behavior measure. Participants were then debriefed.

Data Analysis

Descriptive statistics (i.e., mean, standard deviations) were calculated for participants' climbing times and responses to the manipulation measure items.

Inferential statistical analyses consisted of an Independent samples *t*-test to investigate the effect of the cognitive tasks (i.e., independent variable) on participants' climbing times. An additional Independent samples *t*-test was conducted to examine the effect of the manipulation on experimental group membership.

In accordance with APA guidelines (6^{th} ed., 2010), effect size information is provided to facilitate interpretation of meaningfulness of the findings. Cohen's *d* (1988) effect size estimates are provided for bivariate comparisons. For the current study, effect size estimates were interpreted according to Cohen's (1988, 1992) guidelines.

Results

Descriptive Statistics

Descriptive statistics are presented in Table 1 for participants' climbing times for the experimental conditions. Descriptive statistics for the manipulation measure items are presented in Table 2.

Table 1. Participant Climbing Times in Seconds

	Total (*n* = 18)		Control (*n* = 9)		Experimental (*n* = 9)	
	M	SD	M	SD	M	SD
Time	41.74	25.75	29.09	8.62	54.38	31.32

Table 2. Descriptive Statistics for Manipulation Check

	Total (*n* =18)		Control (*n* =9)		Experimental (*n* =9)	
Question	M	SD	M	SD	M	SD
Quickly as possible	8.00	1.41	7.67	1.32	8.33	1.50
Efficiently as possible	7.28	2.49	6.56	2.70	8.00	2.12
Safely as possible	5.28	2.85	5.78	2.95	4.78	2.82
Ability to prepare	5.56	2.74			5.56	2.74

Effect of Experimental Manipulation between Experimental Conditions

A series of Independent samples *t*-tests were conducted to examine any differences between participants' responses to each of the manipulation measure items based on experimental group membership. No significant differences in mean scores were observed between participant groups. Descriptively, experimental participants scored slightly higher (d = .47) on the itemassessing motivation to climb as quickly as possible (see Table 2). Experimental participants scored moderately higher (d = .59) on the item assessing motivation to climb as efficiently as possible. Control participants scored higher (d = .35) in regards to the item assessing motivation to climb as safely as possible.

Effect of Cognitive Tasks on Climbing Performance

An Independent samples *t*-test was conducted to examine the effect of the cognitive tasks on participants' performance on the climbing task. It was hypothesized that climbing times would be slower for experimental participants. This hypothesis was supported, as results of the *t*-test revealed a significant, t (16) = -2.34, p< .03, difference in climbing times between the two conditions. Experimental participants accounted for a large portion of the variance in climbing times (partial η^2 = .26). Furthermore, a very large effect (d = 1.10), was observed between participants, in regards to climbing times

Discussion

The purpose of the present pilot study was to investigate the effect of cognitive interference on performance within a rock climbing task. Specifically, the aim was to identify whether distracted rock climbing participants would complete a vertical climbing task slower than climbing participants whom were not distracted. Previous research has identified that cognitive interference (Hatzigeorgiadis& Biddle, 1999; 2001) as well as task-irrelevant stimuli (Jackson, 2003; Lonsdale & Tam, 2008) negatively affect task performance within the sport domain. In support, results of the present study indicate that cognitively interfered rock climbers' performed significantly worse (i.e., in terms of climbing times) than uninhibited rock climbers.

Previous research has indicated that risk sport participants do actively engage in preparatory behavior (Kerr, 1991; Kerr &Svebak, 1989). This behavior is believed to not only decrease perceptions of risk regarding uncertain environmental stimuli (Cogan & Brown, 1999; Cazenave et al., 2007; Llewellyn & Sanchez, 2008; Slanger&Rudestam, 1997), but more importantly to positively influence perceptions of control over a risk environment (Piet, 1987). Increased perceptions of control are often beneficial to risk sport task performance (Piet, 1987). Therefore, one possible explanation for the significant slower climbing times observed by experimental climbers may lie within their inability to engage in preparatory behavior for the task.

Preparatory behavior for a risk sport can include, but is not limited to, a routine of behavioral acts, such as the rehearsal of task-relevant motor movements, as well as cognitive processes, such as the attending to of task-relevant cues, the selection of a specific route and the generation of contingency plans of action (Eccles et al., 2002; Fave, Bassi, &Massimini, 2003; Harirchi, Arvin, Vash, &Zafarmand, 2005). Cognitive resources, however, are necessary in order for these routines or plans to commence. Within the present study, experimental climbing participants were distracted by task-irrelevant stimuli (i.e., cognitive tasks). Therefore, they were denied the opportunity to engage in any preparatory behavior or routine. As a result, experimental participants were unable to adequately attend to and focus on the task. Therefore, similar to previous studies (Hatzigeorgiadis& Biddle, 1999; 2001), the current sample of rock climbers' increased degree of cognitive interference may have resulted in their decreased task performance.

The completion of the cognitive tasks not only distracted the experimental participants from the task, it also likely exhausted their cognitive resources. Without an ample degree of cognitive resources, it is likely that these participants would have difficulty employing preparatory behavior, such as selecting a climbing route, mentally devising a plan or strategy of action, or selectively attending to the task. As noted, these types of preparatory behaviors are often conducive to increased sport performance (Jackson, 2003; Singer, 2002). Therefore, the distraction of the cognitive tasks, and the resulting lack of cognitive resources available for preparatory behavior, likely impaired the distracted climbers' performance.

Preparatory processes provide participants an opportunity to mentally rehearse their behavioral movements and assess their sport environment for potential risks (Eccles et al., 2002). Although, the present study did not measure preparatory behavior within all of the climbing participants (i.e., only experimental participants' degree of preparatory behavior was assessed), based on previous evidence of planning-related activity (Kerr, 1991, Kerr &Svebak, 1989),it is likely that the control participants did engage in some type of pre-task behavior. Having the opportunity to employ cognitive and behavior processes in the waning moments preceding a sport-related task is vital to performance (Jackson, 2003). A routine visual strategy, such as scanning the climbing wall, may have provided control participants with information pertaining to the location of various hand and foot holds on the climbing surface, as well as the availability of pre-determined routes or sequences to the top. This information alone would provide a strategic advantage over the climbing task, and consequently may have increased task performance.

Although the degree of preparatory behavior was not assessed within the non-distracted climbers, the aim of the experimental manipulation was to increase the degree of cognitive interference within experimental participants, and subsequently inhibit their degree of cognitive resources available for pre-task preparation. This manipulation was successful as preparatory behavior by experimental participants was suppressed. Additionally, it is likely that this inability to prepare was due to the cognitive tasks employed prior to the task. Therefore, as the manipulation of cognitive resources was the only measurable difference between the two groups, it is likely that the resulting interference influenced the decreased task performance observed.

Conclusion

Engaging in preparatory behavior in any sport or athletic activity is beneficial to performance. In regards to risk sports, this type of behavior can provide participants with several important advantages (e.g., knowledge of task-relevant cues, awareness of potential environmental hazards, etc.). When risk sport participants are prohibited from engaging in this type of behavior, a measurable decrease in task performance may be observed. Although within the current investigation preparatory behavior was not measured within all of the climbers, the manipulation of cognitive resources, prior to the risk sport task resulted in a significant decrease in performance. Specifically, climbers who were distracted via cognitive interference recorded significantly slower climbing times then non-distracted climbers. Therefore, although the results of the present study cannot confirm that preparatory behavior is directly beneficial to performance within a risk sport task, it does provide empirical evidence that the deprivation of cognitive resources does negatively affect performance within such a task.

Limitations and Future Directions

This investigation was a pilot study, and therefore several limitations exist. Of primary concern was the methodological design. Although participants in the control condition were not subjected to the cognitive tasks, they were also not allotted a specific time interval, equivalent in length to that of the time required to complete the cognitive tasks, to prepare themselves if they so chose to. Additionally, control participants were not administered the preparatory measure and as such, the degree of preparation engaged in by these participants, if any, was not assessed. This prohibited any direct comparisons in preparatory behavior between the two participant groups.

Another limitation resided in the climbing wall used for the task. The wall used was one of the least challenging walls available at the facility. The close proximity of hand and foot placements allowed some climbers to climb very quickly, and may have detracted from the need to engage in any prolonged preparatory behavior.

Future research within this area should assess the degree of preparatory behavior within all participants. Additionally, future investigations should include a "preparation" condition, in which participants are encouraged to engage in preparatory-related behavior. The addition of a preparatory condition would enable a more comprehensive examination of the degree of this behavior, if any, between participants who are prompted to prepare verses those who are unprompted or inhibited from preparing. Steps should also be made to assess the duration of time between when participants are instructed to begin their task, and when they actually start the task. This would provide another measure of the potential cognitive resources devoted to preparatory behavior.

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