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認知神經科學對軍事訓練之影響及發展

Investigate the impacts and development of neurocognitive science in military training

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摘　　要

當前國際局勢複雜且難以預測，中國大陸對我國的軍事威嚇日漸頻繁，爲使我國國軍官兵在面對壓力及複雜的環境下。官兵需要具備各種軍事相關技能方能順利遂行任務。此外，因應國防政策的改變，編制內人力縮減，如何將有限的人力資源做最有效的分配亦是我們關心的議題。因此，瞭解官兵在軍事任務中必須具備的能力對於軍隊未來專業人才培育至關重要。然而，國內對於軍事表現之文獻探討仍相當缺乏，特別是在認知神經科學方面。有鑒於此，爲了更進一步瞭解影響軍事表現之認知功能相關因素，本篇文章將透過關鍵詞選出相關文獻並加以評述，此外，我們還深入探討了認知功能訓練在軍隊這類特殊環境中的意義和實際應用。本研究將根據所整理之研究結果與趨勢，提出未來軍事訓練計畫安排之參考及應用，具體如下：建議在日常的體能戰技及軍事專業專長訓練中，適時融入心理技能及動作認知功能訓練以協助官兵在複雜、不確定和緊張的軍事行動中獲得更好表現。其次，從單兵裝備到無人載具，腦機介面在軍事領域的發展潛力不可限量，未來可將相關技術進行調整以符合國軍作戰需求，並實際應用於部隊當中。最後，建議國軍各軍事校院及官方研究機構將認知神經科學納入研究方向，並加深國軍在認知神經科學領域的瞭解及發展其軍事應用價值。

關鍵詞：心理技能、認知功能、腦機介面

Abstract

Amid the current global landscape, the international conflict scenario has grown increasingly intricate and unpredictable, with China's military threat accelerating its complexity. Taiwanese military grapples with many challenges, necessitating soldiers to possess a diverse skill set for the successful execution of each mission. Nevertheless, optimizing human resources by strategically assigning individuals to suitable roles could significantly enhance operational efficiency. Therefore, understanding the abilities related to military performance is an essential issue people need to consider. In order to address the need stated above, this study conducts an extensive narrative review to explore the multifaceted factors influencing military performance, including physical fitness, tactics skills, and psychological factors.

Furthermore, this paper examined the significance and practical applications of psychological skills and cognitive function training within the distinctive context of the military. The result recommends integrating motor-cognitive training into military programs to enhance soldiers' cognitive functions, ultimately improving their performance in complex, uncertain, and stressful operations. Secondly, the rapid development of brain-computer interfaces in the military, whether implemented in personal helmets or unmanned vehicles, is noteworthy. The investigation by this paper suggests that future studies should focus on designing tailored equipment based on soldiers' physical features, considering diverse operational requirements in Taiwan. Lastly, military academies and research institutes can contribute by developing cognitive-related research to understand underlying mechanisms and optimize applications.

Keywords: Psychological Skills, Cognitive Function, Brain-Computer Interface

壹、前　　言

我國軍為因應作戰型態改變，自民國100年12月28日「兵役法」修正公布後，國防部即展開「募兵制」的相關執行工作。其中，為打造「小而精、小而強、小而巧」的專業化常備部隊，如何知人善任、用人唯才是國軍需要面臨的一大考驗。[1] 在各級部隊中，指揮官及領導幹部的能力攸關單位風氣及戰訓任務之執行成效，而在基層部隊軍士官幹部有多數來自國防部下轄之三軍九校院，分別為國防醫學院、國防大學理工、管理、政戰學院、陸、海、空軍官校、陸軍專科學校、空軍航空技術學院。此外，現今國軍官兵退役大致區分為以下幾種情況：合約期滿、軍事院校學生服役管制期滿、符合服役20年領取終身俸、提前退役等。其中，合約期滿及軍校生役期管制期滿退伍雖多為個人生涯考量，然而，國家花費大量金錢及資源培育出一位軍官或士官實屬不易，如何將培育多年的軍事幹部留在部隊，創造更多的價值，達到長留久用是人才培育的最終目標。為此，瞭解軍事人員需具備的能力，並進行針對性的訓練，提升軍事表現，使官兵能夠在工作中找尋到自我的成就感及歸屬感，有望大幅提升其持續留營服役的意願性。

此外，軍事人員在執行任務中所需面對的情況複雜且不乏許多特別的認知挑戰，包含：極度的身體和精神疲勞、高壓和焦慮，甚至是高度不可預測的環境等。[2] 縱使條件惡劣，軍事人員仍須保持高水平的認知表現，其中，認知功能作為旨在探討人類感知及決策歷程的能力，其在軍事領域的應用性是我們感興趣的部分，然而，過去國內研究多在探討體能及戰術相關問題，鮮少針對心理技能訓練及認知功能進行探討。有鑒於此，為深入瞭解國軍軍事人員需要具備的生心理特質及認知功能在軍事領域的應用性，本研究將從軍事角度探討可能影響軍事人員工作表現的因素，其中包括生理和心理因

1 林澤助，〈影響國軍推動「募兵制」關鍵因素探討〉，《國防雜誌》，第25卷第2期，頁102-112。

2 Campbell, D. J., & Nobel, O. B. Y. "Occupational stressors in military service: A review and framework," *Military Psychology*, Vol.21, No.2, 2009, pp. 47-67.

素。同時，將探究軍事人員在心理技能和認知功能之訓練方法以及應用情境，以文獻回顧(literature review)的方式，使用英文關鍵詞：(military OR cadets) AND (physiological OR cognitive function OR executive function OR psychological skills training OR motor-cognitive training OR brain-computer interface)從PubMed和Google Scholar等國外資料庫，蒐集正式出版在專業期刊之英文文獻，不包括未出版之碩博士論文，關鍵詞均以交集作為搜尋之標準，並就目前相關理論及應用研究加以整理。此外，學術研究的終點並不僅止於實驗室，而是需要應用到實際場域，因此作者透過網路搜尋引擎查詢「認知科學於軍事應用」，將我國國軍及美軍相關公開資料及研究報告進行蒐集後進一步探討認知神經科學於軍事領域之研究趨勢及限制，提供未來軍事人員訓練計畫制定之參考依據及未來可能之研究方向。

貳、國軍幹部人力資源現況

現今國軍軍士官幹部來源包含軍事校院正期畢業生、志願役專業預備軍（士）官班及志願役士兵晉升，縱使有多種管道可進用人力，但最重要的是如何留住人才並透過適才適用，將個人的優點最大化的發揮在他後續的工作及團體之中，如此既能保障工作任務順利遂行，更能使人在工作中得到更多的肯定及成就感，提升工作幸福感。在探討適才適用的第一步即是因應部隊特性選擇合適人才。國軍部隊分為以下軍種區分：陸軍、海軍、空軍、憲兵、海巡署；性質區分：戰鬥單位、戰鬥支援單位、後勤單位、國防部直屬單位；地域則區分為：本島及外離島。每一個的單位的特性及工作需要對應不同的人才需求，舉例來說：特戰部隊及戰鬥單位在單兵身體適能及協調性的要求較高，官兵需要藉此支持戰技術操作；砲兵中高階專長，包含：射擊指揮、測量及觀測專長不僅需要官兵擁有良好的數學運算能力（包含對數及三角函數），更需要有良好的方向方位概念。由此可見，各部隊如果在接收新進人員時即接收到相關領域專長人才，對於主官及幹部在分配職位、業務及派訓時，可以達到事半功倍的效果。

美國西點軍校畢業生於畢業前夕的兵科之夜(Branch Night)及分配之夜(Post Night)根據他們在校的綜合成績選擇軍種及畢業後第一個任職的單位。過去研究透過西點軍校學生美國大學入學測驗成績(Scholastic Aptitude Test, SAT)學術成績(academic GPA)及軍事成績(military GPA)，追蹤其後續工作狀態發現，研究顯示軍事成績可以有效預測畢業生在畢業後被提前晉升或擔任營級指揮官的的可能性，然而，SAT成績卻與職業成功呈現負相關，由此可知，學術成績不能概括到後續在軍旅生涯的發展及成就，而在校期間系統化及標準化的軍事訓練及評分更能幫助我們對軍校生未來的軍旅生涯提供一個有效的參考指標及職涯選擇建議。[3] 此外，據美國陸軍社會及行為科學研究所的一項調查研究利用了人才需求調查(survey of talent requirements, STR)進行數據蒐集及分析，STR是一種衡量美國陸軍軍官完成工作

3 Spain, E. S., Lin, E., and Young, L. V. "Early predictors of successful military careers among West Point cadets," *Military Psychology*, Vol.32, No.6, 2020, pp. 389-407.

所需要的才能、技能及能力的量表，項目共由四個部分組成，分別為：調查背景、才能要求、技能和能力要求及其他工作要求，結果發現在不同的職能領域注重的技能也不盡相同，調查顯示，若要優化陸軍人才管理，必須制定一個以職位分析為基礎的人才要求框架，才能更有效的招募、聘用及培養相關人才。[4] 目前國軍在進用人力時採用智力測驗及相關加分條件所得之綜合成績進行排序，再由個人依志願序進行軍種及兵科選擇，而軍事院校畢業生選填兵科單位的政策則是依據學業成績進行官科及單位的抽籤或選填，是否能真正做到適才適用？本研究將從軍事人員須具備的條件進行探討。

此外，軍事校院是國軍幹部的搖籃，亦承擔起最重要的軍士官養成教育，而畢業生分發到部隊後的職涯追蹤部分乃是檢視及調整現行輔導政策可行性的重要途徑。其中，國防大學理工學院為了進一步追蹤畢業生在分發至部隊後的工作狀況，設置「職涯發展中心」，提供職涯及進修規劃等相關諮詢服務，包含：任官分發資訊、安排諮詢委員對校內學生經驗分享及諮詢座談、針對個案安排諮詢人員進行職涯發展輔導以及製作各系所畢業校友經驗傳承影片等。其目的是幫助理工學院的在校生及畢業生更加快速地融入部隊環境及文化，達到長留久用的目的。而理工學院的實施辦法。[5]

參、軍事人員須具備之條件

軍人為一特殊族群，其工作的特殊性驅使官兵在執行任務時需要擁有良好的身體素質及體能，近年來，陸軍司令部積極推動運動員戰士(athlete warrior)，強調軍人必須如同職業運動員般，透過充分的睡眠、均衡的營養及多元的活動將自身的生理及心理維持在最佳狀態以捍衛國家。在體能戰技種子教官部分，除了陸軍步兵訓練指揮部原有的體能幹部訓練班及運動科學師資班以外，士官養成部分，陸軍專科學校於民國107年正式成立體育科，並於民國111年起更名為運動科學科，在軍官養成部分，陸軍軍官學校於民國109年正式成立運動科學系，這也意味著國軍將透過軍校養成方式為部隊注入基礎學識扎實且接受過完整訓練的體育新血，貫徹「體力即國力、強國必先強身」的宗旨。此外，對於幹部及部隊指揮者來說，如何在壓力下進行最佳決策並利用有限的資源帶領部屬發揮最大的作戰效能則需要有強大的心理及認知能力支持，有鑒於此，以下著重於心理面向進行討論。

除了體格及體能戰技以外，心理能力在軍事人員日常工作中亦佔有舉足輕重的地位，過去在戰爭時期，軍事行動及任務總是帶給軍人難以想像的壓力，然而，縱使現在正處和平時期，但軍人的壓力並沒有隨著戰

4 Boyle, B. E., Darbor, K. E., Cato, C. R., Kammerer, W., and Thurston, J. *Survey of Talent Requirements: Talents, Skills, and Abilities of Army Officers by Branch and Functional Area* (Technical Report 1418), U. S. Army Research Institute for the Behavioral and Social Sciences, 2022.

5 國防大學理工學院，〈職涯發展中心〉，《國防大學理工學院》，<https://www.ccit.ndu.edu.tw/unit/100051/24537>（檢索日期：2023年11月7日）；謝沛宸，〈理工學院職涯發展中心　助長留久用〉，《青年日報》，2022年7月31日，<https://www.ydn.com.tw/news/newsInsidePage?chapterID=1522172&type=military>（檢索日期：2023年11月1日）

爭的停止而有所降低。[6] 現代化的國軍除了維持日常的戰訓本務以外，操演數量逐年增加、文書業務、災害防救、人才招募等工作帶給各級單位有別於以往的壓力型態。國軍現行作業僅針對入伍人員由身心科醫師進行心理健康評估，而現役官兵除了基層的心輔人員外，更多的是仰賴班排組長的關心及疏導。過去在軍事心理學多將研究重點放在創傷後壓力症候群(post-traumatic stress disorder, PTSD)。[7] PTSD通常指人經過重大事件或不幸的遭遇後，其記憶和恐懼揮之不去，其大致分為三大症候群：再體驗症狀(re-experiencing)、迴避症狀(avoidance)及過度焦慮症狀(hyperarousal symptoms)，而這些症狀不只困擾患者本身，更會對其身邊親近的家人朋友增加緊張及焦慮。[8] 現今的國軍雖然目前未面臨殘酷的戰爭，但在日常的任務操演仍然存在許多壓力及危險性，甚至還有可能目擊弟兄殉職或自縊已遂的情況，這些都是有可能造成PTSD的因素。過去已有許多研究發現心理韌性(resilience)、恆毅力(grit)及自我效能(self-efficacy)與軍事人員日常訓練、任務及留任（營）意願具有顯著的關聯性。[9] 以下將就這幾項能力與軍事表現的關聯性進行探討。

一、心理韌性

心理韌性亦被稱為復原力，表示人們會在遇到困難及壓力時，將事件轉換為有價值、可控制且具有挑戰性的任務，並期許自己能透過這個機會學習並成長。過去研究指出軍事心理韌性與PTSD有關，可區分為個人特質及人際關係兩種面向。[10] 在個人特質

6 Bartone, P. T. "Resilience under military operational stress: can leaders influence hardiness?" *Military Psychology*, Vol.18, 2006, pp. 131-148.

7 Dekel, R., and Monson, C. M. "Military-related post-traumatic stress disorder and family relations: Current knowledge and future directions," *Aggression and Violent Behavior*, Vol.15, No.4,2010, pp. 303-309.
Forbes, D., Pedlar, D., Adler, A. B., Bennett, C., Bryant, R., Busuttil, W., Cooper, J., Creamer, M. C., Fear, N. T., and Greenberg, N. "Treatment of military-related post-traumatic stress disorder: challenges, innovations, and the way forward," *International Review of Psychiatry*, Vol.31, No.1, 2019, pp. 95-110.
Monson, C. M., Schnurr, P. P., Resick, P. A., Friedman, M. J., Young-Xu, Y., and Stevens, S. P. "Cognitive processing therapy for veterans with military-related posttraumatic stress disorder," *Journal of Consulting and Clinical Psychology*, Vol.74, No.5, 2006, p. 898.

8 Dekel, R., and Monson, C. M. "Military-related post-traumatic stress disorder and family relations: Current knowledge and future directions," pp. 303-309.

9 Eskreis-Winkler, L., Shulman, E. P., Beal, S. A., and Duckworth, A. L. "The grit effect: Predicting retention in the military, the workplace, school and marriage," *Frontiers in Psychology*, Vol.5, No.36, 2014, pp. 1-12.
Kelly, D. R., Matthews, M. D., and Bartone, P. T. "Grit and hardiness as predictors of performance among West Point cadets," *Military Psychology*, Vol.26, No.4, 2014, pp. 327-342.
(Boe et al., 2018) *International Journal of Learning, Teaching and Educational Research*, Vol.14, 2018, pp. 18-42.
Bartone, P. T. "Resilience under military operational stress: can leaders influence hardiness?" pp. 131-148.

10 McGarry, R., Walklate, S., and Mythen, G. "A sociological analysis of military resilience: Opening up the debate," *Armed Forces and Society*, Vol.41, No.2, 2015, pp. 352-378.

部分，美軍使用之部屬風險及心理韌性量表(Deployment Risk and Resilience Inventory, DRRI)被認為是一個評估軍事人員及退役軍人在被派任至戰區前後的心理風險和復原力的可靠方法。而心理韌性高的軍人除了不易患上PTSD外，更有可能在經歷事件後更加成長(post-traumatic growth, PTG)。[11] 針對國軍醫療中心核生化防護官兵及護士進行了一項橫斷面研究，探討了不同應對策略對官兵復原力及心理健康的影響，結果發現當採用積極應對而非消極迴避策略時，官兵的復原力的指數會更高並可進一步提高官兵工作能力及健康感知狀態。[12] 在人際關係部分，其範圍包括：家庭、分配單位的影響、戰後或移防後家庭團聚對軍人家屬的潛在影響等。因此，對於復原力機制的建設不僅限於軍人家庭，個人、家庭及社區的支持也是極為重要的一部分。[13]

美軍為了幫助士兵、家庭成員和陸軍文職人員在面對陸軍生活中常見的挑戰時保持心理健康，增強心理韌性並提高工作績效提出了許多相關計畫。[14] 一般來說，軍事心理韌性可以透過特定方法進行訓練，例如：美軍預防、心理韌性和準備局(Directorate of Prevention, Resilience and Readiness)的士兵綜合體能(Comprehensive Soldier Fitness, CSF)以及根據美國賓夕法尼亞大學復原力計畫(Penn Resilience Program)所開發出的美國陸軍復原力種子培訓課程(U.S. Army Master Resilience Trainer course)，課程中將由專家對各單位種子師資進行授課，再由這些種子師資回到各部隊進行心理韌性的知識及訓練推廣，美軍也強調：「韌性是一種思考方式，可以讓士兵不陷入弄巧成拙的陷阱。一位優秀的士兵，需要具備一個有彈性的頭腦，才能正確看待金錢問題、人際關係問題、健康問題或戰場上的悲劇，這樣的士兵才能持續且有效的執行任務和維持生活。」簡而言之，就是必須學會彈性思考。[15] 此外，近年更有學者提出虛擬實境壓力復原力訓練(STress Resilience in Virtual Environments Project)，其目的為使官兵可以提前熟悉可能遭遇之場景，以便提前進行心理建設並掌握必要的應對措施。[16] 然而國軍現行針對心理韌性的培

11 Angel, C. M. "Resilience, post-traumatic stress, and posttraumatic growth: Veterans' and active duty military members' coping trajectories following traumatic event exposure," *Elsevier*, Vol.47, 2016, pp. 57-60.
Tsai, J., Sippel, L. M., Mota, N., Southwick, S. M., and Pietrzak, R. H. "Longitudinal course of posttraumatic growth among US military veterans: Results from the National Health and Resilience in Veterans Study," *Depression and Anxiety*, Vol.33, No.1, 2016, pp. 9-18.

12 Chen, K.-J., Yang, C.-C., and Chiang, H.-H. "Model of coping strategies, resilience, psychological well-being, and perceived health among military personnel," *Journal of Medical Sciences*, Vol.38, No.2, 2018, pp. 73-80.

13 McGarry, R., Walklate, S., and Mythen, G. "A sociological analysis of military resilience: Opening up the debate," pp. 352-378.

14 Reivich, K. J., Seligman, M. E., & McBride, S. "Master resilience training in the US Army," *American Psychologist*, Vol.66, No.1, 2011, p. 25.

15 C. Todd Lopez, "Soldiers learn to impart mental toughness on others," U.S. ARMY, 19 Aug 2009, <https://www.army.mil/article/26221/soldiers_learn_to_impart_mental_toughness_on_others >（檢索日期：2023年11月3日）

訓較少，多以邀請專家講座分享為主，未來可聘請專業師資對各級軍士官幹部進行種子培訓，再由種子教官回到各部隊進行推廣，且不限定特定軍種及官科人員才得以參加培訓，對於基層部隊來說，每天生活在一起的不是專業心輔人員，而是士官及基層軍官幹部，應將相關技能交付於他們，以便可以在日常工作發揮最大的效益。

二、恆毅力

恆毅力意味著一個人對長期目標展現出來的堅持與熱情，在失敗、逆境及進度受到困難阻礙時仍能迎向挑戰，具有恆毅力的人其優勢在於耐力，即使面對失望或對事物感到厭倦之時，依然能夠堅持到底直到達成目標。[17] 此外，恆毅力也被證明可以用於預測婚姻、學術及職業相關的成就。[18] 現今的軍隊對軍人在各方面的要求越來越高，然而礙於職務的調整及操演任務逐年增加，導致許多軍人與家人聚少離多，這樣的職業特性使得官兵常年無法兼顧事業及家庭，對於期滿留營意願也會有顯著的影響，因此作為一位軍職人員，尤其是具有領導責任的幹部，恆毅力對其成功表現的重要性更加顯而易見。[19]

過去研究對842位陸軍特種作戰部隊選拔的訓員實施恆毅力李克特五點量表測驗，結果發現，恆毅力得分較高的訓員自願退訓的比例較低，值得注意的是，在控制了一般智力及體能表現因素後，恆毅力對訓員留下並通過訓練的預測力仍然存在，由此可知，智力及體能表現固然重要，然而，軍事訓練的通過與否更可能隨著訓員的恆毅力表現提升而有正向的提高。因此，一個軍人是否可以堅持艱困的訓練、完成任務以及持續留在部隊服役，恆毅力亦是需要被考量的因素之一。[20] 美軍曾在2023年5月於田納西州進行為期12天的GRIT試點計畫，計畫中邀請在恆毅力界的專家對官兵進行恆毅力相關訓練，透過身體、心理、營養和睡眠準備訓練幫助官兵提升軍事表現及士氣，並將相關知識和親身體會之經驗帶會所屬部隊，而參訓官兵也透過課程得到了正向的提升，特別是在精

16 Rizzo, A., John, B., Newman, B., Williams, J., Hartholt, A., Lethin, C., and Buckwalter, J. G. "Virtual reality as a tool for delivering PTSD exposure therapy and stress resilience training," *Military Behavioral Health*, Vol.1, No.1, 2013, pp. 52-58.

17 Duckworth, A. L., Peterson, C., Matthews, M. D., and Kelly, D. R. "Grit: perseverance and passion for long-term goals," *Journal of Personality and Social Psychology*, Vol.92, No.6, 2007, p. 1087.

18 Duckworth, A. L., and Quinn, P. D. "Development and validation of the Short Grit Scale (GRIT–S)," *Journal of Personality Assessment*, Vol.91, No.2, 2009, pp. 166-174.
Eskreis-Winkler, L., Shulman, E. P., Beal, S. A., and Duckworth, A. L. "The grit effect: Predicting retention in the military, the workplace, school and marriage," pp. 1-12.
Robertson-Kraft, C., and Duckworth, A. L. "True grit: Trait-level perseverance and passion for long-term goals predicts effectiveness and retention among novice teachers," *Teachers College Record*, Vol.116, No.3, 2014, pp. 1-27.

19 Kelly, D. R., Matthews, M. D., and Bartone, P. T. "Grit and hardiness as predictors of performance among West Point cadets," pp. 327-342.

20 *Ibid*.

神層面，該計畫預計將在2025年繼續向外推廣。[21] 試點計畫的成功足以成為我國國軍在恆毅力提升方面之借鏡，未來可加入新兵訓練或養成教育課程，使官兵認知到如何在繁忙的工作中，即時的自我調整，甚至可用於嚴苛的特種部隊選拔中，在體力及精神都承受極大負荷之下，幫助官兵堅持到最後一刻。

三、自我效能

自我效能是由社會認知理論之父，心理學家班杜拉(Albert Bandura)所提出，為一個人運用自身過去成就與表現(performance accomplishments)、替代的經驗(vicarious experience)、言語上的勸說(verbal persuasion)及情緒上的激擾(emotional arousal)，相信自己能夠達成特定任務的信念，具體來說，自我效能較高的人，在遇到困難且具有挑戰性的任務時，能堅持自己的信念及行為，且在面對逆境時，仍能通過自己堅持不懈的努力進而克服困難達成目標。[22] 班杜拉也針對提升自我效能提出4種方法，包含：強調同伴示範、尋求反饋、鼓勵參與以及允許人們做出自己的選擇。此外，一項在以色列開展的研究，為探討藉由移動式裝置認知訓練幫助官兵提升心理韌性及自我效能，並進一步降低壓力、提升生活質量，該研究招收153名以色列國防軍進行雙盲隨機對照試驗，區分為認知訓練組及控制組，以Brain HQ應用程式進行每天20分鐘，為期14天的介入，其中，認知訓練組的訓練包含抑制控制、注意力控制及工作記憶的成份，而控制組僅進行一般手機遊戲。結果發現，無論是在心理韌性、生活質量亦或是情緒和自我效能在兩組中皆沒有發現顯著的提升，然而，這可能是因為認知訓練與參與者正在進行的軍事作戰訓練並不存在關聯性，其可行性有限，但此項研究也提供我們未來將認知訓練加入官兵日常訓練提供一個初步的研究。[23] 此外，培養學生「品格」為美國西點軍校之一大特色，根據學者提出3M理論，分別是心態(Mindset)、動機(Motives)及方法(Means)，其中的心態即是圍繞品格，促進成長心態及自我效能感，簡言之即是我們能夠實現目標的信念。[24] 有別於過去「殺不死你的將使你更強大」的信念，西點軍校希望採用更加有系統且有科學依據的方式培養學生在品格的養成，根據過去研究所提出的7個方法，包含：通過實踐養成習慣(habituation through

21 James A. Reed, "Tennessee National Guard Starts New Fitness Initiative," Tennessee State Government Department of Military, 31 May 2023, <https://www.tn.gov/military/news/2023/6/6/tennessee-national-guard-starts-new-fitness-initiative.html>（檢索日期：2023年11月03日）

22 Bandura, A. "Self-efficacy: toward a unifying theory of behavioral change," *Psychological Review*, Vol.84, No.2, 1977, p. 191.

23 Ben-Avraham, R., Afek, A., Berezin Cohen, N., Davidov, A., Van Vleet, T., Jordan, J., Ben Yehudah, A., Gilboa, Y., and Nahum, M. "Feasibility and preliminary effectiveness of mobile cognitive control training during basic combat training in the military," *Military Psychology*, Vol.34, No.1, 2022, pp. 55-67.

24 Dykhuis, A., Erbe, R., Peterson, J. D., "How West Point Is Expanding Character Education," Greater Good Magazine, 18 July 2023, <https://greatergood.berkeley.edu/article/item/how_west_point_is_expanding_character_education>（檢索日期：2023年11月04日）

practice)、對個人經歷進行反思(reflection on personal experience)、與品格楷模進行學習(engagement with virtuous exemplars)、通過對話提高品格素養(dialogue that increases virtue literacy)、對情境變化的認知(awareness of situational variables)、心理提示(moral reminders)和相互問責的友誼(friendships of mutual accountability)。[25] 由高年級學員帶領新進學員完成各項培訓任務，一方面鼓勵高年級學員發揮領導及模範作用，一方面也讓同期的新學員擁有共同的經歷，希望藉此可以塑造良好的品格並促進軍校學員成長心態及自我效能感。對於現階段國軍來說，可以先從軍事院校學生的國防知能教育開始著手，邀請專業師資進行課程規劃及授課，將品格塑造及提升自我效能的觀念潛移默化至未來國軍幹部的心中，並期許他們在分發到各部隊後能運用所學，提升各部隊官兵在這方面的相關能力。

由於運動員及軍人在技能學習、注意力控制、壓力與成績表現的關聯性、心理韌性、恆毅力、自我效能及情緒調節等相關主題上擁有許多共同的特性，且多年來已有許多心理學研究證實了心理技能訓練的重要性。因此，在軍事心理學可以透過運動心理學家提出之評估和預測能力的方法作為一個途徑，透過有針對性的心理技能訓練，或許可以更有效的幫助官兵改善心理因素所帶來的負面影響。[26] 上述已針對不同面向能力提出對應之心理技能訓練方法，特別是部分方法已在真實場域被證實及運用。我國國軍可針對部隊現行狀態實施調整，在不增加基層部隊負擔的情況下，將其加入日常訓練之中，提升官兵之心理能力及軍事表現，增加留營意願。[27]

肆、認知功能於軍事作戰及訓練扮演的角色

2006年，美軍在聯合作戰準則中將信息戰分為認知維度、物理維度及信息維度，其中，認知維度包含人的意志、感知及行為。[28] 具體來說，近年興起的認知作戰概念，即是以有形或無形的活動或行動，透過認知維度對人員心理或網路基礎建設施加影響，以求達到預定效果，而該維度中包含的認知和情感也將會影響個人的決策，英國對於該作戰方式亦稱為「為影響決策者而發展之軍事行動」。[29] 過去研究就認知作戰以中國大陸和臺灣之間作進一步的探討，作者提到，近年中國大陸以認知戰的手段對臺灣採取統戰，其中包含：軍事威嚇、促進兩岸經濟文化交流並藉以增加影響力、宗教以及在

25 Lamb, M., Brant, J., & Brooks, E. (2021). How is virtue cultivated? *Journal of Character Education*, Vol.17, 2021, pp. 81-108.

26 (Ward et al., 2008) *Military Psychology*, Vol.20, 2008, pp. 71-102.

27 LoRusso, N. J., & US Army Command and General Staff College Fort Leavenworth United States. *Application of mental skills training for sustaining effort during operations* (Technical Report), 2018.

28 Staff, J. Information Operations Joint Publication 3-13 (Washington, DC: Department of Defense, 2006).

29 Ducheine, P. A., van Haaster, J., and van Harskamp, R. "Manoeuvring and generating effects in the information environment," *Netherlands Annual Review of Military Studies 2017: Winning Without Killing: The Strategic and Operational Utility of Non-Kinetic Capabilities in Crises*, 2017, pp. 155-179.

網際網路上散播虛假消息，藉此影響臺灣民眾的認知及情感。[30] 由此可知，認知戰屬於一種不分時間、地點、對象及方式的戰法，全體國民應要謹慎看待。除了認知維度概念在現代化新形態戰爭的興起，認知功能對於現代化部隊也具有不容小覷的影響力，以下將探討認知功能於軍事應用的發展及趨勢。

一、生理因素、認知功能與軍事行動之間的關聯性

認知功能對於日常生活及工作也是不可或缺的能力，認知功能是人類運用大腦處理、儲存和擷取訊息與知識的心智運作，包括：感知能力、記憶、注意力和意象等，其中，執行功能(executive function)已被視為一種高階的認知功能，包括：目標設定(goal setting)、工作記憶(working memory)、注意力控制(attentional control)、問題解決(problem solving)、訊息處理(information processing)、抑制控制(inhibitory control)、決策歷程(decision making)及認知彈性(cognitive flexibility)能力。[31] 研究顯示，一般認知功能的測量結果與職業表現呈現正相關，在軍事部分，過去研究探討美國空軍入伍生一般心智能力和特定工作表現及經驗與未來管理工作績效間之關聯性，結果發現預測表現因素最強的即是一般心智相關能力，由此可見，認知功能在軍事工作表現佔有不容小覷的影響力。[32] 此外，針對可能影響軍事人員認知功能的生理因素進行探討後發現，有氧能力、營養、及視力對認知功能具有正面影響，然而，持續軍事活動所引起的疲勞、脫水、營養不良以及對認知任務或壓力源的過度生理壓力反應卻會對認知功能造成負面影響。[33] 此外，軍事人員在工作時，時常需要面臨多任務處理(multitasking)，換句話說就是在同一個時間執行多項任務，甚至是在複雜多變的狀況下。[34] 由於一個微小的軍事失誤就有可能導致嚴重的後果，因此，官兵面臨著越來越多的責任，而如何在受限的條件（時間限制、信息量過大及不熟悉的動態）下，減少認知負荷及認知偏差所導致的決策失誤，成為近幾年來軍事心理學家感興趣的議題。[35] 在軍事領域研究中，不乏有許多學者將認知心理學的概念導入其中，希望能透

30 Hung, T.-C., and Hung, T.-W. "How China's Cognitive Warfare Works: A Frontline Perspective of Taiwan's Anti-Disinformation Wars," *Journal of Global Security Studies*, Vol.7, No.4, 2022, pp. 1-18.

31 Diamond, A. "Executive functions," *Annual Review of Psychology*, Vol.64, 2013, pp. 135-168.

32 Ree, M. J., Earles, J. A., and Teachout, M. S. "Predicting job performance: Not much more than g," *Journal of Applied Psychology*, Vol.79, No.4, 1994, p. 518.
Hunter, J. E. "Cognitive ability, cognitive aptitudes, job knowledge, and job performance," *Journal of Vocational Behavior*, Vol.29, No.3, 1986, pp. 340-362.

33 Martin, K., Périard, J., Rattray, B., & Pyne, D. B. "Physiological factors which influence cognitive performance in military personnel," *Human Factors*, Vol.62, No.1, 2020, pp. 93-123.

34 Chérif, L., Wood, V., Marois, A., Labonté, K., and Vachon, F. "Multitasking in the military: Cognitive consequences and potential solutions," *Applied Cognitive Psychology*, Vol.32, No.4, 2018, pp. 429-439.

35 Rodman, J. "Cognitive biases and decision making: a literature review and discussion of implications for the US army," *US Army Combined Arms Center (USACAC) Repository*, 2015, pp. 1-39.

過除了其他角度探討軍事人員的表現，並進一步提供更客觀的研究結果給軍方參考及運用。過去研究透過兩項研究分別探討戰場壓力與認知功能之間的關聯性；一項研究是招募美國陸軍第75遊騎兵團精英特戰隊員中平均服役9年的軍官，另一項研究則是招募正在接受美國海軍海豹突擊隊隊員篩選訓練中，平均服役3年的士兵，分別在模擬敵對環境戰鬥訓練及地獄週前、後進行與軍事任務相關的認知功能測試，包含：視覺反應、視覺警覺、目標配對、重複獲得以及語法推理測試。[36] 後測結果發現，無論是經驗老道的遊騎兵，還是年輕的士兵、皆發現顯著的認知功能表現下降，而作者也提到其下降幅度甚至比酒精中毒及服用鎮靜藥物的人還要更大，而這樣的結果更加揭示了軍事行動對於官兵認知功能的不利影響。近年，美國國防部及國防高級研究計劃局(Defense Advanced Research Projects Agency)致力於認知功能增強及技術的開發，希望透過相關的技術幫助軍事人員提升警覺性、威脅探測、情況感知、決策、團隊合作及情緒控制等能力，創造出作戰優勢。[37]

過去文獻綜述針對認知訓練應用於軍事環境的相關研究進行探討，學者認為在以學術機制為基礎的科學研究上，輔以軍事背景的設定及操弄，有望可以在軍事相關場景中達到具有針對性的轉移作用，而這樣的機制亦可以提供官兵訓練在處理大量訊息時能更具效率並試探性思考他們做出的選擇並做出相應之正確決策。[38] 另在實驗室內為時常面臨多重壓力的族群包含軍事人員、消防員及救難人員設計出一套簡短但強烈的壓力模擬情境，研究招募13名軍事人員進行為期4天的持續作戰情境訓練，並在期間進行抽血、認知及軍事表現測驗，結果發現多數的認知能力在第3天有顯著的下降，且在第4天下降的情形會更加嚴重，顯示在實驗室內模擬實際狀況可以幫助我們透過定量且參數化的方式，研究各項壓力源之間的交互影響。[39] 此外，另一項招募24名軍人作為參與者，將負重行軍和心理警覺測驗、跑步和單詞回憶測驗分別作為同時執行體力及認知任務的雙重任務(dual task)型態，與其只執行單一任

36 Lieberman, H. R., Bathalon, G. P., Falco, C. M., Georgelis, J. H., Morgan, C. A., Niro, P., & Tharion, W. J. "The "fog of war": Documenting cognitive decrements associated with the stress of combat," paper presented at the 23rd Army Science Conference (2002), pp. 1-9.

37 Brunyé, T. T., Brou, R., Doty, T. J., Gregory, F. D., Hussey, E. K., Lieberman, H. R., Loverro, K. L., Mezzacappa, E. S., Neumeier, W. H., and Patton, D. J. "A review of US Army research contributing to cognitive enhancement in military contexts," *Journal of Cognitive Enhancement*, Vol.4, 2020, pp. 453-468.

38 Rodman, J. "Cognitive biases and decision making: a literature review and discussion of implications for the US army," pp. 1-39.
Blacker, K. J., Hamilton, J., Roush, G., Pettijohn, K. A., and Biggs, A. T. "Cognitive training for military application: a review of the literature and practical guide," *Journal of Cognitive Enhancement*, Vol.3, 2019, pp. 30-51.

39 Lieberman, H. R., Niro, P., Tharion, W. J., Nindl, B. C., Castellani, J. W., and Montain, S. J. "Cognition during sustained operations: comparison of a laboratory simulation to field studies," *Aviation, Space, and Environmental Medicine*, Vol.77, No.9, 2006, pp. 929-935.

務時的表現進行比較，結果發現與單一任務相比，雙重任務條件下的跑步距離及單詞回憶數量表現皆出現顯著的降低。[40] 此研究表明，跑步及單詞記憶的雙重任務設計中的認知與運動干擾具有評估軍事人員多重任務處理的能力，此外，作者認為，後續研究若能將單詞改為軍事術語或命令，能更大程度地符合生態有效性。針對這樣的問題，科學家根據過去經常使用之認知功能評估工具針對軍事人員的視覺和聽覺要求開發出兩款軍事認知功能的評估測驗：軍事特定聽覺N-Back任務(Military Specific Auditory N-Back Task)以及射擊／不射擊作業(Shoot-/Don't-Shoot Task)。[41] 前者係針對官兵於無線電話機通訊時所需要具備之技能，後者則是針對官兵於任務時可能需要具備之視覺搜索及抑制控制之場景（如城鎮作戰）。實驗中要求受試者須分別在靜止坐著及在跑步機上負重行走時完成兩項軍事特定認知作業，而結果也證實了該評估工具在實驗室內實施的可行性。然而，實驗室的測驗結果是否能轉化到真實場域仍然未知，因此，在另一項研究中，進一步於軍事人員日常負重行軍訓練期間加入認知功能測驗，要求他們每隔一段時間需使用平板電腦實施抑制控制作業(Go/No-go task)，結果發現，隨著負重和體力消耗增加，軍事人員的反應抑制能力顯著降低，而以往僅在實驗室環境下實施的研究在轉移到真實的作戰場景中，認知控制能力下降的現象更為明顯。這項結果也進一步表明，在長時間的作戰及訓練後，大腦認知資源會被大量消耗，因此，軍事人員在後續的判斷及決策中可能會出現許多不確定因素。[42] 此外，系統性文獻回顧指出，儘管過去研究所選擇的軍事訓練課程及目標不盡相同，但所有的認知功能包括警覺性、反應時間及工作記憶皆會隨著軍事訓練時長的推移而退化，且退化程度會隨著持續行動的時間延長而增加，根據上述研究，可以總結出，軍人在執行任務時，除了體格及體能戰技以外，生心理狀態及認知功能亦佔有舉足輕重的角色，因此，如何利用平時的訓練幫助軍事人員提身自身能力是我們的目標，過去心理學家提出動作認知訓練(motor-cognitive training)理論，[43] 有別於過去認知功能訓練獨立於身體動作訓練以外採個別訓練，動作認知訓練即是將認知訓練與身體動作訓練結合，使得被訓練者可以同步進行身體及大腦訓練，此種訓練模式對於特殊執業人員在情境模擬（例如：脫水、負重、極端氣候等情境）及在有限時間內進行高效訓練的助益良多，在未來軍事用途可將特定軍事任務結合認知訓練套用在官

40 Gattoni, C., Martinez-Gonzalez, B., Li, C., and Marcora, S. M. "Assessing Cognitive-Motor Interference in Military Contexts: Validity and Reliability of Two Dual-tasking Tests," *Military Medicine*. Article usad048, 2023.

41 Vine, C., Coakley, S., Myers, S., Blacker, S., Runswick, O., and Postal, G. "The development, and day-to-day variation, of a Military-Specific Auditory N-Back Task and Shoot-/Don't-Shoot Task," *Experimental Results*, Vol.3, 2022, p. 15.

42 Giles, G. E., Hasselquist, L., Caruso, C. M., and Eddy, M. D. "Load Carriage and Physical Exertion Influence Cognitive Control in Military Scenarios," *Medicine and Science in Sports and Exercise*, Vol.51, No.12, 2019, pp. 2540-2546.

43 Herold, F., Hamacher, D., Schega, L., & Müller, N. G. "Thinking while moving or moving while thinking–concepts of motor-cognitive training for cognitive performance enhancement," *Frontiers in Aging Neuroscience*, Vol.10, 2018, Article 228.

兵日常訓練之中，[44] 舉例來說，透過壓力情境的模擬及複雜的決策環境，使官兵在惡劣的環境條件及有限時間下進行局勢判斷、人員任務分配及指揮並進一步完成指定任務。

二、神經電生理學於軍事人員之應用

腦電波圖(Electroencephalography, EEG)屬於神經電生理紀錄的一部分，係使用電極帽紀錄受試者於不同認知活動時，大腦電位差變化，過去研究人員透過設計特定認知作業，從EEG中擷取特定區段進行事件相關電位分析(event-related potential, ERP)，並藉由受試者在執行相關任務時的腦電活動，探討有關感知、記憶、注意力、語言及情感等認知歷程。[45] 過去軍事相關腦電研究通常針對因任務導致大腦曾受傷或罹患PTSD之軍事人員，然而，軍事人員在現今社會需要面臨越來越多的認知挑戰，舉例來說：武器及科技的日新月異，對於操作的官兵在注意力、決策過程及動作控制能力的要求也日益提高。[46] 過去研究針對需要高度視覺協調的射擊運動過程進行EEG研究，並建立出一個神經生物模型，而此項研究也進一步指向未來神經電生理學於軍事研究的應用性。[47]

我國國防部為提升裝甲部隊駕駛訓練效益，委由國立中山科學研究院開發出一套三維空間、可沉浸式體驗之虛擬實境(Virtual-Reality-based, VR)訓練模擬器，而Ko等人提出在既有的VR模組上進一步加入EEG及心電圖(Electrocardiography, ECG)監測的概念，以便瞭解官兵在駕駛及射擊狀態下的生理及大腦活動並進一步進行針對性的訓練或是計畫調整，而Von Rosenberg的團隊也近一步驗證使用智能頭盔監測心臟及神經活動的可行性，甚至可以應用在軍事哨兵的睡意監測上。[48] 而在與軍事任務有關的研究上，科學家透過EEG及肌電圖(Electromyography, EMG)監測士兵在跑步機上一般及負重行走時大腦及肌肉的疲勞程度，結果發現士兵在感測疲勞時會先由肌肉感知到再傳達到大腦，促使身體停止運動行為。[49] 除了實驗室

44 Vrijkotte, S., Roelands, B., Meeusen, R., and Pattyn, N. "Sustained military operations and cognitive performance," *Aerospace Medicine and Human Performance*, Vol.87, No.8, 2016, pp. 718-727.

45 Teplan, M. "Fundamentals of EEG measurement," *Measurement Science Review*, Vol.2, No.2, 2002, pp. 1-11.

46 Ganti, L., Daneshvar, Y., Ayala, S., Bodhit, A. N., and Peters, K. R. "The value of neurocognitive testing for acute outcomes after mild traumatic brain injury," *Military Medical Research*, Vol.3, No.1, 2016, pp. 1-7.
Stefanidis, V., Papavlasopoulos, S., Poulos, M., and Bardis, N. "Bibliometrics EEG metrics associations and connections between military medicine and the differentiate post traumatic stress disorder (PTSD)," *WSEAS Transactions on Biology and Biomedicine*, Vol.18, 2021, pp. 66-71.

47 Janelle, C. M., and Hatfield, B. D. "Visual attention and brain processes that underlie expert performance: Implications for sport and military psychology," *Military Psychology*, Vol.20, 2008, pp. 39-69.

48 (Ko et al., 2015) IEEE, 2015. pp. 542-543.
Von Rosenberg, W., Chanwimalueang, T., Goverdovsky, V., Looney, D., Sharp, D., and Mandic, D. P. "Smart helmet: Wearable multichannel ECG and EEG," *IEEE Journal of Translational Engineering in Health and Medicine*, Vol.4, 2016.
(Resalat & Afdideh, 2012) IEEE, 2012, pp. 740-745.

49 (Damit et al., 2017) Springer International Publishing, 2017. pp. 602-612.

內的研究外，另外一項研究招募11名西班牙空軍飛行員於飛行模擬器上實施飛行科目操作，並同時紀錄其EEG及ECG數據後發現，在起飛、著陸、空對空攻擊及空對地攻擊科目時飛行員的腦電活動和自律神經調節發生顯著的變化。[50] 此外，著陸相較於起飛時不只心率變異降低，β 波在P3電極點也發現顯著的差異，顯見在著陸時飛行員壓力指數較高且需要調動更多注意力資源。[51] 另一項研究招募巴西特種部隊中經驗豐富及經驗較少之隊員比較在執行任務前，大腦皮質活動的絕對 α 波（7.5-13赫茲）與壓力水平的差異性，結果發現經驗豐富的特戰隊員在大多數的皮質區域中，絕對 α 波皆顯著高於經驗較少的隊員，顯示具有較多經驗的特戰隊員在任務前可以更加從容地調整自身的狀態，以更好的去執行後續的任務。[52]

由上述文獻可以得知，認知功能與軍事活動息息相關，特別是將大腦活動使用EEG等方式進行收錄、分析及解讀可以幫助我們更好的瞭解其中潛在的神經機制。雖然EEG具有許多潛在的應用性，然而在許多地方仍然存在限制，例如：人體在活動時會有肌電訊號，可能會干擾到腦電訊號的接收而產生偽訊，並進一步影響研究人員的判斷，未來在應用時亦須將此類因素納入考量，收取更嚴謹的數據並為軍事領域提供更高質量的研究結果及建議。[53]

伍、認知神經科學於腦機介面之軍事應用

除了在認知神經科學發現的機制外，應用層面也是科學家積極欲拓展的方向，因此，「腦機介面」概念被提出，腦機介面屬於認知人因工程(Cognitive Ergonomics)的一環，其目的在於以神經工程為基礎，跨越神經肌肉控制，改為直接透過搜集腦部活性訊號、萃取訊號特徵、轉譯演算並輸出，其應用範圍通常區分為以下幾個類別：來自大腦的數據傳輸、直接系統控制、義肢和癱瘓治療[54]、皮質耦合人工智能、機器／大腦向大腦傳輸數據或通信，而這些類別又分為侵入式及非侵入式系統，前者是將設備通過手術置入人的顱骨下或頭骨外，優點是可以精確地放置於欲監測的特定神經元位置，缺點則是手術存在較大風險，反之，非侵入式雖較無風險，但其接受到的訊號難以判別是否由特定神經元發出，故在判讀上也較為困難。[55] 而腦機介面在實際應用時，首先需要找出穩定的EEG訊號，目前有兩種常用類

50 Villafaina, S., Fuentes-García, J. P., Gusi, N., Tornero-Aguilera, J. F., and Clemente-Suárez, V. J. "Psychophysiological response of military pilots in different combat flight maneuvers in a flight simulator," *Physiology and Behavior*, Vol.238, 2021, Article 113483.

51 (Scherz et al., 2020) IEEE, 2020, pp. 4522-4526.

52 Silva, R., Ribeiro, P., Silva, S. G., and Martins, C. L. "Pre-task Intrinsic Cortical Activity in Novice and Experienced Military Specialists: A Cross-sectional Study," *Military Medicine*, Article usad257, 2023.

53 Vos, D. M., Riès, S., Vanderperren, K., Vanrumste, B., Alario, F.-X., Huffel, V. S., and Burle, B. "Removal of muscle artifacts from EEG recordings of spoken language production," *Neuroinformatics*, Vol.8, 2010, pp. 135-150.

54 Mikołajewska, E., and Mikołajewski, D. "Non-invasive EEG-based brain-computer interfaces in patients with disorders of consciousness," *Military Medical Research*, Vol.1, No.1, 2014, pp. 1-6.

型，一是穩態視覺誘發電位(SSVEP)，另一種則是想像動作電位，兩者皆具有較為穩定的特徵。[56] 透過已知的電位特徵，將指令傳送到轉換系統中並進一步控制機器作動。在軍事應用領域，目前BCI支持美國國防部(U.S. Department of Defense, DoD)所進行的技術倡議，包含：改進決策的人機互動、輔助人類行動及先進的有人及無人戰鬥小組等，隨著BCI的技術不斷進步，其未來研究應著重於病人延伸到普通健康族群、從實驗室（可控制）的環境轉換到實際場域以及從基礎知識到實際應用。[57]

2010年美國陸軍為推進和加速神經科學應用方法的成熟，用以瞭解士兵在作戰環境中的表現並加強未來士兵系統的開發，建立了認知和神經工效學協作技術聯盟(The Cognition and Neuroergonomics Collaborative Technology Alliance, CaN CTA)，並啟動美國陸軍在神經科學領域為期十年的基礎科學研究和技術轉型計畫，該計畫匯集了世界頂尖的科學研究人員、經驗豐富的業界人士以及美國陸軍研究實驗室(U.S. Army Research Laboratory, ARL)的科學家參與其中。此外，CaN CTA除了希望能解決神經科學研究中的一些重要差距，更希望能透過這個機會實現更強大的腦機介面(Brain-Computer Interface, BCI)技術，為此，CaN CTA將其研究構成區分為三個新的科學領域：首先是高級計算方法科學領域，其次是腦機交互技術科學領域，第三是現實世界神經影像科學領域。其結案報告也完整的揭示CaN CTA在神經科學、神經技術和相關領域皆取得了重大的進展，並進一步提供相關的神經技術為增強下一代陸軍單兵系統的建設。[58] 目前美軍ARL正在使用3D列印技術為單兵客制專屬的戰術頭盔並將EEG的傳感器置入其中，藉此監測單兵在活動時大腦活動狀況，而在空軍也研究了透過飛行頭盔內置的攝影鏡頭監測飛行員的認知工作量及壓力。[59] 除了單兵應用外，近年無人機(Unmanned Aerial Vehicles, UAV)無論是在民間還是商業用途都與日俱增，而在軍事領域也越來越趨向以無人機替代實際人員駕駛，期望能最大化減少作戰人員傷亡的風險，而在偏遠或難以接近的作戰環境中也可以藉由此項技術的開發進行醫療救助、搜救和探勘。過去研究在無人機應用及腦機交互的基礎上，提出以EEG訊號作為特定用戶在無人機無線通訊上的專屬密鑰，以防止有心人士透過科技手段進行干擾，由腦機交互應用於無人載具的研究，揭示了生

55 Binnendijk, Anika, Timothy Marler, and Elizabeth M. Bartels, *Brain-Computer Interfaces: U.S. Military Applications and Implications, An Initial Assessment* (Santa Monica, CA: RAND Corporation, 2020), <https://www.rand.org/pubs/research_reports/RR2996.html>（檢索日期：2023年11月10日）

56 (Resalat & Afdideh, 2012) pp. 740-745.

57 Van Erp, J. B., Reschke, S., Grootjen, M., and Brouwer, A.-M. *Brain performance enhancement for military operators* (Technical Report RTO-MP-HFM-181), 2009.

58 Touryan, J., and Lee, T. *Cognition and Neuroergonomics Collaborative Technology Alliance Final Report* (2021), pp. 1-218.

59 Binnendijk, Anika, Timothy Marler, and Elizabeth M. Bartels, *Brain-Computer Interfaces: U.S. Military Applications and Implications, An Initial Assessment.*

物特徵識別進一步應用在未來科技戰場上的可行性及未來性。[60]

陸、結　　語

本文透過過去文獻探討軍事人員需要具備的多種特質，其職業的特殊性使得在工作時除了承受生理的負荷之外，同時也需要強大的心理支撐，[61] 據科學家曾對一萬多名西點軍校學生實施一個長達十年的縱貫性研究發現，認知功能為學業及軍事成績的最佳預測因素，有趣的是，恆毅力雖然對學業、體能及軍事表現影響不大，但卻是預測西點軍校學生是否通過野獸營(Beast Barracks)唯一可靠的指標，由此可見強大的心理及認知能力對於軍事人員來說不可或缺。[62] 此外，人力資源的合理配置也是軍事人才管理的一大重點，過去研究提出利用神經心理學測驗可以幫助我們及早發現單兵健康及軍事表現受損徵兆，並有效管理職業健康風險，[63] 而這類的測驗也可以幫助我們更好的確定人員在該職位上的適合程度，著名科學家Lord Kelvin曾說「If you can't measure it, you can't improve it.」換言之，能被測量的能力意味著可透過訓練進一步提升，且心理技能及認知功能訓練已被證實可以幫助軍事人員提升軍事表現。

根據過去研究結果，本文提出未來可在固有的體能戰技及軍事技能訓練之上，加入以各軍事專業為導向的心理及認知訓練，以高效的訓練方式，提升官兵的表現、展現自我價值並進一步提高留營意願。另外美軍為了確定軍事作戰人員認知表現科學現狀，對近年軍事作戰醫學、陸軍航空醫學研究實驗室以及陸軍研究所等針對軍事人員認知表現相關研究文獻進行蒐集統整與討論，並提出幾個當前認知評估方法和能力提出以下關鍵差距：(一)缺乏軍事相關表現與認知功能評估的實證證據；(二)缺乏具有生態效度的評估工具；(三)國防部研究人員與作戰單位缺乏有效溝通協調。為了彌補這些差距，研究人員提供了初步的研究計畫建議：(一)為單項軍事任務及職位制定明確的認知能力標準；(二)驗證測量方法後進一步用於評估作戰人員在特定軍事工作任務中的表現；(三)驗證衡量標準，並用於評估軍事人員在特定工作任務中表現之水平（上升或下降）；(四)根據評估結果提供軍事領導層相關改進建議。[64] 由此可知，認知神經科學在軍事相關

60 (Lee et al., 2021) IEEE, 2021. pp. 1-5.
Singandhupe, A., La, H. M., and Feil-Seifer, D. "Reliable security algorithm for drones using individual characteristics from an EEG signal," *IEEE Access*, Vol.6, 2018, pp. 22976-22986.
(Singandhupe et al., 2017) IEEE, 2017, pp. 2748-2753.

61 Janelle, C. M., and Hatfield, B. D. "Visual attention and brain processes that underlie expert performance: Implications for sport and military psychology," pp. 39-69.

62 Duckworth, A. L., Quirk, A., Gallop, R., Hoyle, R. H., Kelly, D. R., and Matthews, M. D. "Cognitive and noncognitive predictors of success," *Proceedings of the National Academy of Sciences*, Vol.116, No.47, 2019, pp. 23499-23504.

63 Friedl, K. E., Grate, S. J., Proctor, S. P., Ness, J. W., Lukey, B. J., & Kane, R. L. "Army research needs for automated neuropsychological tests: monitoring soldier health and performance status," *Archives of Clinical Neuropsychology*, Vol.22, 2007, pp. 7-14.

領域的發展勢在必行。

現今認知功能為一門新興的研究領域，隨著科技的進步，其應用不僅止於生心理領域，科學家提出認知神經科學結合科技可進一步延伸至人因工程學及腦機互動領域，透過解析人類大腦電生理訊號，驅動機器及裝備進行動作，具體來說：從單兵的戰鬥個裝、裝填彈藥的機械手臂到具基本醫療處置能力的救護機器人等都可以利用腦機結合的技術，讓非必要後勤人力遠離實際戰場，而必要的戰鬥人員則是可以依靠科技在訓練及行動決策的輔助，在未來戰爭中有效減少人員耗損，甚至是增加軍事人員戰場存活率。此外，於2020年美軍軍方智庫蘭德公司(RAND Corporation)，針對展望2040年世界重大安全挑戰與風險提出「關於腦機結合在軍事應用中的初步評估」，其報告內容提出有關BCI技術現今的發展、技術層面的挑戰與風險，以及其運用於軍事作戰當中的潛力。從各方的重視程度，可以預見腦機介面在未來的發展性，但其影響的不只是科技，還有人文及道德層面，科技除了帶給我們便利性以外，我們仍需考量其背後可能引發的潛在問題。[65]

本研究作者提出以下總結：首先，一位優秀的軍人需要具備良好的體格、體能、戰技、心理技能以及認知功能，未來可將相關能力針對各部隊特性列於選材條件之中。其次，心理技能及認知功能的訓練尚未普及，未來建議加入新兵入伍訓練或是軍事校院學生養成教育之訓綱中，並可融入情境模擬及動作認知訓練的概念，提供官兵更為高效的訓練模式。最後，神經電生理學及腦機結合同為未來戰爭中不可或缺的技術，在前人既有的架構及技術上，應針對符合我軍人員的生理特質及可能面臨的作戰模式進行設計，特別是在無人載具的領域，最大化降低人員生命損耗的風險。目前我國國軍對於認知功能及其實際應用方式的探討較為缺乏，期望藉此篇文獻綜述為開端，未來在軍事校院能夠拓展認知科學及腦機介面相關研究方向，為未來科技化建軍、科學化練兵奠定更加穩固的根基。

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64 Proctor, S. P., Heaton, K. J., Lieberman, H. R., Smith, C. D., Edens, E. N., Kelley, A., Balkin, T. J., Capaldi, V., Doty, T. J., and Quartana, P. J. "Military cognitive performance and readiness assessment initiative." Natick, MA USA: Army Research Inst of Environmental Medicine, 2017.

65 Burwell, S., Sample, M., and Racine, E. "Ethical aspects of brain computer interfaces: a scoping review," *BMC Medical Ethics*, Vol.18, No.1, 2017, pp. 1-11.
Binnendijk, Anika, Timothy Marler, and Elizabeth M. Bartels, *Brain-Computer Interfaces: U.S. Military Applications and Implications, An Initial Assessment*.

參考文獻

中文部分

期刊論文

林澤助，〈影響國軍推動「募兵制」關鍵因素探討〉，《國防雜誌》，第25卷第2期，頁102-112。

網際網路

國防大學理工學院，2023/11/7。〈職涯發展中心〉，《國防大學理工學院》，<https://www.ccit.ndu.edu.tw/unit/100051/24537>。

謝沛宸，2022/7/31。〈理工學院職涯發展中心助長留久用〉，《青年日報》，2022年7月31日，<https://www.ydn.com.tw/news/newsInsidePage?chapterID=1522172&type=military>。

外文部分

期刊論文

Adele Diamond, 2013. "Executive functions," *Annual Review of Psychology*, Vol. 64, pp. 135-168.

Albert Bandura, 1977. "Self-efficacy: toward a unifying theory of behavioral change," *Psychological Review*, Vol. 84, No. 2, p. 191.

Albert Rizzo, JoAnn Difede, Barbara Rothbaum, J. Martin Daughtry, and Greg Reger, 2013. "Virtual reality as a tool for delivering PTSD exposure therapy and stress resilience training," *Military Behavioral Health*, Vol. 1, No. 1, pp. 52-58.

Angela L. Duckwortha, Abigail Quirka, Robert Gallopa, Rick H. Hoyleb, Dennis R. Kellyc and Michael D. Matthewsd, 2019. "Cognitive and noncognitive predictors of success," *Proceedings of the National Academy of Sciences*, Vol. 116, No. 47, pp. 23499-23504.

Angela L. Duckworth, Christopher Peterson, Michael D. Matthews and Dennis R. Kelly, 2007. "Grit: perseverance and passion for long-term goals," *Journal of Personality and Social Psychology*, Vol. 92, No. 6, p. 1087.

Angela Lee Duckworth and Patrick D. Quinn, 2009. "Development and validation of the Short Grit Scale (GRIT-S)," *Journal of Personality Assessment*, Vol. 91, No. 2, pp. 166-174.

Ashutosh Singandhupe, Hung Manh La and David Feil-Seifer, 2018. "Reliable security algorithm for drones using individual characteristics from an EEG signal," IEEE Access, Vol. 6, pp. 22976-22986.

Ashutosh Singandhupe, Hung Manh La, David Feil-Seifer, Pei Huang, Linke Guo and Ming Li, 2017. "Securing a UAV using individual characteristics from an eeg signal," paper presented at the 2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC), IEEE, pp. 2748-2753.

Bradley C.Nindl, Brent A. Alvar, Jason R. Dudley, Mike W. Favre, Gerard J. Martin, Marilyn A.

Sharp, Brad J. Warr, Mark D. Stephenson, and William J. Kraemer, 2015. "Executive summary from the National strength and conditioning association's second blue ribbon panel on military physical readiness: military physical performance testing," *The Journal of Strength and Conditioning Research*, Vol. 29, pp. 216-220.

Bridget E. Boyle, Kathleen E. Darbor, Colanda R. Cato, William Kammerer, and Joel Thurston, 2022. *Survey of Talent Requirements: Talents, Skills, and Abilities of Army Officers by Branch and Functional Area* (Technical Report 1418), U. S. Army Research Institute for the Behavioral and Social Sciences.

Candice M. Monson, Paula P. Schnurr, Patricia M. Resick, Matthew J. Friedman, Yinong Young-Xu, and Susan P. Stevens, 2006. "Cognitive processing therapy for veterans with military-related posttraumatic stress disorder," *Journal of Consulting and Clinical Psychology*, Vol. 74, No. 5, p. 898.

Caroline M. Angel, 2016. "Resilience, post-traumatic stress, and posttraumatic growth: Veterans' and active duty military members' coping trajectories following traumatic event exposure," *Elsevier*, Vol. 47, pp. 57-60.

Chiara Gattoni, Borja Martinez-Gonzalez, Caroline Li and Samuele Maria Marcora, 2023. "Assessing Cognitive-Motor Interference in Military Contexts: Validity and Reliability of Two Dual-tasking Tests," *Military Medicine*. Article usad048.

Christopher M. Janelle and Bradley D. Hatfield, 2008. "Visual attention and brain processes that underlie expert performance: Implications for sport and military psychology," *Military Psychology*, Vol. 20, pp. 39-69.

Christopher Vine, Sarah Coakley, Stephen Myers, Sam Blacker and Oliver Runswick, 2022. "The development, and day-to-day variation, of a Military-Specific Auditory N-Back Task and Shoot-/Don't-Shoot Task," *Experimental Results*, Vol. 3, p. 15.

Claire Robertson-Kraft and Angela Lee Duckworth, 2014. "True grit: Trait-level perseverance and passion for long-term goals predicts effectiveness and retention among novice teachers," *Teachers College Record*, Vol. 116, No. 3, pp. 1-27.

D. N. Filzah P. Damit, S. M. N. Arosha Senanayake, Owais A. Malik and Nor Jaidi Tuah, 2017. "Neuromuscular fatigue analysis of soldiers using DWT based EMG and EEG data fusion during load carriage," paper presented at the Intelligent Information and Database Systems: 9th Asian Conference, ACIIDS 2017, Kanazawa, Japan, April 3-5, 2017, Proceedings, Part II 9, Springer International Publishing, pp. 602-612.

Dae-Hyeok Lee, Ji-Hoon Jeong, Hyung-Ju Ahn, and Seong-Whan Lee, 2021. "Design of an EEG-based drone swarm control system using endogenous BCI paradigms," paper presented at the 2021 9th International Winter Conference on Brain-Computer Interface (BCI), IEEE, pp. 1-5

David Forbes, David Pedlar, Amy B. Adler, Clare Bennett, Richard Bryant, Walter Busuttil, John Cooper, Mark C. Creamer, Nicola T. Fear, Neil Greenberg, Alexandra Heber, Mark Hinton, Mal Hopwood, Rakesh Jetly, Ellie Lawrence-Wood, Alexander McFarlane, Olivia Metcalf, Meaghan O' Donnell, Andrea Phelps, J. Don Richardson, Nicole Sadler, Paula P. Schnurr, Marie- Louise Sharp, James M. Thompson, Robert J. Ursano, Miranda Van Hooff, Darryl Wade & Simon Wessely, 2019. "Treatment of military-related post-traumatic stress disorder: challenges, innovations, and the way forward," *International Review of Psychiatry*, Vol. 31, No. 1, pp. 95-110.

Dennis R. Kelly, Michael D. Matthews, and Paul T. Bartone, 2014. "Grit and hardiness as predictors of performance among West Point cadets," *Military Psychology*, Vol. 26, No. 4, pp. 327-342.

Donald J. Campbell & Orly Ben-Yoav Nobel, 2009. "Occupational stressors in military service: A review and framework," *Military Psychology*, Vol. 21, No. 2, pp. 47-67.

Emilia Mikołajewska, and Dariusz Mikołajewski, 2014. "Non-invasive EEG-based brain-computer interfaces in patients with disorders of consciousness," *Military Medical Research*, Vol. 1, No. 1, pp. 1-6.

Eskreis-Winkler, L., Shulman, E. P., Beal, S. A., and Duckworth, A. L, 2014. "The grit effect: Predicting retention in the military, the workplace, school and marriage," *Frontiers in Psychology*, Vol. 5, Article. 36, pp. 1-12.

Everett S. Spain, Eric Lin, and Lissa V. Young, 2020. "Early predictors of successful military careers among West Point cadets," *Military Psychology*, Vol. 32, No. 6, pp. 389-407.

Fabian Herold, Dennis Hamacher, Lutz Schega and Notger G. Müller, 2018. "Thinking while moving or moving while thinking– concepts of motor-cognitive training for cognitive performance enhancement," *Frontiers in Aging Neuroscience,* Vol. 10, Article 228.

Grace E. Giles, Leif Hasselquist, Christina M. Caruso and Marianna D. Eddy, 2019. "Load Carriage and Physical Exertion Influence Cognitive Control in Military Scenarios," *Medicine and Science in Sports and Exercise*, Vol. 51, No. 12, pp. 2540-2546.

Harris R. Lieberman, Philip Niro, William J. Tharion, Bradley C. Nindl, John W. Castellani and Scott J. Montain, 2006. "Cognition during sustained operations: comparison of a laboratory simulation to field studies," *Aviation, Space, and Environmental Medicine*, Vol. 77, No. 9, pp. 929-935.

Jan B.F. van Erp, Stefan Reschke, Marc Grootjen and Anne-Marie Brouwer, 2009. *Brain performance enhancement for military operators*.

Jack Tsai, Lauren M. Sippel, Natalie Mota, Steven M. Southwick, and Robert H. Pietrzak, 2016. "Longitudinal course of posttraumatic growth among US military veterans: Results from the National Health and Resilience in

Veterans Study," *Depression and Anxiety*, Vol. 33, No. 1, pp. 9-18.

Jani P. Vaara, Herbert Groeller, Jace Drain, Heikki Kyröläinen, Kai Pihlainen, Tommi Ojanen, Chris Connaboy, Matti Santtila, Philip Agostinelli & Brad C. Nind, 2022. "Physical training considerations for optimizing performance in essential military tasks," *European Journal of Sport Science*, Vol. 22, No. 1, pp. 43-57.

John E. Hunter, 1986. "Cognitive ability, cognitive aptitudes, job knowledge, and job performance," *Journal of Vocational Behavior*, Vol. 29, No. 3, pp. 340-362.

Jonathan Touryan and Timothy Lee, 2021. *Cognition and Neuroergonomics Collaborative Technology Alliance Final Report,* pp. 1-218.

Jonpaul Nevin, and Martin Ian Jones, 2022. "Human Performance Optimization (HPO) for the Warfighter-Keeping It Simple in a Complex Age: A Narrative Review," *Strength and Conditioning Journal*, Vol. 10, No. 1519.

Joonas Hele'n, Heikki Kyröläinen, Tommi Ojanen, Kai Pihlainen, Matti Santtila, Risto Heikkinen, and Jani P. Vaara, 2023. "High-Intensity Functional Training Induces Superior Training Adaptations Compared With Traditional Military Physical Training," *The Journal of Strength and Conditioning Research*, Vol. 37, No. 12, pp. 2477-2483.

Joseph Rodman, 2015. "Cognitive biases and decision making: a literature review and discussion of implications for the US army," *US Army Combined Arms Center (USACAC) Repository*, pp. 1-39.

Kara J. Blacker, Joseph Hamilton, Grant Roush, Kyle A. Pettijohn and Adam T. Biggs, 2019. "Cognitive training for military application: a review of the literature and practical guide," *Journal of Cognitive Enhancement*, Vol. 3, pp. 30-51.

Karen J. Reivich, Martin E. P. Seligman and Sharon McBride, 2011. "Master resilience training in the US Army," *American Psychologist*, Vol. 66, No. 1, p. 25.

Karl E. Friedl, Stephen J. Grate, Susan P. Proctor, James W. Ness, Brian J. Lukey and Robert L. Kane, 2007. "Army research needs for automated neuropsychological tests: monitoring soldier health and performance status," *Archives of Clinical Neuropsychology*, Vol. 22, pp. 7-14.

Ko Li-Wei, Lai Peng-Wen, Yang Bao-Jun and Lin Chin-Teng, 2015. "Mobile EEG and ECG integration system for monitoring physiological states in peforming simulated war game training," paper presented at the 2015 IEEE Conference on Computational Intelligence and Games (CIG), IEEE, pp. 542-543.

Kristy Martin, Julien Périard, Ben Rattray and David B. Pyne, 2020. "Physiological factors which influence cognitive performance in military personnel," *Human Factors*, Vol. 62, No. 1, pp. 93-123.

Kuan-Jung Chen, Chia-Chen Yang, and Hui-Hsun Chiang, 2018. "Model of coping

strategies, resilience, psychological well-being, and perceived health among military personnel," *Journal of Medical Sciences*, Vol. 38, No. 2, pp. 73-80.

Latha Ganti, Yasamin Daneshvar, Sarah Ayala, Aakash N. Bodhit and Keith R. Peters, 2016. "The value of neurocognitive testing for acute outcomes after mild traumatic brain injury," *Military Medical Research*, Vol. 3, No. 1, pp. 1-7.

Lauren Eskreis-Winkler, Elizabeth P. Shulman, Scott A. Beal, and Angela L. Duckworth, 2014. "The grit effect: Predicting retention in the military, the workplace, school and marriage," *Frontiers in Psychology*, Vol. 5, No. 36, pp. 1-12.

Lieberman, H. R, Bathalon, G. P, Falco, C. M, Georgelis, J. H, Morgan, III, C. A, Niro, P and Tharion, W. J, 2002. "The "fog of war": Documenting cognitive decrements associated with the stress of combat," paper presented at the 23rd Army Science Conference, pp. 1-9.

Lo Russo, N. J., & US Army Command and General Staff College Fort Leavenworth United States, 2018. *Application of mental skills training for sustaining effort during operations* (Technical Report).

Lobna Chérif, Valerie Wood, Alexandre Marois, Katherine Labonté and François Vachon, 2018. "Multitasking in the military: Cognitive consequences and potential solutions," *Applied Cognitive Psychology*, Vol. 32, No. 4, pp. 429-439.

M. De Vos, S. Riès, K. Vanderperren, B. Vanrumste, F.-X. Alario, S. Van Huffel, and B. Burle, 2010. "Removal of muscle artifacts from EEG recordings of spoken language production," *Neuroinformatics*, Vol. 8, pp. 135-150.

Malcolm James Ree, James A. Earles and Mark S. Teachout, 1994. "Predicting job performance: Not much more than g," *Journal of Applied Psychology*, Vol. 79, No. 4, p. 518.

Michael Lamb, Jonathan Brant and Edward Brooks, 2021. "How is virtue cultivated?" *Journal of Character Education*, Vol. 17, pp. 81-108.

Ole Boe, Reidar Säfvenbom, Rino Bandlitz Johansen, and Robert Buch, 2018. "The relationships between self-concept, self-efficacy, and military skills and abilities," *International Journal of Learning, Teaching and Educational Research*, Vol. 14, pp. 18-42.

Paul A.L. Ducheine, Jelle van Haaster and Richard van Harskamp, 2017. "Manoeuvring and generating effects in the information environment," *Netherlands Annual Review of Military Studies 2017: Winning Without Killing: The Strategic and Operational Utility of Non-Kinetic Capabilities in Crises*, pp. 155-179.

Paul T. Bartone, 2006. "Resilience under military operational stress: can leaders influence hardiness?" *Military Psychology*, Vol. 18, pp. 131-148.

Paul Ward, Damian Farrow, Kevin R. Harris, A. Mark Williams, David W. Eccles and

K. Anders Ericsson, 2008. "Training perceptual-cognitive skills: Can sport psychology research inform military decision training?" *Military Psychology*, Vol. 20, pp. 71-102.

R B Silva, Pedro Ribeiro, Siqueira Grace Silva and Cx Lilian Martins, 2023. "Pre-task Intrinsic Cortical Activity in Novice and Experienced Military Specialists: A Cross-sectional Study," *Military Medicine*, Article usad257.

Rachel Dekel, and Candice M. Monson,2010. "Military-related post-traumatic stress disorder and family relations: Current knowledge and future directions," *Aggression and Violent Behavior*, Vol. 15, No. 4, pp. 303-309.

Rhonda Cornum, Michael D. Matthews, and Martin E. P. Seligman, 2011. "Comprehensive soldier fitness: building resilience in a challenging institutional context," *American Psychologist*, Vol. 66, No. 1, p. 4.

Rina Ben-Avraham, Anat Afek, Noa Berezin Cohen, Alex Davidov, Tom Van Vleet, Josh Jordan, Ariel Ben Yehudah, Yafit Gilboa and Mor Nahum, 2022. "Feasibility and preliminary effectiveness of mobile cognitive control training during basic combat training in the military," *Military Psychology*, Vol. 34, No. 1, pp. 55-67.

Robin M. Orr, and Rodney Pope, 2015. "Optimizing the conditioning of new tactical trainees," *Strength and Conditioning Journal*, Vol. 37, No. 4, pp. 53-59.

Ross McGarry, Sandra Walklate and Gabe Mythen, 2015. "A sociological analysis of military resilience: Opening up the debate," *Armed Forces and Society*, Vol. 41, No. 2, pp. 352-378.

Santos Villafaina, Juan Pedro Fuentes-García, Narcis Gusi, Jose F. Tornero-Aguilera, Vicente J. Clemente-Suarez, 2021. "Psychophysiological response of military pilots in different combat flight maneuvers in a flight simulator," *Physiology and Behavior*, Vol. 238, Article 113483.

Sasha Burwell, Matthew Sample and Eric Racine, 2017. "Ethical aspects of brain computer interfaces: a scoping review," *BMC Medical Ethics*, Vol. 18, No. 1, pp. 1-11.

Seyed Navid Resalat and Fardin Afdideh, 2012. "Real-time monitoring of military sentinel sleepiness using a novel SSVEP-based BCI system," paper presented at the 2012 IEEE-EMBS Conference on Biomedical Engineering and Sciences, IEEE, pp. 740-745.

Susan P. Proctor, Kristin J. Heaton, Harris R. Lieberman, Carl D. Smith, Edward N. Edens, Amanda Kelley, Thomas J. Balkin, Vincent Capaldi, Tracy Jill Doty and Philip J. Quartana, 2017."Military cognitive performance and readiness assessment initiative." Natick, MA USA: Army Research Inst of Environmental Medicine.

Susan Vrijkotte, Bart Roelands, Romain Meeusen and Nathalie Pattyn, 2016. "Sustained military operations and cognitive performance," *Aerospace Medicine and*

Human Performance, Vol. 87, No. 8, pp. 718-727.

Tad T. Brunyé, Randy Brou, Tracy Jill Doty, Frederick D. Gregory, Erika K. Hussey, Harris R. Lieberman, Kari L. Loverro, Elizabeth S. Mezzacappa, William H. Neumeier, Debra J. Patton, Jason W. Soares, Thaddeus P. Thomas and Alfred B. Yu, 2020. "A review of US Army research contributing to cognitive enhancement in military contexts," *Journal of Cognitive Enhancement*, Vol. 4, pp. 453-468.

Teplan Michal, 2002. "Fundamentals of EEG measurement," *Measurement Science Review*, Vol. 2, No. 2, pp. 1-11.

Tzu-Chieh Hung and Tzu-Wei Hung, 2022. "How China's Cognitive Warfare Works: A Frontline Perspective of Taiwan's Anti-Disinformation Wars," *Journal of Global Security Studies*, Vol. 7, No. 4, pp.1-18.

Vasileios Stefanidis, Sozon Papavlasopoulos, Marios Poulos, Nikos Bardis, 2021. "Bibliometrics EEG metrics associations and connections between military medicine and the differentiate post traumatic stress disorder (PTSD)," *WSEAS Transactions on Biology and Biomedicine*, Vol. 18, pp. 66-71.

Walter L. Sharp, 2006. Information Operations Joint Publication 3-13 (Washington, DC: Department of Defense).

Wilhelm D. Scherz, Ralf Seepold, Natividad Martínez Madrid, Paolo Crippa, and Juan Antonio Ortega, 2020. "RR interval analysis for the distinction between stress, physical activity and no activity using a portable ECG," paper presented at the 42nd annual international conference of the IEEE engineering in medicine and biology society (EMBC), IEEE.

Wilhelm von Rosenberg, Theerasak Chanwimalueang, Valentin Goverdovsky, David Looney, David Sharp and Danilo P. Mandic, 2016. "Smart helmet: Wearable multichannel ECG and EEG," *IEEE Journal of Translational Engineering in Health and Medicine*, Vol. 4.

Boe, O., Säfvenbom, R., Johansen, R. B., & Buch, R., 2018. The relationships between self-concept, self-efficacy, and military skills and abilities.

Cornum, R., Matthews, M. D., & Seligman, M. E., 2011. Comprehensive soldier fitness: building resilience in a challenging institutional context. *American psychologist, 66*(1), 4.

Damit, D. F. P., Arosha Senanayake, S., Malik, O. A., & Tuah, N. J., 2017. Neuromuscular fatigue analysis of soldiers using DWT based EMG and EEG data fusion during load carriage. Intelligent Information and Database Systems: 9th Asian Conference, ACIIDS 2017, Kanazawa, Japan, April 3-5, 2017, Proceedings, Part II 9.

Ko, L.-W., Lai, P.-W., Yang, B.-J., & Lin, C.-T., 2015. Mobile EEG & ECG integration system for monitoring physiological states in peforming simulated war game training. 2015 IEEE Conference on Computational Intelligence and Games (CIG).

Lee, D.-H., Jeong, J.-H., Ahn, H.-J., & Lee, S.-W., 2021. Design of an EEG-based drone swarm control system using endogenous BCI paradigms. 2021 9th International Winter Conference on Brain-Computer Interface (BCI).

Resalat, S. N., & Afdideh, F., 2012. Real-time monitoring of military sentinel sleepiness using a novel SSVEP-based BCI system. 2012 IEEE-EMBS Conference on Biomedical Engineering and Sciences.

Scherz, W. D., Seepold, R., Madrid, N. M., Crippa, P., & Ortega, J. A., 2020. RR interval analysis for the distinction between stress, physical activity and no activity using a portable ECG. 2020 42nd annual international conference of the IEEE engineering in medicine & biology society (EMBC).

Singandhupe, A., La, H. M., Feil-Seifer, D., Huang, P., Guo, L., & Li, M., 2017. Securing a uav using individual characteristics from an eeg signal. 2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC).

Ward, P., Farrow, D., Harris, K. R., Williams, A. M., Eccles, D. W., & Ericsson, K. A., 2008. Training perceptual-cognitive skills: Can sport psychology research inform military decision training? *Military Psychology*, 20(sup1), pp. 71-102.

網際網路

Binnendijk, Anika, Timothy Marler and Elizabeth M. Bartels. *Brain-Computer Interfaces: U.S. Military Applications and Implications, An Initial Assessment* (Santa Monica, CA: RAND Corporation, 2020), <https://www.rand.org/pubs/research_reports/RR2996.html>

Dykhuis, A., Erbe, R., Peterson, J. D., 2023/7/18. "How West Point Is Expanding Character Education," Greater Good Magazine, <https://greatergood.berkeley.edu/article/item/how_west_point_is_expanding_character_education>

Lopez C. Todd, 2009/8/19. "Soldiers learn to impart mental toughness on others," U.S. ARMY, <https://www.army.mil/article/26221/soldiers_learn_to_impart_mental_toughness_on_others>

James A. Reed, 2023/5/31. "Tennessee National Guard Starts New Fitness Initiative," Tennessee State Government Department of Military, <https://www.tn.gov/military/news/2023/6/6/tennessee-national-guard-starts-new-fitness-initiative.html>