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Mild executive dysfunction and basic psychological needs satisfaction in stroke patients during the chronic phase

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OBJECTIVE **To examine the relationship between mild executive dysfunction and the satisfaction of the basic psychological needs of autonomy, competence, and relatedness in stroke patients.** METHOD **In all 52 patients who had a chronic-phase ischemic frontal stroke six to nine months previous were included. Set-shifting ability was assessed using the Trail Making Test-Part B (TMT-B), and inhibitory control was measured using the Stroop Neuropsychological Screening Test (SNST). The satisfaction of psychological needs using the Basic Psychological Needs Satisfaction Scale-General. Pearson correlation and multiple regression analyses were used to determine associations and predictive relationships.** RESULTS **Pearson correlation analysis identified significant associations between executive functioning and the satisfaction of psychological needs. TMT-B was negatively correlated with autonomy and competence, and SNST was positively correlated with autonomy, competence, and relatedness. Multiple regression analyses confirmed that both TMT-B and SNST significantly predicted autonomy and competence, although only SNST significantly predicted relatedness.** CONCLUSIONS **This study clarified the significant influence of mild executive dysfunction on the satisfaction of psychological needs in patients with chronic-phase stroke. Deficits in set-shifting and inhibition impair autonomy, competence, and relatedness, highlighting the need for assessments and interventions to target both cognitive and psychological domains. A holistic approach that addresses these factors could improve rehabilitation outcomes and enhance quality of life in stroke survivors.**

Ήπια επιτελική δυσλειτουργία και ικανοποίηση των βασικών ψυχολογικών αναγκών σε ασθενείς με αγγειακό εγκεφαλικό επεισόδιο κατά τη χρόνια φάση

Περίληψη στο τέλος του άρθρου

Key words

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Stroke remains a leading cause of long-term disability worldwide, and it can result in a broad spectrum of physical, cognitive, and emotional impairments that significantly hinder recovery and reduce quality of life.[1–3] Among these impairments, executive dysfunction poses a particularly formidable challenge, disrupting the cognitive processes essential for goal-directed behavior, effective problem-solving, and daily adaptability.[4] Executive functions –in particular specifically set-shifting and inhibition– are critical for the management of complex tasks, emotion regulation, and flexible response to environmental demands.[5] Impairments in these areas are frequently observed in stroke survivors, including those in the chronic phase, in which persistent deficits severely limit functional independence.[6]

Deficits in set-shifting undermine the ability to fluidly transition between tasks and adapt to novel situations, which are critical for daily routines, including multitasking, responding to unexpected challenges, or adopting flexible problem-solving approaches. In addition, deficits in inhibitory control entail a reduced ability to suppress inappropriate or impulsive responses, which leads to difficulty focusing attention, regulating the emotions, and maintaining socially appropriate behavior. Such cognitive impairments exacerbate the challenges of performing instrumental activities of daily living (IADLs), including financial management and adherence to a medication regime, which are key points in maintaining functional independence. Furthermore, cognitive impairments can contribute to social withdrawal, diminished community participation, or increased psychological distress, which compounds the overall burden of disability.[7]

Thus, the psychological impact of stroke further undermines recovery outcomes.[8] The Basic Psychological Needs Satisfaction (BPNS) framework, which is rooted in

Self-Determination Theory, emphasizes the fundamental role played by three innate psychological needs –autonomy, competence, and relatedness– in fostering well-being and optimal functioning.[9] This theory considers these needs universal and essential for psychological growth, motivation, and overall mental health. In this context, autonomy refers to the sense of volition and self-endorsed action, while competence reflects a sense of mastery and effectiveness for dealing with life's challenges. Relatedness, by contrast, captures the need for meaningful connection and belonging with others. When these needs are satisfied, individuals tend to experience enhanced well-being and resilience, as well as showing engagement in adaptive behaviors. Conversely, unmet needs are associated with negative outcomes, such as stress, anxiety, and depression, underscoring the critical role they play in maintaining psychological balance.

Empirical evidence underscores the critical role of satisfying basic psychological needs (BPNs) for enhancing well-being, promoting positive health outcomes, and supporting disease recovery.[10,11] Despite this growing body of research, a significant gap remains in understanding how BPNs operate in stroke patients, who can face unique physical and cognitive challenges that can disrupt their psychological needs. A recent qualitative study highlighted the nuanced impact of stroke on the satisfaction of BPNs as conceptualized in the BPNS framework.[12] The participants reported greater emotional support and attention from family members and healthcare providers during recovery, fostering a sense of belonging and connectedness. However, patients' autonomy was challenged by the limitations imposed by the stroke, such as a reduced ability to make independent decisions, in particular in medical and rehabilitation contexts, or by a loss of control over daily activities. Competence was similarly undermined by functional impairments affecting IADLs and the capacity to work. According to these findings, while stroke can hinder certain aspects of psychological well-being, it can also strengthen social bonds, which emphasizes the need for targeted interventions to balance autonomy and competence with the relational benefits of stroke recovery.

The BPNS framework is particularly relevant for executive dysfunction on the satisfaction of BPNs in stroke patients. Notably, executive dysfunction may directly impede the fulfillment of these BPNs, further compounding the cycle of psychological distress and functional disability. As these cognitive abilities are impaired, stroke survivors may struggle to maintain autonomy, as they lose the capacity to independently manage IADLs and make decisions. Likewise, executive dysfunction can undermine competence, as patients may feel ineffective or frustrated by their inability to perform tasks that they had once had mastery of. Additionally, relatedness could be affected, as cognitive challenges can strain interpersonal relationships, which makes it harder for patients to communicate effectively or engage socially.

This study explored the relationship between mild executive dysfunction –in particular on set-shifting and inhibition– and the satisfaction of BPNs in stroke survivors during the chronic phase. Investigating these relationships, this study seeks to provide a more comprehensive understanding of how cognitive impairments interact with psychological well-being to inform the development of targeted interventions addressing both the cognitive and psychological dimensions of stroke recovery. Interventions of this type may enhance the functional outcomes and quality of life in this vulnerable population.

MATERIAL AND METHOD

Participants

The study included 52 patients who were diagnosed with ischemic frontal stroke in the chronic phase, 6–9 months post-stroke, 28 of whom had right hemisphere lesions, and 24 of whom had had left hemisphere lesions. There were 27 females and 25 males. The inclusion criteria were the following: (a) No clinical evidence of aphasia, apraxia, or agnosia syndromes; (b) mild deficit performance on the Trail-Making Test-Part B (TMT-B) and the Stroop Neuropsychological Screening Test (SNST; z-scores between -1.00 and -1.99); (c) absence of severe global cognitive decline (Montreal cognitive assessment [MoCA] >18); and (d) sufficient physical and mental capacity to complete the neuropsychological tests that were administered.

Measures

Shifting: Cognitive flexibility was assessed using the Greek version of the TMT-B,[13] which measures the ability to switch attention between two sets of stimuli (numbers and letters). The completion time was recorded, measured in seconds.

Inhibition: Capability of suppressing automatic or habitual responses was assessed using the Greek version of the SNST.[14] This test was performed to evaluate inhibitory control, requiring participants to name the color of ink that is used for incongruent color-word pairs within 120 seconds. The minimum and maximum scores for the SNST are 0 and 112, respectively.

Basic psychological needs satisfaction: The satisfaction of BPNs was measured using the Greek version of the BPNS Scale-General.[15] This self-report scale shows how far individuals consider that their needs for autonomy, competence, and relatedness are fulfilled. The questionnaire consists of 21 items that are scored on a 7-point

Likert scale. The minimum and maximum scores for responses to the questionnaire are 21 and 147, respectively.

Procedure

The participants were recruited from a rehabilitation unit. After written informed consent was obtained from all participants, they underwent cognitive and psychological assessment in a quiet, distraction-free environment. The assessment session lasted for approximately 45 minutes and was conducted by a PhD-level clinical neuropsychologist.

Statistical analysis

Descriptive statistics were calculated for demographic and clinical variables (tab. 1). The relationships between executive dysfunction (shifting and inhibition) and basic psychological needs satisfaction were analyzed using Pearson correlation coefficients. Multiple regression analyses were conducted to evaluate the unique contributions of TMT-B and SNST scores to variations in BPNS subscales (tab. 2). All analyses were performed using the Statistical Package for Social Sciences (SPSS), version 28.0.

RESULTS

Pearson correlation analyses revealed significant associations between measures of executive dysfunction and basic psychological needs satisfaction. Longer TMT-B completion times, indicating poorer shifting ability, were negatively correlated with autonomy satisfaction ($r=-0.78$, $p<0.01$) and competence satisfaction ($r=-0.84$, $p<0.01$), but not with relatedness satisfaction ($r=-0.04$, $p>0.05$). Similarly, lower SNST correct answer scores, reflecting poorer inhibitory control, were associated with reduced autonomy satisfaction ($r=0.56$, $p<0.01$), competence satisfaction ($r=0.41$, $p<0.01$) and relatedness satisfaction ($r=0.29$, $p<0.01$). The multiple regression analysis examined the contribution of executive functioning measures (TMT-B and SNST) on the satisfaction of psychological needs measured by BPNS: Autonomy, competence, and relatedness.

Table 1. Demographics, neuropsychological performance, and psychometric data.

Variable	M	SD
Age *(years)*	72.35	4.45
Education *(years)*	13.56	3.28
Post-stroke time *(months)*	7.40	2.85
MoCA	20.05	3.62
TMT-B *(seconds)*	218.45	29.78
SNST	55.12	9.65
Autonomy	22.59	3.23
Competence	20.33	4.76
Relatedness	24.82	5.64

M: Mean, SD: Standard deviation, MoCA: Montreal Cognitive Assessment, TMT-B: Trail Making Test-part B, SNST: Stroop Neuropsychological Screening Test

Table 2. Multiple regression analysis predicting BPNS subscales from TMT-B and SNST.

Predictor	B	SE	t	p	Adjusted R^2
Autonomy					0.79
TMT-B	-0.26	0.03	-10.52	<0.001	
SNST	0.53	0.04	6.59	<0.001	
Competence					0.81
TMT-B	-0.38	0.04	-13.03	<0.001	
SNST	0.58	0.09	4.15	<0.001	
Relatedness					0.11
TMT-B	0.05	0.04	1.14	0.25	
SNST	0.30	0.13	2.29	<0.05	

BPNS: Basic Psychological Needs Satisfaction Scale, TMT-B: Trail Making Test-part B, SNST: Stroop Neuropsychological Screening Test

Autonomy

The model predicting autonomy had an adjusted R^2 of 0.79, indicating that 79% of the variance in autonomy scores was explained by TMT-B and SNST. These results suggested that both executive functioning measures play an important role in predicting autonomy, with better executive function associated with greater satisfaction of this need.

Competence

The model predicting competence had an adjusted R^2 of 0.81, meaning that 81% of the variance in competence scores was accounted for by TMT-B and SNST. Both predictors were statistically significant. These findings highlighted that both measures of executive functioning are strongly linked to the satisfaction of the need for competence, with TMT-B having a slightly stronger negative effect than SNST's positive contribution.

Relatedness

The model predicting relatedness showed an adjusted R^2 of 0.11, indicating that 11% of the variance in relatedness scores was explained by TMT-B and SNST. However, the contribution of the predictors differed. These results

indicated that only SNST contributes meaningfully to the prediction of relatedness, suggesting that better inhibitory control supports psychological need of connection.

DISCUSSION

The present study investigated the relationship between mild executive dysfunction and the satisfaction of BPNs (autonomy, competence, and relatedness) in patients with chronic-phase stroke. It was found that deficits in set-shifting and inhibition, two core components of executive functioning, were significantly associated with unmet BPNs. These results highlighted the critical role that cognitive impairments play in shaping psychological well-being during stroke recovery and offer insights into potential strategies for intervention.

The results demonstrated that set-shifting deficits, as measured by TMT-B, were strongly negatively associated with autonomy and competence satisfaction. Poor task-switching ability limited the flexibility that is required for decision-making and for adapting to novel situations, which is essential for the maintenance of autonomy. This was consistent with previous research that highlights the role of cognitive flexibility in supporting goal-directed behavior and self-regulation.[4,5] Likewise, the negative association obtaining between TMT-B and competence satisfaction suggests that set-shifting impairments reduce patients' confidence in their ability to perform tasks effectively, which reinforces feelings of incompetence.

Inhibitory control, as measured by SNST, contributed positively to all three BPNs. Improved inhibitory control supports autonomy through enabling patients to self-regulate their impulsive behaviors and exercise greater self-control in decision-making. The positive association it had with competence indicated that inhibition has a critical role to play in maintaining focus and achieving task-related goals. Further, SNST is a significant predictor of relatedness, which suggests that better inhibition facilitates social interactions through supporting emotional regulation and promoting appropriate communication. These findings align with prior evidence concerning the importance of inhibitory control for social engagement and emotional well-being.[6,7] It is interesting to note that TMT-B scores did not significantly predict relatedness satisfaction, indicating that task-switching ability may have a limited direct impact on interpersonal relationships. This highlights the nuanced role that executive functions play in different domains of psychological needs, suggesting that social engagement relies more on emotional regulation than it does on cognitive flexibility.

The strong association between executive dysfunction and unmet BPNs suggests that addressing cognitive deficits is essential for promoting psychological well-being in patients with chronic-phase stroke. Cognitive rehabilitation programs targeting set-shifting and inhibition could have downstream benefits for psychological recovery. Thus, task-specific cognitive training could improve task-switching efficiency; in this way, supporting autonomy and competence by restoring patients' ability to manage daily routines and perform instrumental activities. In addition, structured interventions such as Problem-Solving Therapy could reduce stroke survivors' levels of depression and anxiety and their improved quality of life and task-oriented coping.[16,17] Likewise, emotion regulation strategies, such as those provided by mindfulness-based interventions, could strengthen inhibitory control, and enhance relatedness by improving social interactions and emotional stability. In fact, a meta-analysis found that Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) may promote promising treatments for depressive symptoms in stroke patients.[18] Moreover, interventions including Group Acceptance and Commitment Therapy (Group ACT) could also have an impact for the management of post stroke depressive symptoms,[19] while Computerized Cognitive Behavioral Therapy (cCBT) could also treat post stroke emotional distress.[20] In addition to cognitive rehabilitation, these findings emphasize the importance of integrating BPN assessments into stroke recovery programs. Addressing the unmet needs for autonomy, competence, and relatedness in tailored interventions could complement cognitive training and foster holistic recovery. For example, an empowerment-focused strategy, such as shared decision-making in rehabilitation planning, could enhance autonomy, and social support initiatives could further strengthen relatedness.

This study provided valuable insights, but its several limitations should be acknowledged. The cross-sectional design used precludes causal inferences, leaving unaddressed questions about the temporal dynamics between executive dysfunction and the satisfaction of psychological needs. Longitudinal studies must be performed to explore whether improvements in cognitive functioning translate directly to enhanced psychological outcomes. In addition, this study focused on set-shifting and inhibition as key aspects in executive functioning. Future research in this vein should take other domains into account, including working memory and planning, to provide a more comprehensive understanding of the cognitive mechanisms that underlie the satisfaction of psychological needs. Finally, relatedness satisfaction could be influenced by cultural and contex-

tual factors, such as caregiver involvement and societal norms with respect to social support. At the same time, the psychological burden on caregivers, who play a key role in facilitating rehabilitation in stroke patients, should not be overlooked. Dyadic psychoeducation (involving both stroke survivors and family caregivers) appears to be a promising approach for providing knowledge concerning strokes and appropriate self-care or caregiving skills to improve rehabilitation outcomes. Future studies could investigate these dynamics and identify context-specific strategies for the enhancement of social connectedness in stroke survivors.

In conclusion, this study highlighted the critical role that mild executive dysfunction has in shaping BPNS among chronic-phase stroke patients. Deficits in set-shifting and inhibition significantly impact autonomy and competence, and inhibition also contributes to relatedness. These findings indicate that interventions which target executive functions and psychological needs could enhance the recovery outcomes and quality of life in this population. By addressing recovery in both its cognitive and psychological dimensions, healthcare providers can develop holistic strategies to support stroke survivors in regaining their independence, competence, and meaningful social connections.

ΠΕΡΙΛΗΨΗ

Ήπια επιτελική δυσλειτουργία και ικανοποίηση των βασικών ψυχολογικών αναγκών σε ασθενείς με αγγειακό εγκεφαλικό επεισόδιο κατά τη χρόνια φάση

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ΣΚΟΠΟΣ Εξέταση της σχέσης μεταξύ ήπιας εξασθένισης των επιτελικών λειτουργιών και του βαθμού ικανοποίησης των βασικών ψυχολογικών αναγκών (αυτονομία, επάρκεια και σχετίζεσθαι) σε ασθενείς με αγγειακό εγκεφαλικό επεισόδιο (ΑΕΕ). **ΥΛΙΚΟ-ΜΕΘΟΔΟΣ** Συμμετείχαν 52 ασθενείς με μετωπιαία ΑΕΕ 6–9 μήνες μετά το επεισόδιο. Η ικανότητα νοητικής ευελιξίας αξιολογήθηκε με τη δοκιμασία Trail Making Test-Part B (TMT-B), ενώ ο έλεγχος αναστολής με τη δοκιμασία Stroop Neuropsychological Screening Test (SNST). Η ικανοποίηση των βασικών ψυχολογικών αναγκών αξιολογήθηκε με την κλίμακα ικανοποίησης βασικών ψυχολογικών αναγκών-γενική μορφή. Διεξήχθησαν αναλύσεις συσχέτισης Pearson και πολλαπλής γραμμικής παλινδρόμησης για τον προσδιορισμό συσχετίσεων και προβλεπτικών σχέσεων. **ΑΠΟΤΕΛΕΣΜΑΤΑ** Οι αναλύσεις Pearson έδειξαν σημαντικές συσχετίσεις μεταξύ της επιτελικής λειτουργίας και της ικανοποίησης των ψυχολογικών αναγκών. Ο δείκτης TMT-B συσχετίστηκε αρνητικά σημαντικά με την αυτονομία και την επάρκεια, ενώ ο δείκτης SNST συσχετίστηκε θετικά σημαντικά με την αυτονομία, την επάρκεια και το σχετίζεσθαι. Οι αναλύσεις πολλαπλής παλινδρόμησης επιβεβαίωσαν ότι τόσο ο TMT-B όσο και ο SNST προβλέπουν σημαντικά την αυτονομία και την επάρκεια, ενώ μόνο ο SNST προβλέπει σημαντικά το σχετίζεσθαι. **ΣΥΜΠΕΡΑΣΜΑΤΑ** Η παρούσα μελέτη ανέδειξε τη σημαντική επίδραση της ήπιας επιτελικής δυσλειτουργίας στην ικανοποίηση των ψυχολογικών αναγκών σε ασθενείς με ΑΕΕ στη χρόνια φάση. Ελλείμματα στην ευελιξία και στην αναστολή επηρεάζουν την αυτονομία, την επάρκεια και το σχετίζεσθαι, υπογραμμίζοντας την ανάγκη για αξιολογήσεις και παρεμβάσεις που στοχεύουν τόσο στους νοητικούς όσο και στους ψυχολογικούς τομείς. Μια ολιστική προσέγγιση που λαμβάνει υπ' όψιν αυτούς τους παράγοντες θα μπορούσε να βελτιώσει τα αποτελέσματα της αποκατάστασης και να ενισχύσει την ποιότητα ζωής των επιζησάντων εγκεφαλικού επεισοδίου.

Λέξεις ευρετηρίου: Αγγειακό εγκεφαλικό επεισόδιο, Αναστολή, Βασικές ψυχολογικές ανάγκες, Επιτελική δυσλειτουργία, Νοητική ευελιξία

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