

Neuropsychological

Trends

39

April 2026

- Elisa De Bartolo - Giovanni Cicinelli - Stefania Brighenti
Emanuela Nobile - Francesca Capiotto - Roberto Keller*
A pilot investigation of the Italian short version of the Sensory
Perception Quotient (SPQ) in autistic and neurotypical adults 7
- Davide Crivelli - Michela Balconi*
Neuroassessment and monitoring of higher cognitive functions
in naturalistic context: a case of organizational neuroscience 23
- Rael H. Morley - Paul B. Jantz - Anastasia J. Gumatay
Bayley R. Grimshaw*
The impact of posterior cingulate and dorsal lateral connectivity
on aggression 43
- Michela Balconi - Laura Angioletti - Angelica Daffinà*
Are you sure about your choice? EEG correlates of decision
confidence before and after reframing 63
- Domenico Gambino*
Are negative affect and executive functioning related in healthy
young adults? 87
-

Are negative affect and executive functioning related in healthy young adults?

Domenico Gambino^{1,2}

¹ International research center for Cognitive Applied Neuroscience (IrcCAN),
Università Cattolica del Sacro Cuore, Milan, Italy

² Research Unit in Affective and Social Neuroscience, Department of Psychology,
Università Cattolica del Sacro Cuore, Milan, Italy

DOI: <https://doi.org/10.7358/neur-2026-039-gamb>

domenico.gambino@unicatt.it

ABSTRACT

The present study examined associations between negative affect (NA) and executive functioning (EFs) in healthy young adults. Thirty-nine participants completed a battery of cognitive tasks assessing EFs, that is visuospatial learning, attention, planning, working memory, and cognitive flexibility, alongside self-report measures of anxiety, depression, stress, and mood. Pearson correlations were computed between affective and cognitive measures. Firstly, not all affective measures were related to cognitive outcomes, and associations varied across tasks and domains. Secondly, higher levels of stress and mood-related dimensions were negatively associated with visuospatial learning and attentional performance, while state anxiety was positively associated with reaction times in complex planning tasks. In contrast, positive associations emerged between mood dimensions and performance in a task requiring generative processes. These findings indicate that NA is differentially associated with executive functions in non-clinical populations, highlighting the importance of considering both task characteristics and specific affective dimensions.

Keywords: negative affect; executive functions; visuospatial learning; cognitive performance; emotional measures

1. INTRODUCTION

Even in the absence of a clinical disorder, subclinical symptoms of anxiety and depression are common in the general population. International estimates indicate that approximately 6.19% of individuals experience subthreshold anxiety and about 11.02% experience subthreshold depression (Zhang et al., 2022; Zhong et al., 2024). Similar patterns have been reported in Italy, where subclinical anxiety affects around 5–6% of adults and subclinical depression about 3–4% (Rucci et al., 2003). Elevated levels of perceived stress are also frequently observed in non-clinical samples (Costa et al., 2021). These findings highlight that experiences such as anxiety, sadness, and stress are relatively common aspects of everyday psychological functioning, even when they do not meet clinical criteria. Such experiences can be understood within the broader construct of Negative Affect (NA), conceptualized as a general dimension of emotional distress and unpleasant engagement that encompasses a range of aversive mood states (Watson et al., 1988). Rather than reflecting isolated moods, NA represents a broader affective dimension that captures the experience of negative emotions across different situations and contexts. This conceptualization allows for the examination of how variations in NA may relate to cognitive functioning beyond clinical conditions.

Goal-directed behavior relies on a set of interrelated cognitive processes commonly referred to as executive functions (EFs), which enable the regulation of thoughts, actions, and emotions in response to changing environmental demands. Rather than reflecting a unitary ability, EFs encompass multiple components, including inhibitory control, which supports the suppression of irrelevant or prepotent responses; working memory, which allows the temporary maintenance and manipulation of information; attentional control, which enables the allocation and shifting of attention; cognitive flexibility, which supports the adaptation of strategies across contexts; and planning and problem solving, which guide the organization of complex, multi-step actions toward future goals. Through the coordination of these processes, EFs support adaptive behavior in everyday contexts, allowing individuals to respond flexibly to situational demands and maintain goal-directed performance. Recent research has further emphasized the central role of EFs in sustaining adaptive performance across different contexts, highlighting their sensitivity to variations in cognitive demands and mental workload (Balconi et al., 2020, 2023; Balconi & Angioletti, 2024).

Within this framework, elevated NA has been associated with variations in EFs including planning, working memory, visuospatial learning and working memory processes, attentional control, inhibition of impulsive responses, and cognitive flexibility. These cognitive domains are essential for adaptive behavior and goal-directed activity, and prior research suggests that they may be sensitive to the influence of NA (Derakshan & Eysenck, 2009; Girotti et al., 2017). However,

evidence suggests that these effects may not be uniform across domains, with NA influencing the efficiency of cognitive resource allocation in ways that can vary depending on task demands and contextual factors (Brose et al., 2014). While most research has focused on clinical populations or experimentally induced emotional states, less is known about how natural variations in NA relate to EFs in non-clinical adults (Brose et al., 2014; Carver & Scheier, 2014; Eysenck et al., 2007). The present study aimed to examine the associations between NA and cognitive performance in healthy young adults, including cognitive processing efficiency, planning, attentional control, inhibition of impulsive responses, visuospatial learning processes, and cognitive flexibility.

We hypothesized that higher levels of NA would be associated with variations in performance across these domains, although the direction and magnitude of these associations were expected to differ depending on task demands. By employing multiple tasks tapping distinct aspects of EFs, this study seeks to provide a more comprehensive characterization of how NA relates to cognitive performance in non-clinical contexts, contributing to the understanding of affect–cognition interactions in everyday functioning.

2. METHOD

2.1 Participants

A total of 40 healthy young adults (Mage = 23.54, SD = 1.30; 21 females) participated in the study. Participants were recruited through convenience sampling in an academic setting. Inclusion criteria required participants to be at least 18 years old, in good general health, and to have normal or corrected-to-normal vision and hearing. Exclusion criteria included a history of psychiatric or neurological disorders, severe head trauma, stroke or current treatment with psychoactive medications that could affect cognitive functioning.

All procedures were conducted in accordance with the Declaration of Helsinki (2013) and the General Data Protection Regulation (EU Reg. 2016/679). Ethical approval was obtained from the Ethics Committee of Politecnico di Torino (CER-Polito), and all participants provided written informed consent prior to participation.

2.2 Procedure and experimental task

The experiment was conducted individually in a quiet, light-controlled laboratory setting, with each session lasting approximately one and a half hours. Following a

full explanation of the procedure, written informed consent was obtained, and a demographic questionnaire was completed.

Subsequently, participants performed a structured battery of cognitive tasks targeting multiple domains of executive and attentional functioning. Selective attention and interference control were measured with a computerized version of the Stroop Task (ST; Stim2 software, Compumedics Neuroscan, Charlotte, NC) (Stroop, 1935), while selective and sustained attention were assessed with a Complex Dual Task (CDT; Balconi & Angioletti, 2024), featuring a Pure condition (CDT-P) for visual discrimination and a Mixed condition (CDT-M) requiring the coordination of concurrent task demands. Planning and decision-making were evaluated using a Tower of Hanoi task (ToH; Balconi & Angioletti, 2024; Shallice, 1982) with three levels of increasing complexity. visuospatial learning was assessed using the Corsi Supra-Span task (CSP; Spinnler & Tognoni, 1987), working memory was measured with the Backward Digit Span (BDS; Balconi & Crivelli, 2021) and cognitive flexibility was examined using the Modified Five-Points test (MFP; Balconi & Crivelli, 2021; Cattelani et al., 2011; Regard et al., 1982). After completing the cognitive tasks, a series of standardized self-report questionnaires was administered to assess emotional and mood states. Anxiety was measured with the State-Trait Anxiety Inventory (STAI; Spielberger, 2012), depressive symptoms with the Beck Depression Inventory (BDI; Beck et al., 1961), perceived stress with the Perceived Stress Scale (PSS; Cohen et al., 1983), and mood states with the Profile of Mood States (POMS; McNair et al., 1992). The experimental procedure is illustrated in Figure 1, showing the overall structure of the session.

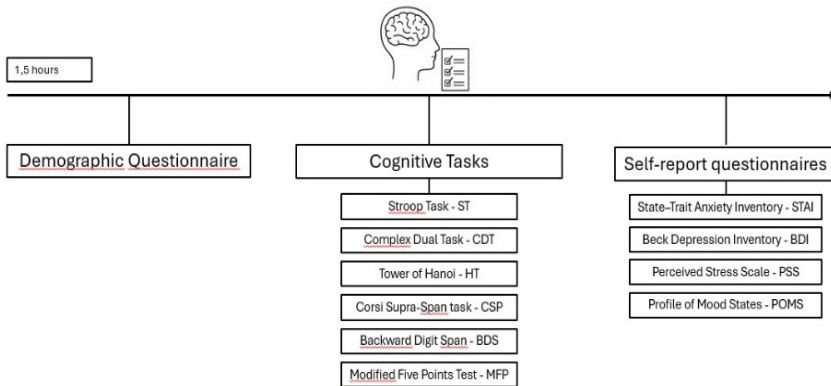


Figure 1. Graphic representation of the experimental procedure

2.3 Data analysis

Pearson correlation analyses were conducted to examine associations between participants' self-report measures of emotional distress (STAI, BDI, PSS, POMS) and cognitive performance (CDT, CSP, BDS, MFP, ToH). Correlation coefficients (r) were interpreted according to conventional thresholds: small ($0.10 \leq r < 0.30$), medium ($0.30 \leq r < 0.50$), and large ($r \geq 0.50$), with statistical significance set at $\alpha = 0.05$.

Correlations were computed between questionnaire scores and task-specific performance measures, including reaction times (RTs), accuracy, total scores, and task-specific indices where applicable. Assumptions of normality and linearity were verified prior to conducting all analyses.

3. RESULTS

3.1 Corsi Supra-Span

Performance on the CSP measure, assessing visuospatial learning, was negatively associated with perceived stress (PSS; $r = -0.342$, $p = .031$) and with anger (POMS Anger; $r = -0.471$, $p = .002$), fatigue (POMS Fatigue; $r = -0.475$, $p = .002$), and total mood disturbance (POMS TMD; $r = -0.344$, $p = .030$). Higher scores on these measures were associated with lower CSP performance as shown in Figure 2.

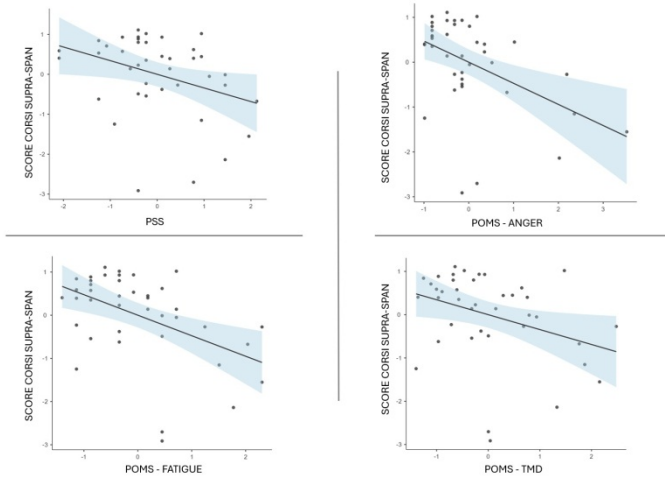


Figure 2. Correlations between affective measures (PSS, POMS Anger, POMS Fatigue, POMS TMD) and performance on the CSP

3.2 Complex Dual Task

In the CDT-P, RTs in the shape task were positively associated with depression (POMS Depression; $r = .370, p = .019$) and anger (POMS Anger; $r = .325, p = .041$) (Figure 3). Accuracy in the shape and filling tasks of the CDT-P condition was negatively associated with perceived stress (PSS; $r = -.472, p = .002$), tension (POMS Tension; $r = -.332, p = .036$), depression (POMS Depression; $r = -.353, p = .025$), and anger (POMS Anger; $r = -.400, p = .011$) (Figure 4).

In the CDT-M, accuracy was positively associated with fatigue (POMS Fatigue; $r = .333, p = .036$), confusion (POMS Confusion; $r = .320, p = .044$), and TMD (POMS TMD; $r = 0.345, p = .029$) (Figure 5).

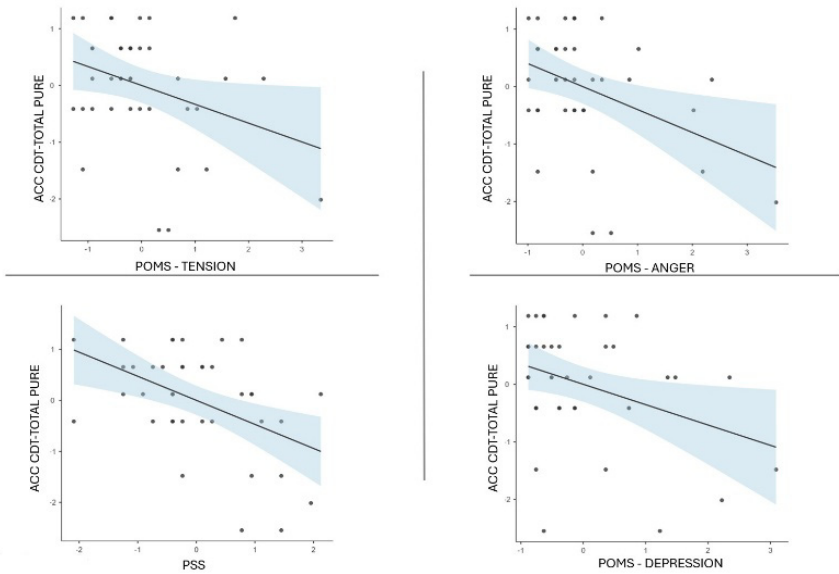


Figure 3. Correlations between affective measures (POMS Tension, POMS Anger, PSS, POMS Depression) and performance in CDT-P (accuracy)

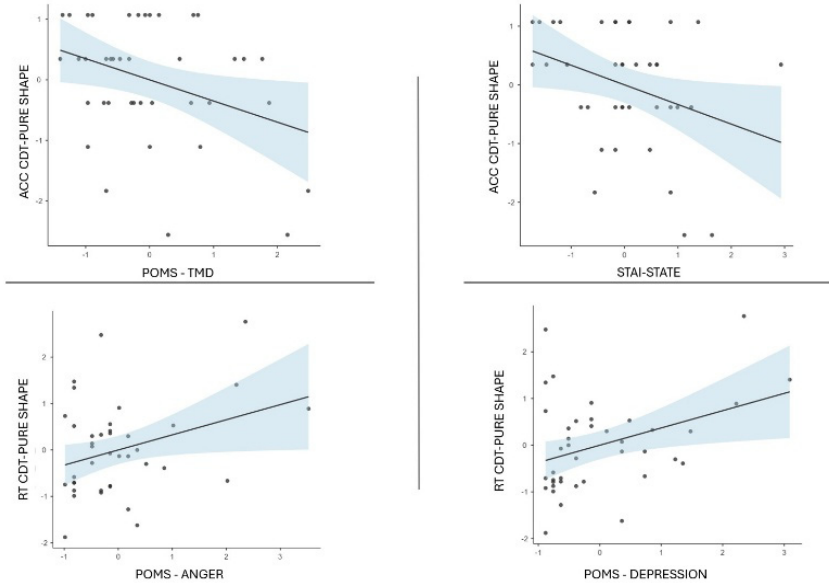


Figure 4. Correlations between affective measures (POMS TMD, STAI-State, POMS Anger, POMS Depression) and performance in the CDT-P (accuracy and RTs in the Shape task)

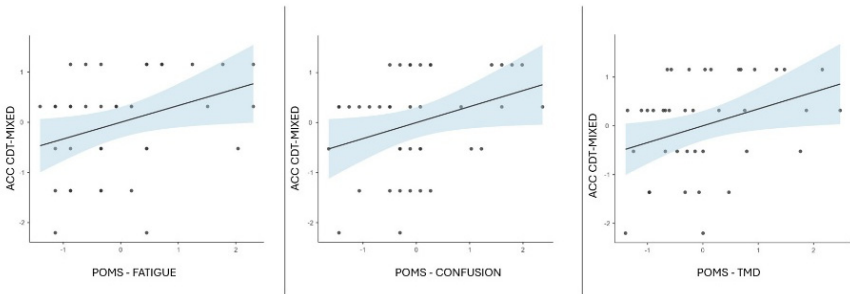


Figure 5. Correlations between affective measures (POMS Fatigue, POMS Confusion, POMS TMD) and performance in the CDT-M (accuracy)

3.3 Modified Five Point

As shown in Figure 6, Performance on the MFP was positively associated with depression (POMS Depression; $r = .377, p = .017$), anger (POMS Anger; $r = .323, p = .042$), fatigue (POMS Fatigue; $r = .381, p = .015$), and TMD (POMS TMD; $r = .359, p = .023$).

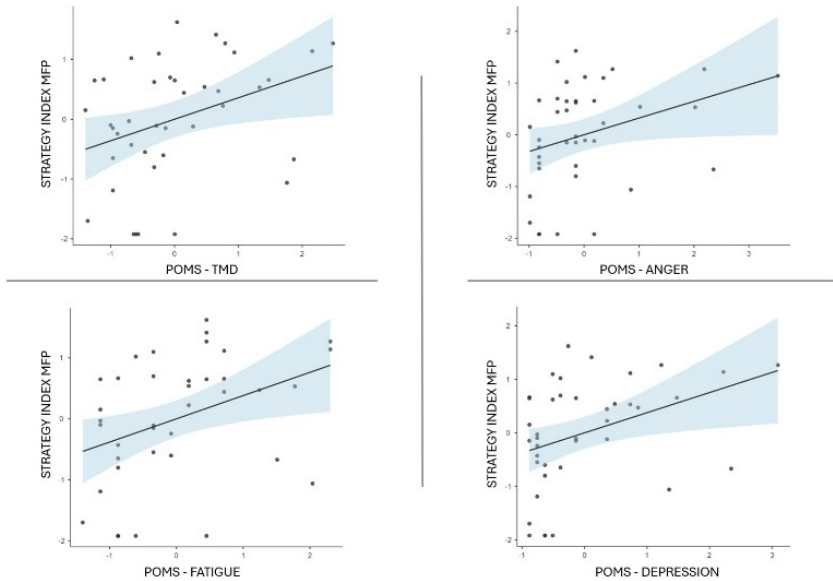


Figure 6. Correlations between POMS dimensions (TMD, Anger, Fatigue, Depression) and Strategy Index in the MFP

3.4 Tower of Hanoi

Performance on the ToH was examined in relation to measures of NA. As illustrated in Figure 7, Total RTs was positively associated with state anxiety (STAI-State; $r = .409, p = .009$). When examining the most complex level (Level 3), RTs was also positively associated with state anxiety (STAI-State; $r = .368, p = .019$).

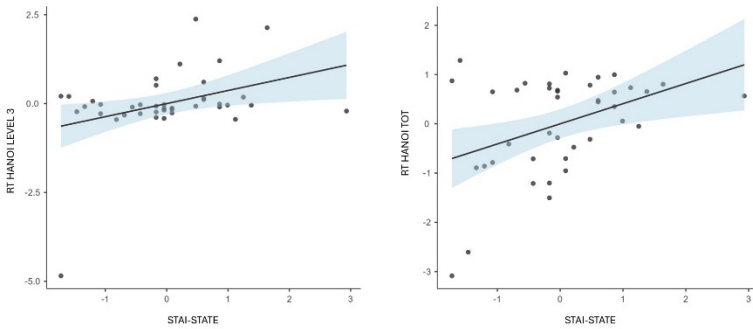


Figure 7. Correlation between state anxiety (STAI-State) and RTs in the Tower of Hanoi (total and Level 3)

All other correlations between NA measures and cognitive tasks were non-significant.

4. DISCUSSION

The present study examined the impact of NA on cognitive performance in healthy young adults. Overall, the findings indicate that individual differences in NA are associated with variations in executive processes underlying visuospatial working memory, attentional control, and higher-order EFs such as strategic planning and cognitive flexibility, although these effects were not uniform across all affective dimensions and task components.

Participants reporting higher levels of specific NA dimensions, including stress, anger, fatigue, and depression, showed task-dependent variations in performance, with some components associated with changes across different task indices. These findings are broadly consistent with theoretical accounts suggesting that NA may influence cognitive efficiency by modulating the allocation of cognitive resources and prefrontal control processes, particularly under conditions of increased task demands (Eysenck et al., 2007; Brose et al., 2014; Girotti et al., 2017). The following sections examine these patterns in detail across the different cognitive tasks, highlighting how specific dimensions of NA relate to performance in each domain.

4.1 Corsi Supra-Span

Performance on the CSP task appears to be associated with specific dimensions of NA, particularly perceived stress and mood-related factors. Participants reporting higher levels of these dimensions tended to show lower scores on the task. These findings suggest that these dimensions may be associated with reduced efficiency in visuospatial working memory processes (Monaco et al., 2013), particularly in tasks requiring the processing of multiple spatial elements, pointing to a selective association between NA and performance in complex visuospatial working memory tasks in healthy young adults.

4.2 Complex Dual Task

Performance in the CDT-P, which primarily indexes selective attention, appears to be associated with specific dimensions of NA, including state anxiety, perceived stress, and mood-related factors. Across the Pure condition, participants reporting higher levels of these dimensions tended to show lower accuracy across the Pure condition, reflecting overall performance across the Shape and Filling tasks, with consistent associations observed for overall accuracy across the condition, particularly in relation to perceived stress, tension, depression, anger, and TMD. RTs in the shape task specifically were positively associated with mood dimensions such as depression and anger, indicating that these affective components may differentially influence response speed. Overall, these findings suggest that different dimensions of NA are associated with distinct performance indices within the pure condition, with accuracy showing broader associations across NA dimensions and response speed reflecting more specific mood-related influences (Girotti et al., 2017).

In CDT-M, which involves the coordination of concurrent processes and places greater demands on sustained and divided attention, accuracy showed associations with mood-related dimensions, including fatigue, confusion, and TMD. Notably, these associations were positive, indicating that higher levels of these affective components were related to higher accuracy in the task. This pattern differs from that observed in the pure condition and suggests that the relationship between NA and cognitive performance may vary depending on task demands. In particular, tasks requiring the coordination of multiple processes may be differentially associated with specific affective dimensions.

4.3 Modified Five Point

Unlike other cognitive measures, the strategy index of the MFP task showed positive associations with mood dimensions such as depression, anger, fatigue, and TMD. Participants reporting higher levels of these dimensions tended to show higher values on the strategy index, suggesting a different pattern of association compared to the other tasks. This pattern may reflect variations in how specific dimensions of NA relate to strategic aspects of task performance, rather than indicating a general impairment.

These findings differ from those observed in other tasks, where higher NA was generally associated with reduced performance, highlighting that the relationship between affect and cognition may vary depending on task demands and individual engagement (Brose et al., 2014). In the context of the MFP, these associations may be linked to differences in task engagement or strategy use under more complex planning requirements, although this interpretation should be considered with caution given the correlational nature of the data.

4.4 Tower of Hanoi

RTs in the ToH were selectively associated with state anxiety, with no significant associations observed for other dimensions of NA. In this task, which involves planning, decision-making, and strategy learning, significant effects were observed only for overall performance and level 3, the most complex stage of the task. This pattern suggests that higher levels of state anxiety are associated with longer RTs, which may reflect increased demands on response selection and planning under more complex condition, while simpler stages appear relatively unaffected.

These findings indicate that the relationship between anxiety and EFs may be more evident in tasks requiring sustained planning and the coordination of multiple cognitive processes, rather than across all stages of performance. In other words, acute anxiety does not appear to be uniformly associated with performance, but rather with increased response times in more demanding condition, pointing to a selective association between anxiety and complex problem-solving in healthy young adults. Importantly, this pattern was specific to state anxiety and was not observed for other dimensions of NA, suggesting that anxiety may have a distinct relationship with planning-related processes, particularly in situations requiring sustained monitoring and strategic control, which place greater demands on cognitive control processes.

5. CONCLUSION

The present findings underscore the selective and context-dependent effects of NA on cognitive performance. Rather than producing a uniform impairment, different dimensions of NA were associated with variations in distinct executive processes depending on task demands. State anxiety was associated with slower performance in more complex problem-solving condition, while certain mood-related dimensions showed task-specific associations with strategic aspects of performance.

In some cases, these associations diverged from the general pattern of reduced performance observed in other domains, with certain affective dimensions showing positive associations with task performance under specific conditions. This pattern was observed both in tasks involving generative or fluency-based processes and in tasks requiring the coordination of concurrent cognitive demands. Attentional processes, visuospatial learning, and higher-order EFs such as cognitive flexibility and non-verbal generativity were associated with specific dimensions of NA, highlighting domains that may be particularly sensitive to affective influences in non-clinical populations. Importantly, these associations were primarily observed for state measures of NA, whereas trait measures did not show significant relationships, suggesting that transient emotional states may play a more prominent role in modulating cognitive performance.

These patterns suggest that affective states can shape cognitive performance in nuanced ways, with associations varying depending on both the type of affective dimension and task characteristics. Recognizing this variability is important for understanding how emotional factors interact with EFs in daily life, offering insight into the conditions under which specific dimensions of NA may be associated with differences in cognitive performance in healthy individuals.

Funding

This study was carried out within the «Empathically enhanced robot for the collaboration with HUmans in MANufacturing (E.HU.MAN) » project – funded by the Ministero dell’Universita e della Ricerca – within the PRIN 2022 program (D.D.104–02/02/2022). This manuscript reflects only the authors’ views and opinions, and the Ministry cannot be considered responsible for them. This publication is part of the project PNRR-NGEU which has received funding from the MUR – DM 352/2022.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author due to ethical reasons for sensitive personal data protection (requests will be evaluated according to the GDPR - Reg. UE 2016/679 and its ethical guidelines).

Ethics statement

The research followed the ethical principles of the Declaration of Helsinki (2013) and complied with the GDPR - Reg. UE 2016/679. Approval was obtained from the Comitato Etico per la Ricerca del Politecnico di Torino (CER-Polito).

Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

- Balconi, M., Acconito, C., Allegretta, R. A., & Crivelli, D. (2023). What Is the Relationship between Metacognition and Mental Effort in Executive Functions? The Contribution of Neurophysiology. *Behavioral Sciences*, *13*(11), 1-13. <https://doi.org/10.3390/bs13110918>
- Balconi, M., Angioletti, L., & Crivelli, D. (2020). Neuro-empowerment of executive functions in the workplace: *The reason why*. *Frontiers in Psychology*, *11*, 1-5. <https://doi.org/10.3389/fpsyg.2020.01519>
- Balconi, M., & Angioletti, L. (2024). The Digitalized Assessment for Decision-Making (DAsDec): a novel integrated neuroscientific and behavioral tool. *Neuropsychological Trends*, *36*, 69–79. <https://doi.org/10.7358/NEUR-2024-036-BALC>
- Balconi, M., & Crivelli, D. (2021). *The assessment of executive functions: A new neuropsychological tool for addiction*. In M. Balconi (Ed.), *Neuropsychology of addiction* (pp. 61–85). Springer. https://doi.org/10.1007/978-3-030-82408-2_3
- Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*(6), 561–571. <https://doi.org/10.1001/archpsyc.1961.01710120031004>
- Brose, A., Lövdén, M., & Schmiedek, F. (2014). Daily fluctuations in positive affect positively co-vary with working memory performance. *Emotion*, *14*(1), 1–6. <https://doi.org/10.1037/a0035210>
- Carver, C. S., & Scheier, M. F. (2014). Dispositional optimism. *Trends in Cognitive Sciences*, *18*(6), 293–299. <https://doi.org/10.1016/j.tics.2014.02.003>
- Cattelani, R., Dal Sasso, F., Corsini, D., & Posteraro, L. (2011). The Modified Five-Point Test: normative data for a sample of Italian healthy adults aged 16-60. *Neurological Sciences*, *32*(4), 595–601. <https://doi.org/10.1007/s10072-011-0489-4>
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396. <https://doi.org/10.2307/2136404>
- Costa, C., Briguglio, G., Mondello, S., Teodoro, M., Pollicino, M., Canalella, A., Verduci, F., Italia, S., & Fenga, C. (2021). Perceived Stress in a Gender Perspective: A Survey in a Population of Unemployed Subjects of Southern Italy. *Frontiers in public health*, *9*, 1-9. <https://doi.org/10.3389/fpubh.2021.640454>
- Derakshan, N., & Eysenck, M. W. (2009). Anxiety, processing efficiency, and cognitive performance: New developments from attentional control theory. *European Psychologist*, *14*(2), 168–176. <https://doi.org/10.1027/1016-9040.14.2.168>
- Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion (Washington, D.C.)*, *7*(2), 336–353. <https://doi.org/10.1037/1528-3542.7.2.336eysen>

- Girotti, M., Adler, S. M., Bulin, S. E., Fucich, E. A., Paredes, D., & Morilak, D. A. (2017). Prefrontal cortex executive processes affected by stress in health and disease. *Progress in neuro-psychopharmacology & biological psychiatry*, 85, 161-179. <https://doi.org/10.1016/j.pnpbp.2017.07.004>
- McNair, D. M., Lorr, M., & Droppleman, L. F. (1992). Profile of Mood States (POMS) (A. Tavormina, adatt. it.: Questionario di valutazione dello stato d'animo). Giunti O.S.
- Monaco, M., Costa, A., Caltagirone, C., & Carlesimo, G. A. (2013). Forward and backward span for verbal and visuo-spatial data: standardization and normative data from an Italian adult population. *Neurological Sciences: Official Journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology*, 34(5), 749-754. <https://doi.org/10.1007/s10072-012-1130-xmonaco>
- Regard, M., Strauss, E., & Knapp, P. (1982). Children's production on verbal and non-verbal fluency tasks. *Perceptual and Motor Skills*, 55(3), 839-844. <https://doi.org/10.2466/pms.1982.55.3.839>
- Rucci, P., Gherardi, S., Tansella, M., Piccinelli, M., Berardi, D., Bisoffi, G., Corsino, M. A., & Pini, S. (2003). Subthreshold psychiatric disorders in primary care: prevalence and associated characteristics. *Journal of affective disorders*, 76(1-3), 171-181. [https://doi.org/10.1016/s0165-0327\(02\)00087-3](https://doi.org/10.1016/s0165-0327(02)00087-3)
- Shallice, T. (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London B*, 298(1089), 199-209. <https://doi.org/10.1098/rstb.1982.0082>
- Spielberger, C. D., Pedrabissi, L., & Santinello, M. (2012). *STAI: State-Trait Anxiety Inventory*, forma Y: Manuale. Giunti O.S.
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18(6), 643-662. <https://doi.org/10.1037/h0054651>
- Spinnler, H., & Tognoni, G. (1987). Standardizzazione e taratura italiana di test neuropsicologici. *Italian Journal of Neurological Sciences*, 8(Suppl), 1-120.
- Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, 54(6), 1063-1070. <https://doi.org/10.1037/0022-3514.54.6.1063>
- Zhang, R., Peng, X., Song, X., Long, J., Wang, C., Zhang, C., Huang, R., & Lee, T. M. C. (2023). The prevalence and risk of developing major depression among individuals with subthreshold depression in the general population. *Psychological medicine*, 53(8), 3611-3620. <https://doi.org/10.1017/S0033291722000241>
- Zhong, Q., Niu, L., Chen, K., Lee, T. M. C., & Zhang, R. (2024). Prevalence and risk of subthreshold anxiety developing into threshold anxiety disorder in the general population. *Journal of Affective Disorders*, 367, 815-822. <https://doi.org/10.1016/j.jad.2024.09.031>