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Relationship between Executive Functions, Positive Psychology and Depression: A Positive Neuropsychology Framework

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Abstract

This study explores the relationship between executive functions, positive psychology, and depression within the context of a positive neuropsychological framework. The participants comprised 286 university students (113 male and 173 female). The study utilized the Executive Function Index (EFI), Beck Depression Inventory-II (BDI-II), and Positive Psychology Scale for data collection. Research questions were addressed through the application of simple regression, Pearson correlation, and t-test methodologies. The study findings revealed that the EFI failed to predict positive psychology and depression. Conversely, positive psychology exhibited predictive capabilities for depression. Additionally, the results demonstrated a negative correlation between depression and positive psychology, depression and executive functions, as well as a positive correlation between positive psychology and executive functions. Furthermore, the study revealed that females exhibited higher levels of depression, while males exhibited higher levels of positive psychology.

Keywords: *Depression, executive functions, positive psychology, positive neuropsychology*

Introduction

Executive functions (EFs) encompass control processes that include goal-oriented planning, flexible strategy generation, sustained maintenance, self-monitoring and inhibition, working memory, initiation of behavior, sequencing, and monitoring goal-directed behavior (refer to Diamond, 2013 for a comprehensive review). These functions oversee the execution of intricate activities (Royall et al., 2002) and are recognized as higher-level cognitive functions that control

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and regulate low-level cognitive processes and goal-directed, future-oriented behavior (Cristofori et al., 2019).

These EFs play a crucial role in human autonomy, facilitating successful engagement in independent, purposeful, and self-serving behavior (Lezak et al., 2012; Matheson et al., 2011). The lack of EFs is associated with significant dysfunctional behavior (e.g., Zelazo, 2020), while elevated levels of EFs contribute to a more adaptive and prosperous life (Gioia et al., 2010). Anatomically, EFs have been associated with the prefrontal cortex (PFC) (Friedman & Robbins, 2022). Additionally, existing evidence indicates that damage to the frontal lobe (FL) can result in executive dysfunction, posing significant challenges in coping with various real-world situations, as exemplified by the case of Phineas Gage (Ratiu et al., 2004).

Recent neuroimaging advancements propose the involvement of frontal subcortical circuits in executive functions (EFs). These circuits comprise the dorsolateral prefrontal circuits (DLPF), linked to executive cognitive dysfunction; the lateral orbital prefrontal circuit (LOPFL), associated with disorders of self-regulation like inhibition; and the anterior cingulate circuit (AC), connected to activation and motivation issues (Friedman & Robbins, 2022). EFs are categorized into "hot" and "cool" EFs. Cool EFs are associated with the DLPFC and encompass working memory, planning, and problem-solving. On the other hand, hot EFs involve effective decision-making, particularly decisions with emotionally significant consequences, thought to be associated with the orbital prefrontal cortex (OPFC) (Salehinejad et al., 2021).

Researchers have developed various theories and models to understand executive functions better. Although there is currently no widely acknowledged theory or model in the field, most researchers concur that executive functioning encompasses higher-order skills that are used to organize, monitor, and manage complicated thoughts and behaviors (see Diamond, 2013; Friedman & Robbins, 2022).

The cerebral cortex assumes a central role in emotional behavior (Heilman & Gilmore, 1998). Notably, neuropsychological research indicates that impaired emotional perception and expression are associated with dysfunction in the posterior and anterior regions of the brain, respectively (Borod, 1992). Moreover, studies have observed that healthy individuals experiencing sadness exhibit decreased activation in the right hemisphere (Dixon et al., 2017). Additionally, there is a suggestion that the activation of the left anterior hemisphere is linked to approach behaviors in

response to rewards and heightened positive affect (Gordon et al., 2014). Consequently, one would anticipate that reductions in left-anterior activation may impact these responses.

Relatedly, research has identified disruptions in various areas of the FL among individuals with depression (Watkins & Brown, 2002). Additionally, depressed individuals exhibit reduced metabolism and regional cerebral blood flow (CBF) in the frontal cortex (Bench et al., 1992; Fallucca, 2018). Studies consistently report a decline in executive functions, encompassing flexibility, planning, fluency, inhibition, speed, problem-solving, and reasoning, among depressed patients (e.g., Shenal et al., 2003). Some investigations have identified an association between depression severity and executive functioning (e.g., Monteiro et al., 2016). In line with this, Kraft et al. (2023) concluded that core symptoms of depression, such as loss of interest/pleasure and fatigue/energy loss, are closely linked to poor executive functions. Additionally, cognitive deficits observed in patients with depression may also be correlated with executive function deficits (Nuno et al., 2021).

Results from Miley and Spinella's (2006) study revealed a positive relationship between the EFI scales and motivational drive, empathy, strategic planning, self-gratitude, and satisfaction. Unexpectedly, they observed a negative relationship between impulse control and forgiveness. The authors suggested that the brain structure associated with executive functions might be essential for successful task completion and could serve as the basis for what Seligman termed authentic happiness.

Miley and Spinella's (2006) findings significantly contribute to positive neuropsychology by exploring the relationship between EFs and positive psychological traits—Gratitude, Satisfaction with life, and Forgiveness. They suggest that the neurological substrates underlying executive function may be associated with and necessary for goal attainment and task accomplishment. The study concludes that executive functioning skills could be the basis for Seligman's (2002) model of authentic happiness, incorporating satisfaction with life, gratitude, forgiveness, hope, and optimism. Seligman (2002) outlines various characteristics of authentic happiness, encompassing satisfaction with life, gratitude, forgiveness, hope, and optimism. This perspective was examined in a sample of college students, comprising 54 men and 100 women, with ages ranging from 17 to 76 years.

Furthermore, positive correlations were identified between executive functions, gratitude, optimism, and hope. However, mixed results were observed in the relationship between executive

functions, forgiveness, and satisfaction with life. In a related context, Kruger (2011) and Fallucca (2018) discovered that in the presence of deficits in executive functions, hope may serve as a buffer against depression. Research consistently indicates a positive correlation between Efs and hope, as demonstrated by studies such as those conducted by Miley and Spinella (2006), Kruger (2011), Fallucca (2018), and Kryza-Lacombe et al. (2021). This suggests that individuals with elevated levels of hope may exhibit compensatory mechanisms when confronted with deficits in executive functioning, as highlighted by Sears (2007).

The issue of sex differences in executive functions, depression and positive psychology has controversial results, except for depression, where females have higher depression symptoms than males (Zhao et al., 2020). There is minimal evidence supporting substantial gender or sex disparities in executive functions (Grissom and Reyes, 2018). Nonetheless, research indicates that girls demonstrate better executive functions than boys between the ages of 13 and 17 (Shoqeirat, 2020). Furthermore, the use of the Executive Function Index has revealed that females exhibit higher executive functions compared to males (Shoqeirat, 2021)

According to Miller et al. (2008), women are often perceived as having amiable, empathetic dispositions, being more empathic, and appreciating relationships. However, other studies show that men are more likely than women to be forgiving (Cabras et al., 2022; Kaleta & Morz, 2021). In addition, women are frequently more adept than men in expressing gratitude (Skalsk & Pochwatko, 2020). Hormonal fluctuations and societal norms around gender identity may be to blame for this. Moreover, across a range of economic, educational, and occupational categories, women consistently reported higher levels of life satisfaction than men (Joshanloo & Jovanovic, 2019).

Research Questions

1. Can measures of executive functions (EFI) predict positive psychology (GRA, FOR and SAT) and depression (BDI-II)?
2. Can measures of positive psychology predict depression?
3. Is there a significant correlation between EFI, positive psychology and depression?
4. Are there significant sex differences in FEI, positive psychology and depression?

Literature Review of Related Theories

Forgiveness and Depression

Psychologists commonly define forgiveness as a deliberate, conscious decision to release feelings of anger or the desire for revenge toward an individual or group that has wronged you, irrespective of whether they deserve your forgiveness (Krentzman et al., 2018). Scholars posit that a failure to forgive intensifies negative emotions, contributing to heightened levels of depression and emotional instability. In severe cases, this may culminate in mental illness (Hong et al., 2009).

Correlational research indicates a strong association between a lack of forgiveness and the Psychopathology scales of the Minnesota Multiphasic Personality Inventory, encompassing hostility, depression, anxiety, and neurosis (Chung, 2016). Furthermore, these findings suggest a connection between a failure to forgive and depressive symptoms, pointing towards psychological maladjustment (Chung, 2016).

Findings from the study by Fayyaz and Besharatb (2011) revealed that individuals without depression exhibited higher levels of forgiveness compared to those who were depressed. This implies that the act of forgiveness may act as a protective factor against the harmful consequences of anger, hostility, and vengeance, potentially preventing individuals from falling into the depths of depression.

Executive functions and forgiveness

Results from a previous study conducted on undergraduate students (Kruger, 2011) indicated that forgiveness played a crucial role in explaining the variance in EFs. Evolutionary models propose that the prefrontal cortex, the region housing EFs, is linked to more benevolent and less punitive actions, likely due to enhanced theory of mind (Billingsley & Losin, 2017).

Theory of mind involves recognizing and attributing beliefs, intentions, desires, knowledge, and emotions to oneself and others, acknowledging that others may have different perspectives (Premack & Woodruff, 1978). Consequently, higher EFs may contribute to forgiveness, as executive functioning facilitates the process (Pronk et al., 2010).

A neuropsychological model of forgiveness posits a negative correlation between the frontal lobe and right parietal lobe functioning with forgiveness, as indicated by the findings of Johnstone et al. (2014). Additionally, the results revealed that elevated forgiveness scores were linked to a larger grey matter volume in the dorsolateral prefrontal cortex regions (Li & Lu, 2017).

Gratitude and depression

Wood et al. (2010) introduced a novel gratitude model in their review, merging appreciation stemming from recognizing the kindness of others with gratitude derived from consistently focusing on the positive aspects of life. Gratitude assumes a protective function against the onset of psychopathology by fostering improved interpersonal relations and cultivating a relationship with oneself characterized by reduced judgment, diminished punitive tendencies, and heightened empathy.

Numerous studies have established associations between gratitude and reduced levels of psychopathological symptoms, specifically depression and anxiety (Emmons & Stern, 2013; Wood et al., 2010). In a meta-analysis study, Iodice, Malouff and Schutte (2021) found a substantial association between gratitude and depression. Also, gratitude predicted fewer symptoms of depression and anxiety (Petrocchi & Couyoumdjian, 2015). Dispositional gratitude was also positively associated with acceptance of illness (Tomczyk et al., 2022).

Research has demonstrated that gratitude contributes to enhanced mood and sleep quality, crucial components of brain health. Moreover, gratitude has been linked to increased levels of dopamine and serotonin, two brain chemicals associated with feelings of well-being, as noted in the study by Fox et al. (2015).

Gratitude and Executive functions

Miley and Spinella (2006) and Kruger (2011) identified a noteworthy positive correlation between Executive Function and Gratitude, particularly among university students. Additionally, elevated levels of gratitude were linked to improved cognitive function, as revealed by the findings of Tani et al. (2022). The research indicates that higher levels of gratitude are associated with larger volumes in both the right and left Fusiform Gyrus.

Moreover, a structural equation model analysis conducted by Tani et al. (2022) demonstrated that amygdala volume mediated the relationship between gratitude levels and cognitive function. Additionally, gratitude ratings were found to correlate with brain activity in the anterior cingulate cortex and medial prefrontal cortex, as evidenced by the findings of Fox et al. (2015).

Depression and life satisfaction

Life satisfaction is commonly defined as a comprehensive assessment of an individual's standard of living based on their self-determined criteria (Shin & Johnson, 1978). The broad and 'global'

nature of this definition enables individuals to subjectively prioritize elements in their lives, such as money, career, and location, according to their personal values and preferences.

Numerous studies have demonstrated a negative correlation between depression and life satisfaction. For instance, in older individuals, Van Damme-Ostapowicz et al. (2021) discovered that as depression levels increased, life satisfaction declined, indicating that depression adversely impacts life satisfaction. Additionally, Joshanloo (2022) reported that only life satisfaction served as a predictor for future depressive symptoms.

Executive functions and life satisfaction

Executive functions have been shown to correlate with gratitude, life satisfaction, and forgiveness, as indicated by studies conducted by Kruger (2011) and Miley and Spinella (2006). Furthermore, executive functions have predictive value for life satisfaction, as demonstrated by the findings of Marshall (2016) and Oh & Yang (2021). Elevated satisfaction levels were linked to increased activity in specific brain regions, as identified by Acevedo et al. (2012).

These regions include the Ventral Tegmental Area, associated with reward and motivation; the Orbitofrontal Cortex, reflecting reward evaluation; the Arnold Insula, indicative of empathy; the Immediate Prefrontal Gyrus, reflecting the mirror system; the Bed Nucleus of Stria Terminalis, reflecting stress control; and Frontal receptors, indicative of affective regulation.

Positive Neuropsychology Framework

The positive neuropsychology theory of positive affect, positing an association between increased brain dopamine levels and positive affect, is suggested by Ashby et al. (1999). This theory implies a systematic influence of positive affect on various cognitive functions. The authors also introduce a dopaminergic theory of positive affect, suggesting an accompanying increase in dopamine release in the mesocorticolimbic system and possibly in the nigrostriatal system. Furthermore, they assume that elevated dopamine levels impact performance on diverse cognitive tasks, including episodic memory, working memory, and creative problem-solving (Ashby et al., 1999).

Randolph (2013, p. 9) defines the field of positive neuropsychology as aiming to incorporate positive psychology ideas into neuropsychological research and practice, with the ultimate goal of promoting cognitive health through various means. Despite this, most research approaches in neuropsychology remain focused on negative psychological characteristics (Randolph & Chaytor, 2013). This perspective is reinforced by Lezak et al. (2012), who question the continued reliance on the deficit model in current neuropsychological assessment practices.

In a review study, Randolph (2010) observed a predominant focus on investigating deficits in neuropsychiatric populations, with 52% of the studies concentrating on this aspect. Notably, only 13% of the reviewed studies addressed the concept of normal cognitive function, 2% examined preserved functioning in neurological disorders, and a mere 1% focused on cognitive rehabilitation. These findings underscore the prevailing deficit model approach in neuropsychology.

Positive psychology is the scientific study of what makes life worth living, focusing on developing strengths and positive characteristics instead of addressing weaknesses or illnesses (Peterson, 2008). However, the exploration of protective factors and positive psychological characteristics influencing brain behavior functioning is limited. Thus, there is a significant need for neuropsychology to shift towards a more positive neuropsychological framework for a comprehensive understanding of the intricate relationships between the human brain and behavior. In neuropsychology, there is a necessity to redirect research efforts towards comprehending normative cognitive functioning, intensifying the advocacy for cognitive health promotion, and exploring the impact of positive psychological constructs on higher-order cognitive functions, such as executive functioning skills (Randolph, 2013). In conclusion, as per Randolph (2018), Positive Neuropsychology has surfaced as a neuropsychological orientation dedicated to research and practice that emphasizes the promotion of cognitive health.

Method

Research Design

This study employed a descriptive correlational approach as the most suitable method for achieving its objectives (Barker et al., 2016). The study investigates the relationship between executive functions, positive psychology, and depression within the context of a positive neuropsychological framework. Anticipating a moderating role, positive psychological constructs such as gratitude, forgiveness, and satisfaction with life are expected to moderate the relationship between executive function and depression. The following statistical model was used:

The general linear regression model can be stated by the equation:

Where is the intercept, are the slope between Y and the appropriate Xi, and ε is the error term that captures errors in the measurement of Y.

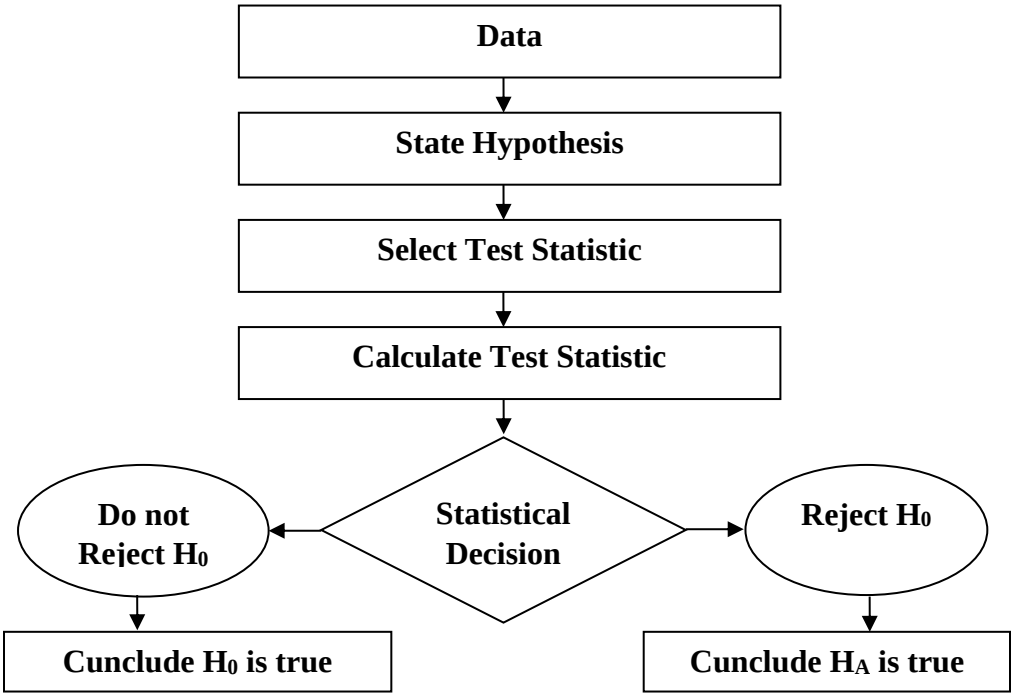


Figure 1. Hypothesis testing Flow.

Participants

The study comprised 286 Jordan University students (113 male and 173 female) aged 18 to 26 years during the second semester of 2023. Participants were recruited through word-of-mouth on a college campus. Table (1) presents sample demographical variables.

Table 1

Demographic variables.

SEX	College					
	Scientific		Art		Total	
Male	70	24.5%	43	15%	113	39.5%
Female	81	28.3%	92	32.2%	173	60.5%
Total	151	52.8%	135	47.2%	286	100.0%

Data Collection Tools

The Executive Function Index (EFI).

The self-rating index consists of (27) items, known as the EFI. It includes five subscales identified through factor analysis: empathy (EM), strategic planning (SP), organization (ORG), impulse control (IC), and motivational drive (MD) (Spinella, 2005). A factor analysis revealed three higher-order factors aligning with executive functions linked to the dorsolateral prefrontal cortex (SP, ORG), orbitofrontal cortex (IC, EM), and medial prefrontal cortex (MD) regions (Spinella, 2005). Participants were instructed to rate items on a scale of 1-5, indicating' how much does this describe you', with 1 signifying' not at all' and 5 denoting' very strongly'. The resulting score ranged from 27 to 135 points, with higher scores indicative of better executive functions. The Cronbach alpha reliability coefficient was calculated for this index, yielding a value of 0.78, which falls within acceptable ranges. The index, translated into Arabic by Al Sunna' and Shoqeirat (2019) using standardized methods, demonstrated reliability (alpha= 0.970 for the current study) and validity (Pearson correlation coefficient= 0.57) for application within the Jordanian population.

Beck Depression Inventory-II (BDI-II):

The BDI-II (Beck et al., 1996) is an inventory designed to assess depressive symptomatology in adults. Comprising (21) items, each offering 4 alternatives and scoring from 0 to 3 based on severity, the BDI-II takes 5-10 minutes to complete. The total score is the sum of the ratings assigned to each of the 21 items, yielding a potential range from 0 to 63. The BDI-II has demonstrated relatively high-reliability indices, with Cronbach alpha coefficients ranging from 0.84 to 0.85 and 0.85 in separate instances and test-retest reliability coefficients of 0.87, 0.86, and 0.86 (Al da'asin, 2004).

Positive Psychology Scale

This scale, as employed by Miley and Spinella (2006), comprises (17) items rated on a 7-point scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Notably, scores for items 3, 6, 7, 9, and 11 were reversed. The positive scale encompasses three subscales: gratitude (items 1-6), forgiveness (items 7-12), and satisfaction with life (items 13-17). The overall scale demonstrated a high level of internal consistency, with a Cronbach alpha coefficient of 0.922. Subscale reliabilities ranged from 0.807 to 0.743.

Data Collection

The instruments were distributed in classes, allowing students the choice to respond or not. To ensure anonymity and foster honest responses, participants were encouraged to return the tools if they chose not to participate. The study occurred at the University of Jordan during the second semester of 2023. The study tools were distributed in three introductory classes.

The instruments were distributed by the first and the second author, and students willing to answer them returned all the instruments. Students who did not wish to participate returned the instruments before they answered them. The first author scored the BDI-II as a total score, and then the tools were given to the third and last authors to tabulate them on SPSS.

Data Analysis

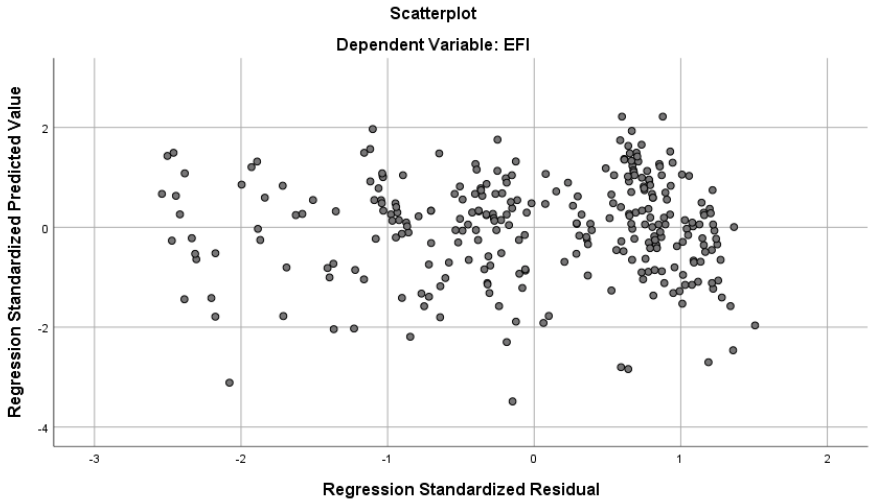
The data analysis utilized the SPSS statistical package. Multiple linear regression, Simple linear regression, Pearson correlation, and t-tests as statistical tests were employed to address the study questions. After checking the assumption, all instruments were fit, and normality and homogeneity tests using Levene's tests were made as a requirement for using parametric tests. The results show a normal distribution (Ghozali, 2018), and there was homogeneity, according to Hair et al. (2018). employing Pearson correlation, t-test and Chi-square tests to analyze the data at hand.

Results

The linear regression model was used to quantify the relationship between two predictors (question 1) and one predictor (question 2). The Multicollinearity Predictors: (Constant) Depression, Positive Psychology, Dependent Variable: EFI. Prediction Equation: EFI=102.533+ 0.059(Positive psych) + -0.078(Depression). Predictors Table (3).

Homogeneity

The following shape proved the homogeneity, as results appeared randomly.



Descriptive statistics

Table 2 presents the means and standard deviations (SD) of the sample's performance on the measures.

Table 2

Means, standard deviations of EFI, depression and positive psychology

	SEX			
	Male		Female	
	Mean	Standard Deviation	Mean	Standard Deviation
EFI	107.02	21.05	104.45	22.07
Depression	16.34	8.02	16.51	10.02
Positive psych	76.91	15.95	73.23	20.26

Table 2 shows the means between males and females in EFI, depression and positive psychology.

Hypothesis Testing

First, the null hypothesis stated that executive function measures cannot predict depression and positive psychology.

Second, the null hypothesis stated that measures of positive psychology cannot predict depression.

The study results pertaining to Question 1, which examines whether measures of EFI can predict positive psychology and depression (BDI-II), utilised Multiple Linear Regression analysis. The outcomes are presented in Table 3.

Table 3

Multiple Linear Regression Analysis Summary for EFI, Positive Psychology and Depression

Predictors	R	R^2	F	Constant	B	Std. Error	t	Sig.	VIF
positive psychology	.073	.005	.751	102.533	.059	.076	.770	.442	1.254
Depression					-.078	.154	-.506	.614	1.254

Predictors: (Constant), Depression, Positive psychology, Dependent Variable: EFI
Prediction Equation: EFI=102.533+ 0.059(Positive psych) + -0.078(Depression)

Table 3 shows the model's results, including the constant (intercept), for each independent variable. The unstandardised coefficient B indicates the expected change in the dependent variable EFI for each one-unit increase in the independent variable.

Positive Psychology

If the value of the variable positive psychology changes by one unit, the value of the variable EFI changes by .059 units. The p-value is .442, indicating that this coefficient is not statistically significantly different from zero, which means we cannot confidently say that positive psychology impacts the dependent variable. More precisely, the null hypothesis that the coefficient of positive psychology is zero in the population is accepted.

Depression

If the value of the variable Depression changes by one unit, the value of the variable EFI changes by -.078 units. The p-value is .614, indicating that this coefficient is not statistically significantly different from zero, which means we cannot confidently say that Depression impacts the dependent variable. More precisely, the null hypothesis that the coefficient of Depression is zero in the population is accepted.

Regarding Question 2, examining whether measures of positive psychology can predict depression, simple linear regression was utilised, and the results are presented in Table 4.

Table 4

Simple Linear Regression Analysis Summary for Positive Psychology and Depression

Predictors	R	R^2	F	Constant	B	Std. Error	T	Sig.
Positive Psychology	.211	.459a	71.916	33.480	-3.618-	.416	-8.694-	*.000

Predictors: (Constant), Positive psych, Dependent Variable: Depression,
Prediction Equation: Depression =33.480 + -3.618(Positive psych)

Table 4 shows that positive psychology can predict depression within the sample, accounting for 45.9 % of the variance. The null hypothesis is rejected.

For Question 3, Pearson correlation analysis was employed to investigate the correlation between EFI, positive psychology, and depression. The outcomes are presented in Table 5.

Table 5

Correlation Matrix for the Study Tools

	GRA	FOR	SAT	Positive psych	EFI_MD	EFI_ORG	EFI_SP	EFI_EM	EFI_IC	EFI
Depression	-0.072	0.079	-.462*	-.308*	-.310*	-.298*	-.196*	-.129*	-.199*	-.389*
GRA	1	.155*	0.085	.563*	.145*	-0.035	0.070	-0.015	-0.093	0.030
FOR		1	0.115	.564*	0.015	-0.089	0.072	0.012	-.148*	-0.047
SAT			1	.766*	.212*	.158*	.224*	.234*	.145*	.332*
Positive psych				1	.213*	0.056	.214*	.159*	0.001	.221*

* Correlation is significant at the 0.05 level (2-tailed).

(GRA: gratitude, FOR: forgiveness, SAT: satisfaction, EFI: executive function index, MD: Motivational Drive, ORG: Organisation, SP: Strategic Planning, EM: Empathy, IC: Impulse Control).

As depicted in Table 5: Firstly, depression demonstrated a significant negative correlation with positive psychology and EFI, along with all the subscales of EFI. However, only satisfaction with life (a positive psychology scale) exhibited a significant negative correlation with depression. Secondly, gratitude positively correlated with forgiveness, positive psychology, and motivational drive (EFI subtest). Thirdly, forgiveness showed positive correlations with positive psychology but negative correlations with impulse control (EFI subtest). Fourthly, satisfaction with life displayed positive correlations with positive psychology, EFI, and EFI subscales. Fifthly, positive psychology exhibited positive correlations with the EFI total score and EFI subscales, excluding organisation and impulse control, which demonstrated no correlation.

For Question 4, examining sex differences in FEI, positive psychology, and depression, the independent samples t-test was employed. The results are presented in Table 6.

Table 6

Independent Samples T-Test (Differences)

D. V	Sex	N	M	SD	F	df	Sig.
Depression	Male	112**	16.34	8.02	5.951	283	**.015***
	Female	173	16.51	10.02			
EFI	Male	113	107.02	21.05	.336	284	**.563**
	Female	173	104.45	22.07			
Positive psychology	Male	113	76.91	15.95	12.421	284	***.000**
	Female	173	73.23	20.25			

*. Significant at the 0.05 level (2-tailed), M: Mean, SD: Std. Deviation.
** One value missed.

Table 6 presents significant differences between males and females in depression, with females exhibiting higher levels of depression. Additionally, the results revealed significant sex differences in positive psychology, where males demonstrated higher levels of positive psychology.

Discussion

The discussion of results pertaining to Question 1 indicates that executive functions cannot predict positive psychology. However, a positive correlation exists between executive functions and positive psychology, suggesting that higher executive functions correspond to higher levels of positive psychology. Notably, forgiveness demonstrated a positive correlation with positive psychology but a negative correlation with impulse control, a subscale of EFI. This unexpected result contrasts with the anticipated positive correlation, where an increase in impulse control is expected to coincide with an increase in forgiveness. Similar results were reported by Miley & Spinella (2006), and Quintero Reynaga et al. (2020) found a negative correlation between forgiveness and impulse control among adolescents. Impulse control also referred to as self-control or inhibition, represents a crucial executive functioning skill that empowers individuals to act autonomously in their daily lives.

Forgiveness, recognized as a positive attribute, alleviates the emotional burden for the one extending forgiveness, thereby diminishing negative emotions and fostering more adaptive emotional functioning. However, an indiscriminate practice of forgiveness may introduce additional life challenges, leading to emotional distress. It is imperative for individuals to judiciously assess the reasons for extending forgiveness, thereby striking a balance between forgiveness and prudent discernment. The current study's evaluation tools may not adequately capture this nuanced aspect of seeking adaptive emotional behavior.

On the contrary, Kruger (2011) identified a favorable correlation between impulse control and forgiveness, facilitating the occurrence of ordinary forgiveness. Despite using similar age groups (adolescents and university students) in current and prior studies, Kruger's findings diverge from the aforementioned results. A pertinent inquiry arises: do younger individuals possess adequate life experiences to furnish rational responses pertaining to forgiveness?

Satisfaction with life exhibited a positive correlation across all executive function subscales, including motivational drive, organization, strategic planning, empathy, impulse control, and the total score of the EFI. This implies that as executive functions increase, so does life satisfaction. These findings align with previous studies (e.g., Miley & Spinella, 2006; Kruger, 2011; Marshall, 2016; Oh & Yang, 2021).

The study's findings indicate that EFs assessed through EFI do not serve as predictors for depression, as measured by BDI-II. Nevertheless, a negative correlation was observed between depression and executive functions, implying that higher levels of EFs are associated with lower levels of depression. This outcome finds support in various study results (e.g., Monteiro et al., 2016; Nuno et al., 2021; Kraft et al., 2023).

The results discussion pertaining to Question 2 findings revealed that measures of positive psychology could predict depression; positive psychology measures can predict 45.9% of depression. To interpret this appropriately, we need to consider the measures of positive psychology (gratitude, forgiveness and satisfaction with life), all of which are associated with positive mental health. For example, gratitude predicts less depression, and a negative correlation between life satisfaction, forgiveness and depression has been reported (see the introduction). Related to this, it is also found that through positive psychology interventions, people with depression can focus less on negative thinking and feelings, increase self-esteem, and create a sense of purpose and meaning in their lives (see Pan et al., 2022).

In the discussion of the results pertaining to Question 3, Negative correlations emerged between depression and positive psychology, suggesting that higher positive psychology was associated with lower depression. Positive psychology makes life worth living and makes people focus on developing strengths and positive attitudes rather than addressing negative ideas or illnesses (Peterson, 2008).

Also, a negative correlation emerged between depression and executive functions. The core symptoms of depression, such as loss of interest/pleasure and fatigue/energy loss, are closely

linked to poor executive functions, and other studies have found similar results (e.g., Monteiro et al., 2016). Finally, a positive correlation between positive psychology and executive functions emerged. One would expect such a correlation if we regard executive functions and positive psychology as both positive elements of human life and brain function. Similar results were reported by Miley and Spinella (2006).

The results discussion pertaining to Question 4, The study also showed higher depression levels in females and higher positive psychology levels in males. This gender disparity may be due to women facing challenges in coping with adverse events and emotional regulation, possibly influenced by hormonal factors. Ultimately, the results indicated elevated depression symptoms in females compared to males. This outcome aligns with the consensus in existing studies, which consistently propose a higher prevalence of depression symptoms in females (see Maji, 2018; Zhao et al., 2020). The results revealed higher levels of positive psychology among males, encompassing forgiveness, gratitude, and life satisfaction. Women are commonly perceived as more forgiving, valuing connections, and possessing amiable, empathetic personalities (Miller et al., 2008). However, contrary findings exist, with some studies suggesting that males exhibit more forgiveness than females (Cabras et al., 2022; Kaleta & Morz, 2021). Additionally, women tend to excel in expressing gratitude compared to men (Skalsk & Pochwatko, 2020), potentially influenced by hormonal differences and societal norms regarding masculinity and femininity. Moreover, across various economic, educational, and occupational categories, women consistently reported higher levels of life satisfaction than males (Joshanloo & Jovanovic, 2019).

These findings uphold the neuropsychological framework, emphasizing the importance of evaluating the state of functions in both clinical and non-clinical subjects. While the majority of research investigates these variables among clinical samples, there is a limited focus on studying these variables within non-clinical samples within the positive neuropsychology framework (see Randolph, 2013).

The non-clinical sample results in this study support the positive neuropsychology domain, aligning with research on clinical samples highlighting the crucial role of prefrontal systems in cognitive, social, and emotional functioning in both health and disease. This study prompts questions about common neural substrates, positive neuropsychological traits, and executive function similarities, urging further comprehensive research in the field.

Conclusion

The study delved into the relationship between depression, executive functions, and aspects of positive psychology within the framework of positive neuropsychology. Results indicated a negative correlation between depression and both positive psychology and executive functions, while a positive correlation emerged between positive psychology and executive functions.

Limitations, implications and future directions

The possibility of generalizing the results of the study is determined in the light of its sample, place and time; Where the study was conducted on a sample of university students aged 18 to 26 in Jordan in the year 2023. The study's results may be significant for the mental health field. Consequently, it is recommended that comprehensive future studies be conducted to further explore and understand these variables among normal and clinical subjects within the framework of positive neuropsychology.

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