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Workload and cortisol levels in helicopter combat pilots during simulated flights

A. García-Mas[a], E. Ortega[b], J. Ponseti[c,*], C. de Teresa[d], D. Cárdenas[e]

[a] Psychology Faculty, Universitat de les Illes Balears (UIB), Cra. Valldemossa, km. 7.5, 07122 Palma de Mallorca, Illes Balears, Spain
[b] Facultad de Ciencias del Deporte, Universidad de Murcia, Spain
[c] Department of Pedagogy, Physical Education and Sports, Universitat de les Illes Balears (UIB), Spain
[d] Andalusian Center of Sports Medicine, Ministry of Tourism and Sports, Regional Government of Andalusia, Spain
[e] Department of Physical Education and Sport, Faculty of Sport Sciences, University of Granada, Spain

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ABSTRACT

Objective: Examine and compare the cortisol levels before and after a simulated flight related to workload in experienced helicopter combat pilots, searching for physiological levels of anxiety.
Method: 15 volunteer Spanish Army helicopter combat pilots (36.83 ± 8.04 years) were studied before and after a simulated flight (eight new tasks). Salivary cortisol was measured by DRG salivary cortisol ELISA, and we studied workload using the NASA-TLX.
Results: The differences in the mean values of cortisol level before (5.33 ± 1.55) and after the task at the flight simulator (4.47 ± 0.73) are statistically significant (t_{14} = 3.301; p = .005) with a high effect size (d = 0.75). Similar significant differences were also found (t_{14} = 3.301; p = .005) between the workload before (19.76 ± 10.54), and after the task (24.82 ± 10.42; medium effect size d = −0.48). No significant relationships were found between the cortisol levels and the workload.
Conclusions: Cortisol levels in saliva and workload are the usual in stress situations, and change inversely: workload increases at the end of the task, whereas the cortisol levels decrease after the simulated flight. The somatic anxiety decreases as the task is done. In contrast, when the pilots are faced with new and demanding tasks, even if they fly this type of helicopter in different conditions, the workload increases toward the end of the task. From an applied point of view, these findings should impact the tactical, physical and mental training of such pilots.

Carga mental y niveles de cortisol en pilotos de helicóptero de combate en vuelos simulados

Palabras clave:
Carga de trabajo
Ansiedad
Cortisol
Vuelos simulados
Helicópteros de combate
Pilotos

RESUMEN

Objetivo: Examinar y comparar los niveles de cortisol antes y después de un vuelo simulado en relación con la carga de trabajo de pilotos de helicópteros con experiencia de combate, en busca de niveles fisiológicos de la ansiedad.
Método: Se estudió a 15 pilotos de helicópteros voluntarios del Ejército Español (36.83 ± 8.04 años) antes y después de un vuelo simulado compuesto por 8 tareas nuevas. El cortisol salival se midió por DRG Cortisol ELISA y la carga de trabajo con el NASA-TLX.
Resultados: Las diferencias entre los valores medios de nivel de cortisol antes (5.33 ± 1.55) y después de la tarea en el simulador de vuelo (4.47 ± 0.73) son estadísticamente significativas (t_{14} = 3.301; p = 0.005; elevado tamaño de efecto, d = 0.75), así como (t_{14} = 3.301; p = 0.005) entre la carga de trabajo antes (19.76 ± 10.54) y después de la tarea (24.82 ± 10.42; tamaño de efecto medio, d = −0.48). No hubo relaciones significativas entre los niveles de cortisol y la carga de trabajo.

* Corresponding author.
E-mail address: xponseti@uib.es (J. Ponseti).

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Conclusiones: Los niveles de cortisol en saliva y la carga de trabajo son habituales en situaciones de estrés, y cambian inversamente: la carga de trabajo aumenta al final de la tarea, mientras que los niveles de cortisol —y de ansiedad somática— disminuyen después del vuelo simulado. En cambio, frente a tareas nuevas y exigentes, la carga de trabajo aumenta al final. Estos hallazgos deberían afectar la planificación del entrenamiento táctico, físico y mental de estos pilotos.

Carga de trabalho e níveis de cortisol em pilotos de helicópteros de combate durante voos simulados

Palavras-chave:
Carga de trabalho
Ansiedade
Cortisol
Voos simulados
Helicópteros de combate
Pilotos

R E S U M O

Objetivo: Examinar e comparar os níveis de cortisol antes e depois de voo simulado em relação a carga de trabalho de experientes pilotos de helicóptero de combate, procurando por níveis fisiológicos de ansiedade.
Métodos: 15 voluntários pilotos de helicópteros de combate do exército espanhol (36.83 ± 8.04 años) foram estudados antes e depois de um voo simulado (8 novas tarefas). Cortisol salivar foi mensurado por DRG *Cortisol* salivar ELISA, e foi estudado a carga de trabalho usando o NASA-TLX.
Resultados: As diferenças nos valores médios dos níveis de cortisol antes (5.33 ± 1.55) e depois da tarefa no simulador de voo (4.47 ± 0.73) foram estatisticamente significantes ($t_{14} = 3.301$; $p = .005$) com o tamanho do efeito ($d = 0.75$). Diferenças significantes similares também foram encontradas ($t_{14} = 3.301$; $p = .005$) entre a carga de trabalho antes (19.76 ± 10.54), e depois da tarefa (24.82 ± 10.42); tamanho do efeito médio ($d = -0.48$). Nenhuma relação significativa foi encontrada entre os níveis de cortisol e a carga de trabalho.
Conclusão: Níveis de cortisol na saliva e carga de trabalho são comuns em situações de estresse, e mudam inversamente: a carga de trabalho aumenta ao final da tarefa, enquanto o nível de cortisol diminui depois do voo simulado. A ansiedade somática diminui quando a tarefa acaba. Em contraste, quando os pilotos enfrentam uma nova e exigente tarefa, mesmo que eles voem no mesmo tipo de helicóptero em diferentes situações, a carga de trabalho aumenta em direção ao final da tarefa. Para um ponto de vista aplicável, os achados devem impactar o treinamento tático, físico e mental destes pilotos.

Introduction

It has been well known that the cortisol levels are related with anxiety and anger in performance situations.[1] Globally, it has been demonstrated preferentially in athletes,[2–5] although there are other demanding performance settings.

Military combat helicopter pilots have a great physical and mental demanding tasks, forcing them to undergo high training loads and long-duration flights.[6]

Mental effort is tightly related to *cognitive workload*, and this to the amount of information and the level of processing that information demands. Or, in other words, cognitively loading tasks are those requiring managing and operating with large amounts of information in a non-automatic way as piloting an aircraft. In addition, mental workload has emotional correlations. In general, the effort associated to mental workload is hedonically negative, and increases general arousal. Indirectly, load makes tasks subjectively more difficult, and elicits more errors, which can imply more frustration and a lesser sense of self-efficiency.[7–9]

The anxiety reaction is an emotional state characterized by high activation levels of the autonomic nervous system, stress, worry that can alter attentional processes and other cognitive functions.[10] These responses depend critically on the subject's perception of a situation as challenging, potentially dangerous, or harmful.

Somatic anxiety is the direct result of increased physiological arousal, showing several bodily signs.[8]

Psychological manifestations such as fear, panic, alarm, restlessness, apprehension, obsessions, and attentional changes, or intrusive thoughts[9] make up cognitive anxiety, which in turn is split into two components: preoccupation or worry regarding the consequences associated with a poor performance and lack of attention, which prevents clear thinking during the task.[11,12]

Both types of anxiety can be modulated by their interpretation by individuals, who even may believe them to be beneficial to his performance,[13] indeed developing a sense of "excitation",[14] which does not interfere negatively with their performance.

However, it is known that the directional component of anxiety depends on various factors, such as the preceding temporal patterns of response to the anxiety, or the type of task.[15]

Considering these antecedents, the objective of this study is to examine and compare the cortisol levels before and after an helicopter simulated flight which includes a complex set of tasks, related to the perceived workload levels in experienced combat pilots, in order to determine the physiological levels of task related anxiety.

Method

Subjects

15 volunteer military helicopter combat pilots (14 men and 1 women) from the base in Almagro, Ciudad Real (Spain), with a mean age between 25 and 52 years ($M = 36.83$; $SD = 8.04$), took part in this study (see Table 1, where personal and professional data are explained). This sample means the whole population certified for to flight in the Spanish solely combat helicopter type ("Tigre"). The academic training and military rank were diverse, between the foreman and the lieutenant colonel. In order to take part in the experiment, participants were required to maintain a regular sleep–wake cycle for at least one day before the study and to