Effect of Ego Depletion and Expectancy Beliefs on Working Memory, Problem Solving, Task Persistence, and Performance

Adnan Adil, Asmara Kanwal, Saba Ghayas, and Anam Khan

University of Sargodha

The present study was undertaken to examine the influence of ego depletion and expectancy beliefs (EB) about the limited will power of self-control on task performance and task persistence through a 2 (ego depleted vs. non-ego depleted group) x 3 (group with positive EB, group with negative EB, and the group without any EB) between subject experimental design. The participants ($N = 210$) were undergraduates of University of Sargodha who were randomly distributed to each of the six treatment conditions. Ego Depletion Task (Baumeister, Bratslavsky, Muraven, & Tice, 1998) and Feedback Task (Fried & Aronson, 1995) were adapted for the manipulation of the independent variables. Working memory (WM) was assessed through Digit Symbol Coding subscale of WAIS (Wechsler, 1997) and scores and time taken on an anagram task (Clarkson, Hirt, Jia, & Alexander, 2010) operationalized performance on problem-solving and task persistence, respectively. Multivariate analysis of variance indicated that the participants in the non-depleted group had significantly higher mean scores on problem-solving and WM tasks than those of their counterparts in the ego-depleted group. The group with the positive EB had the highest mean scores on WM and problem-solving tasks as compared to the other groups. The interaction effect of beliefs about limited will power of self-control and ego depletion remained nonsignificant. Limitations and recommendations for future research were reflected upon.

Keywords. Expectancy beliefs, ego depletion, working memory, problem-solving, task persistence

The term ego depletion is widely explored and it has received substantial attention from researchers working in various fields of

Adnan Adil, Asmara Kanwal, Saba Ghayas, and Anam Khan, Department of Psychology, University of Sargodha, Pakistan.

Correspondence concerning this article should be addressed to Adnan Adil, Department of Psychology, University of Sargodha, Sargodha, Pakistan. E-mail: livespirit786@yahoo.com

psychology. Baumeister coined the term of ego depletion (Muraven, Tice, & Baumeister, 1998). Ego depletion occurs when after performing a task that requires self-control, one's reservoir of self-regulation resource may be depleted or exhausted owing to which one's performance on a subsequent self-control task could be impaired (Dang, 2018). This means that ego depletion state is characterized by the temporary decrease in the energy level required for the preparedness to participate in a particular activity (Baumeister et al., 1998). Hence, with the decrease in the level of energy required for mental activity, there will be a decrease in self-control. This shows that in the state of ego depletion, a person may have reduced capability for the regulation of self, owing to the extensive mental activity.

The general procedure used for testing the ego depletion involves two conditions and participants in both the conditions are required to complete two successive tasks. Commonly used ego depletion tasks include crossing out letters, modified Stroop test, white bear paradigm, affect regulation while watching the video, and controlling attention while watching a video. In the depletion condition, participants are required to perform a task related to self-control, on the other hand, the participants assigned to the control condition are asked to perform on a task that is comparable, but neutral in nature. Subsequently, participants in both the conditions complete a second, unrelated self-control task. The evidence for the ego depletion is established if the performance of participants under the depleted condition is worse on the subsequent self-control task than that of their counterparts in the control condition (Dange, 2018). For instance, in crossing out letters, all participants are instructed to cut off the letter "e" from the given passage in the first task. In the second task, participants are asked to cut off that letter "e", when the vowel is one letter moved from the "e" in either direction or when the "e" is written next to a vowel. For the ego nondepleted or the control group, both the tasks are the same and involve cutting the letter "e" in the paragraph. Then their subsequent performance is measured on a working memory (WM) task. Similarly, in affect regulation tasks, participants in the experimental group watch an emotionally-charged movie under instructions to suppress their emotions whereas their counterparts in the control group watch the movie as normal. Then their subsequent performance on a Stroop task is measured.

A meta-analysisd conducted by Dang (2018) observed that WM task and attention video tasks were ineffective in depleting the ego reservoir. Dang (2018) further observed that the most frequently used ego depletion task in the pertinent research was crossing out letters

task, that is why the present study chose the crossing out letters task for the manipulation of ego depletion.

The recent meta-analytic findings of Dang (2018) suggested that the dependent measure or the subsequent task in an ego depletion study must involve self-control because the self-control strength model of ego depletion defines ego depletion as the impairment in subsequent self-control tasks. Both WM and problem-solving tasks require self-control, therefore, they are one of the safest choices among the outcome variables. Moreover, WM and anagram tasks are included in the most frequently used outcome measures in ego depletion research. Dang criticized the studies that have examined the effect of the initial level of self-control efforts on other variables (instead of investigating the subsequent self-control variables) and conceived them as one of the potential reasons for the low to a medium effect size of ego depletion in her meta-analysis. Carter Kofler, Forster, and McCullough (2015) and Hagger, Wood, Stiff, and Chatzisarantis (2010) asserted that, for the study of ego depletion, only those research evidence could be conceived as legitimate that is based on persistently used depleting as well as the outcome tasks. Thus, the use of crossing out letters task as the ego depletion task, and WM and problem-solving task as the outcome measures justify the present study as valid research that might empirically contribute to the accumulating evidence on the ego depletion. Previously researchers designed various types of experimental studies related to ego depletion and inferred that that ego depletion negatively influenced level of self-control among different individuals (Baumeister, 2002, 2003; Vohs et al., 2008). Previous literature depicts that ego depletion was related to the level of self-esteem (Murray & Rose, 2005); ego depletion was also found to be related to social exclusion (Baumeister, DeWall, Ciarocco, & Twenge, 2005), and impression management (Vohs, Baumeister, & Ciarocco, 2005). It is also worth mentioning that some studies have found no support for the ego depletion phenomenon (Lurquin et al., 2016; Xu et al., 2014). Ego depletion is theoretically explained by various models. There are basically two well-established models of ego depletion. The first model is self-control strength model (Muraven & Baumeister, 2000), which provides a classic explanation of ego depletion whereas the second model is the process model (Inzlicht & Schmeichel, 2012), which focuses on the fine dynamics of the ego depletion process.

The Self-Control Strength Model of Ego Depletion

This model provides a coherent theoretical explanation of ego depletion and it suggests that self-control is a process which requires

efforts in order to control and alter person's automatic focus of attention and automatic tendencies, in the quest of long-term objectives (Schmeichel & Vohs, 2009). The model suggests that the energy reservoir is inadequate and the effortful process of self-control may drain a substantial amount of energy from this reservoir, resulting in a depleted energy state. This process can be compared to the working of a muscle. After extended stretching of the muscle, it might get fatigued and needs rest in order to return to its original state. One cannot stretch one's muscle after it has been fatigued. Likewise, the resource of self-regulation requires energy, which is limited, and once consumed in a self-regulatory task, it is no more available for any subsequent self-control task. One has to wait so that the depleted energy reservoir may be restored over time. Keeping in view the analogy of muscles, it can be inferred that consistent involvement and usage of muscles can lead towards the muscle tiredness and ultimately cause reduction of capacity (Muraven, Tice, & Baumeister, 1998). Muravenet al. (1998) asserts that when a person uses the control in performing a particular activity, it will lead to a decrease in the quality and quantity of performance in a subsequent unrelated task that also demands self-control in performance.

This model also argues that it can be predicted that the performance of the experimental group will be reduced when they will be asked to perform on the second task as compared to that of the control group because the limited energy/resource reservoir possessed by the participants of the experimental group will begin to deplete after performing the first self-control task (Baumeister, Vohs, & Tice, 2007). Certain studies suggested that regulatory resources are comparable to energy, therefore, they are limited indeed (Muraven & Baumeister, 2000). It has been demonstrated that some regulation activities including control of behavior, thoughts, and emotion are necessary for intellectual performance, self-representation, and decision-making skills, and tend to wear out regulation resources, (Vohs et al., 2005; Vohs, Baumiester, & Tice, 2006).

Hagger et al. (2010) carried out a meta-analysis of studies related to ego depletion and found low to the medium effect of ego depletion. Findings of a study conducted by Muraven (2011) portrayed that in general, participants who experience depletion will perform poorer on the assigned tasks which they consider unimportant while on the other hand, they excel in performance if they take the task as an important one. Participants whose ego depleted as a result of behaviors related to self-control revealed a feebler tendency for socially desirable activities and behaviors in comparison with participants in the state of non-depletion (Vohs et al., 2005). It was also demonstrated that self-

control may fluctuate and one may experience various levels of self-control (Tangney, Baumeister, & Boone, 2004).

The process model. Postulates of the process model illustrate various specific mechanisms regarding self-control and the resultant levels of depletion (Inzlicht & Schmeichel, 2012). According to Inzlicht and Schmeichel (2012), initial efforts of will power may cause an individual to experience varying levels of gratification. Due to alterations in the levels of motivation and attention, level of self-control may shrink at Time 2 as compared to the Time 1. This model provided a precise description of lower levels of self-control, which an individual may experience at Time 2. It indicates that a low level of self-control is initiated as a consequence of a dearth of motivation for exercising self-control and diminished attention for pointing out the demand for self-control. This phenomenon was described via two processes: The first one is marked by the alteration in the motivational level. It explains that people are more motivated to sustain their efforts at tasks, which are personally meaningful, reinforcing, and enjoyable to them as compared to the ones which are less enjoyable or less gratifying. The second process deals with the swings in attention. People seem to show decreased attention towards those cognition and affect-based signals, in which they found some inconsistency between the assumed idea and current states and they only notice those cues, which are related to any type of reinforcement and satisfaction. Thus, ego depletion seems to be a function of one's motivation and attention, which varies in relation to the task's salience and the inherited gratification in doing it. Ego depletion facilitates intellectual thinking in individuals (Schmeichel et al., 2003). Similarly, Rottenstreich, Sood, and Brenner (2007) reported that depletion appeared to disturb the level of performance on those tasks which demand a high level of executive control.

The aforementioned models share the common theme, which justifies the phenomenon of ego depletion that is, the capacity or the motivation for the mental exertion at a subsequent task becomes lowered when one has already been engaged in a self-regulating task.

Ego Depletion and Personal Beliefs

According to Vohs, Baumeister, and Schmeichel (2012), motivations, beliefs, and different types of mindsets appeared as more important determinants of self-control than the mental energies. It has also been observed that the undesirable influence of ego depletion can be buffered one's personal values (Schmeichel & Vohs, 2009). Another research reported that aggression-based reactions following

the depletion are reduced as a result of the belief that a person has taken a dose of caffeine (Denson et al., 2012).

The offering of incentives can be beneficial for the control of ego depletion, which indicates that instead of decreased levels of energy, depletion may have been the result of the lower level of motivation (Muraven & Slessareva, 2003). Previously, it was reported that believing in the unlimited power of mental reservoirs can cause an increase in immunity for the ego depletion (Job, Dweck, & Walton, 2010). It was also suggested that existence of ego depletion actually lies "within one's head" and may crop due to having belief in the limited nature of will power (Vohs et al., 2012).

Research on the impact of various types of negative and positive expectancies on depletion claims that even after exerting self-control, people anticipate failure in their subsequent attempts because of their conviction that self-control is having boundaries and limits. For instance, individuals having belief in limited nature of self-control were more susceptible to get influenced by requirements of self-control as compared to the persons who did not have persistence in their ideas (Job et al., 2010). Another study by Alberts, Martijn, Nievelstein, Jansen, and de Vries (2008) reported contradictory findings that less attentive individuals towards efforts for self-control had revealed a reduced level of self-control in comparison with more attentive people. These results provide validating evidence for the idea that expectations related to self-control demands may mediate the impact of self-control on later self-control related performances. In a study conducted by Clarkson et al. (2010), the individual's performance on self-control related tasks were determined by perception about the level of depletion. The participants assigned to the experimental conditions of ego non-depletion and ego depletion were provided with incorrect feedback for the depletion task that made them attribute their resources either externally or internally. In short, it is argued that expectancy lays a very important role in an account of depletion because the reason behind failure at self-control is generally the result of belief in failure. Mostly, individuals are convinced that self-control is comprised of boundaries and have limited reserve and once utilizing self-control reserves, this conviction gets triggered; that becomes a source of further decrement in the degree of self-control (Muraven, 2011).

In research by Clarkson et al. (2010), before testing the task persistence, participants in the low and highly depleted conditions were provided with feedback about the situation. An interactive effect between feedback about the situation and the depletion level was observed in relation to the task persistence. It was also found that the

subjects assigned to the depleted condition who were provided with depleted feedback, showed a low level of persistence on the tasks related to problem-solving; on the other hand, participants provided with replenished feedback showed persistence on a problem-solving task. The results validated the notion that reservoirs of self-regulation of highly depleted individuals are more severely affected by the nature of feedback about the situation.

The main objective of the present research is to replicate the results of the previous studies, which not only lead to the experimental verification of ego depletion in aboriginal settings, but may also pave a way for a richer understanding of ego depletion phenomenon. In the present study, both the self-control strength model and the process model of ego depletion have been tested. The ego depletion task chosen in the present study provides a test of the self-control strength model whereas the manipulation of the expectancy beliefs (EB) constitutes a test of the process model. Though several meta-analytic studies (Hagger et al., 2010) have provided supportive evidence for the classic self-control strength model of ego depletion phenomenon, yet to the best of our knowledge, there is no published study in Pakistan that has ever experimentally tested the ego depletion phenomenon. Hence, the major provision of the present research is the empirical replication of the experimental findings on ego depletion that may lead to a better understanding of this under-researched phenomenon in Pakistan.

Aim in the present study is also to examine the potential role of participants' beliefs about the limited reservoir of self-control in ego depletion by empirically testing the assertion Job et al. (2010) that ego depletion is "within one's head only". This study leads to imperative understanding whether a self-regulation task actually leads to ego depletion or it is a simple matter of the lack of impetus to be indulged in an additional task that has nothing to do with the energy depletion (as postulated in the process model). This aspect of the present study is quite intriguing as it essentially tests a modern conception of ego depletion, which conceives that self-control is influenced by one's expectations, intentions, beliefs, attitude, and judgments (Hagger et al., 2010). This cognitive vantage point on self-control is incongruent with the classical strength models of ego depletion. As discussed earlier, the strength model explains ego depletion as a function of one's limited reservoir of self-regulation that needs to be refilled once resources of self-control are depleted after being engaged in a self-regulation task (Baumeister et al., 1998; Baumeister et al., 2007). This model does not account for the potential role of individual's other cognitive resources such as beliefs, intentions, motivation, and

expectations that the cognitive and the process model of ego depletion do incorporate in the explanation of ego depletion.

Hypotheses

Keeping in view the aforementioned literature, the following hypotheses have been formulated:

1. Participants in the non-depleted group will show a higher degree of persistence and a higher score on problem-solving and WM tasks as compared to their counterparts in the depleted group.
2. Participants in the +EB group will exhibit a greater degree of persistence and higher scores on WM and problem-solving tasks as compared to their counterparts in the -EB group and No-EB group.
3. Participants in the depleted -EB group will demonstrate a lower degree of persistence and poorer perform on problem-solving and WM tasks as compared to their counterparts in other experimental conditions.

Method

Research Design

A 2×3 between subject experimental design was employed. Two independent variables were manipulated. The first independent variable was ego depletion with two levels: ego depletion vs non-ego depletion. The second manipulated independent variable was EB and it had three levels including a +EB group, a -EB group, and a No-EB group. Thus, manipulation of these two factors led to six treatment conditions. Participants were randomly assigned to each treatment condition.

Sample

The sample of the current research consisted of (N = 210, Girls = 178, Boys = 32) students of the Psychology Department, University of Sargodha. Students were allocated into various groups of the present study through random assignment. The students of all semesters of the master's program and students of fifth or upper semesters of the BS programs were recruited. The age range of the participants was 18-24 years (M = 21.43, SD = 0.10). All participants were randomly allocated to one of the six treatment conditions with the help of a random number table and each condition had 35 participants.

Instruments

Ego Depletion Task. The ego depletion phenomenon was assessed through an Ego Depletion Task as used in the previous studies (Baumeister et al., 1998). Participants were randomly allocated into two groups in terms of ego depletion that is, ego depleted and ego nondepleted group. For participants in the ego depletion group, a paragraph was given to every participant, which consisted of meaningful words, but all sentences of the paragraph were meaningless. In the first part of Task I, all subjects were instructed to cut off the letter "e" from the given passage. In task II, subjects were asked to cut off that letter "e", when the vowel was one letter moved from the "e" in either direction or when the "e" was written next to a vowel. For the ego nondepleted group, both the tasks were the same and involved cutting the letter "e" in the paragraph.

Feedback Form. In order to manipulate the EB, the feedback form was taken up from the earlier studies on misattribution (Fried & Aronson, 1995). The subjects were randomly allocated to one of the three EB groups including a +EB group, a -EB group, and the N–EB group. After Task 1 of the ego depletion task, the participants of the +EB group and the -EB group received feedbacks. Afterward, both of these groups were led to Task 2 of ego depletion. Participants in the No-EB group were not provided with any type of feedback and they were led to Task 2 of the ego depletion task.

Participants in the +EB group received the feedback that the yellow color of the paper of the ego depletion task had been scientifically proven to have a very *healthy influence* on mental capacities of people and it helps in *energizing* the ability to focus on given information. Participants assigned to the -EB group were given negative feedback by telling that the yellow color of the page could have very *negative effects* on mental abilities of people and it might *exhaust and deplete* one's ability to attend to information.

The combination of two conditions of ego depletion and three conditions of feedback gave rise to six treatment conditions. Two groups were without any induced beliefs (depleted – No-EB and nondepleted – No-EB). They were led to task II, which was the same as the first one for the participants in the nondepleted no-EB condition. They were instructed to cut off the letter "e" in the same manner as they did in task I. However, task II for the participants in the depleted No-EB group was changed. They were advised to cut off that "e", which was either preceded or followed by a vowel.

Task II provided to the participants in the depleted group (including both conditions of +EB and the -EB) was in washed-out

tint (Grey). The task II was modified for the participants in both the groups and they were instructed to cross out that "e" letter, which was written when the vowel was one letter removed from the "e" or it was next to a vowel. The participants in the nondepleted group (including both +EB and the -EB conditions) were instructed to carry on with task II. For these participants, instructions for task II and task I were identical.

Manipulation Checks. Participants under depleted as well as nondepleted conditions were tested on the manipulation checks by asking them to specify the degree of difficulty and tiresomeness of the activity on a 5-point Likert rating scale (1 = *not at all*, 5 = *very much*).

Digit Symbol Coding. Digit symbol coding subscale of the Wechsler Adult Intelligence Scale (Wechsler, 1997) was used to operationalize WM. It comprised of nine pairs of digits and symbols which were trailed by a list of numbers. The participants had to write the corresponding symbol under each number as fast as they could. The number of correct symbols written under the digits within 90 seconds were recorded as a measure of WM. High scores on this scale reflected a high degree of WM.

Anagram Task. The task for solving the anagram was chosen from the earlier research (Clarkson et al., 2010). Participants were instructed to unscramble 7 English alphabets to form meaningful English words, which should comprise of at least three letters without any repetition of the letter. Participants were allowed to produce as many words as they could. The number of correct English words produced by the individuals were recorded as the index of their problem-solving ability. The higher the number of meaningful English word produced, the higher the problem-solving capability. The amount of time spent by each individual on the anagram task was also recorded, which operationalized the degree of persistence on the task. The greater the time spent on the anagram task, the higher the task persistence.

Procedure

Various booklets of the scales were prepared for each experimental condition. After welcoming the participants to the research, they were randomly allocated to each experimental condition. After seeking their informed written willingness to participate in the study, they were assured of the confidentiality of their information. Relevant demographic information pertaining to

gender and age were recorded and the subjects were requested to perform the ego depletion task. They were instructed to complete the task I first and then start task II. At the completion of the ego depletion task, feedback forms were distributed among the participants in both depleted and nondepleted groups. Since "No-EB" was the control group, therefore, participants in this condition were not provided with any feedback forms. In the end, participants were instructed to complete manipulation checks, anagram task, and digit symbol coding. Half of the participants completed the anagram task first and the remaining half participants completed the digit symbol coding task first. In the end, participants were appreciated for their cooperation in the research.

Results

A 2-way factorial ANOVA was undertaken for testing the main as well as interaction effects of ego depletion and EB on the manipulation checks. Multivariate analysis of variance (MANOVA) was undertaken for testing the proposed hypotheses of the present research.

Table 1
2-Way Factorial ANOVA for Manipulation Checks

Source	SS	df	MS	F	p	Partial η^2	Post Hoc[a]
Ego depletion	24.01	1	24.01	4.67	.03	.02	
EB	40.23	2	20.11	3.91	.02	.04	No > Ne
Ego depletion x EB	13.32	2	6.66	1.29	.28	.01	
Error	1049.31	204	5.14				

Note. EB = Expectancy Beliefs
[a] The post hoc test was Tukey's HSD test.

The 2-way factorial ANOVA suggests a significant main effect of ego depletion on the manipulation checks, which suggests that participants under the ego depleted condition perceive the task as more difficult and fatigue-inducing as compared to their counterparts in the nondepleted condition. This suggests that the ego depletion task is successful in manipulating ego depletion across the two treatment conditions ($M = 5.36$, $SD = 2.37$ for the depleted group; $M = 4.69$, $SD = 2.23$ for the non-depleted group). The main effect of EB on the manipulation checks is also significant. Tukey's HSD post hoc reveal (Tukey's $HSD = 1.07$, $p < .05$) that participants in the -EB condition perceive the task more difficult and experience fatigue ($M = 5.57$,

SD = 2.35) as compared to the participants in the No-EB condition (*M* = 4.5, *SD* = 2.33). However, participants under the +EB condition (*M* = 5.00, *SD* = 2.19) and -EB conditions (*M* = 5.57, *SD* = 2.35) do not significantly differ on the manipulation checks (Tukey's *HSD* = 0.57, *p* > .05). Finally, the interaction effect of ego depletion and EB on the manipulation checks remain nonsignificant.

Table 2

Mean and Standard Deviation Values of the Outcome Variables in Different Experimental Groups (N = 210)

Outcomes	Expectancy Beliefs	Ego Depletion Group			
		Depleted (*n* = 105)		Non depleted (*n* = 105)	
		M	*SD*	*M*	*SD*
Digit Symbol Coding	No-EB (54.11, 19.17)	48.08	21.43	60.14	14.56
	+EB (58.87, 17.71)	49.68	16.41	68.05	13.91
	-EB (46.28, 21.29)	41.57	18.07	51.00	23.41
	Total	46.44	18.90	59.73	18.99
Anagram Performance	No-EB (8.81, 4.00)	7.94	4.29	9.68	3.53
	+EB (9.01, 3.75)	7.45	3.2	10.57	3.64
	-EB (7.44, 4.48)	6.31	3.8	8.57	4.82
	Total	7.23	3.84	9.61	4.08
Anagram Persistence	No-EB (7.70, 3.38)	6.91	3.42	7.70	3.38
	+EB (6.85, 2.57)	6.48	2.20	6.58	2.57
	-EB (6.24, 2.53)	5.88	2.64	6.24	2.53
	Total	6.42	2.80	7.26	2.97

Note. No-EB = No Expectancy Belief; +EB = Positive Expectancy Belief; -EB = Negative Expectancy Belief. The italicized values in parenthesis against each expectancy belief group are their means and standard deviations, respectively.

Table 2 shows the arithmetic means and standard deviations for the digit symbol coding, scores on the anagram task, and the time spent on the anagram task for the participants under six experimental conditions. The arithmetic mean of participants in the nondepleted condition suggests that the participants under this condition score higher on all the outcomes measures as compared to the depleted group. The higher arithmetic means of participants in the +EB condition suggest that participants under this condition score higher than the participants in the other two EB groups. As evidenced in Table 2, participants in the nondepleted group have consistently scored higher than their counterparts in the depleted condition irrespective of the type of EB they have been exposed to.

Table 3

Multivariate Effects of Ego Depletion and EB (N = 210)

	Pillai's Trace	Wilk's λ	F	Partial η^2	p
Ego depletion	.16	.84	12.41	.16	.000
Expectancy Beliefs	.13	.88	4.62	.06	.000
Ego Depletion x Expectancy Beiefs	.03	.96	1.08	.03	.16

MANOVA reveals that the multivariate main effects of both ego depletion and EB are significant in relation to the linear combination of the outcome variables. However, the multivariate interaction effect between ego depletion and EB comes out to be non significant. The post hoc univariate analyses reveal that participants in non-ego depleted condition score significantly higher on anagram task and digit symbol coding and spend significantly more time on the anagram task.

Table 4

Univariate Effects of Ego Depletion and EB (N = 210)

Source	Dependent Variable	SS	df	MS	F	η^2
Ego depletion	Digit Symbol Coding	9266.78	1	9266.78	27.66***	.12
	Anagram Performance	295.24	1	295.24	19.09***	.09
	Anagram Persistence	36.04	1	36.04	4.48*	.02
EB	Digit Symbol Coding	5654.06	2	2827.03	8.44***	.08
	Anagram Performance	102.44	2	51.22	3.31*	.03
	Anagram Persistence	81.26	2	40.63	5.06**	.05
Ego depletion x EB	Digit Symbol Coding	739.40	2	369.70	1.10	.01
	Anagram Performance	16.80	2	8.40	.54	.005
	Anagram Persistence	16.80	2	8.40	1.05	.01
Error	Digit Symbol Coding	68325.03	204	334.93		
	Anagram Performance	3154.80	204	15.47		
	Anagram Persistence	1639.71	204	8.04		

Note. EB = Expectancy Beliefs.
*$p < .05$. **$p < .01$. ***$p < .001$.

The univariate main effects of EB are also found to be significant in terms of digit symbol coding, anagram task and time spent on the anagram task. Tukey's HSD reveals that participants in the -EB condition have a significantly lower mean score on digit symbol coding as compared to their counterparts under +EB and No-EB conditions. The mean scores of participants under +EB and No-EB conditions are comparable. On the anagram task, the mean score of participants under +EB condition is higher than that of the participants under -EB condition; the rest of the comparisons are nonsignificant. Participants in the No-EB condition have spent significantly more time on the anagram task as compared to their counterparts in the -EB group; the rest of the comparisons are nonsignificant.

Table 5

Summary of Tukey's HSD Test (N = 210)

Variables	Comparisons	Mean Difference	SE	95% CI	
				LL	*UL*
Digit Symbol Coding	+EB vs. No-EB	4.76	3.09	-2.54	12.06
	No-EB vs. -EB	7.83*	3.09	.53	15.13
	+EB vs. -EB	12.59***	3.09	-5.28	19.89
Anagram Performance	No-EB vs. -EB	1.37	.66	-.19	2.94
	+EB vs. No-EB	.20	.66	-1.36	1.76
	+EB vs. -EB	1.57*	.66	.002	3.15
Anagram Persistence	No-EB vs. -EB	1.46*	.48	.33	2.59
	+EB vs. No-EB	-1.11	.48	-2.25	.02
	+EB vs. -EB	.34	.48	-.78	1.47

Note. No-EB = No Expectancy Belief; +EB = Positive Expectancy Belief; -EB = Negative Expectancy Belief.
*$p < .05$. ***$p < .001$.

Discussion

The current research attempted to examine the effects of ego depletion on WM and problem-solving tasks. Before testing the main hypotheses of the present study, manipulation checks were tested. Results of manipulation checks in terms of ego depletion and EB were significant, which suggested that these variables' manipulation was successful. Students in the depleted group mentioned that they faced difficulty while performing on the task and they felt more tired as compared to the students in the nondepleted group. Similarly, participants in the -EB group reported that the task was more difficult and they felt more tired in comparison with the No-EB group and the +EB groups. These findings indicated that the experimental procedure was successful in the manipulation of ego depletion and the EB.

The test of the proposed hypotheses of the present study revealed the significant main effects of ego depletion and EB, while the interactive effect between the two was nonsignificant. The mean scores obtained by participants assigned in nondepleted condition were significantly higher on both problem solving and WM tasks as compared to the participants assigned in the depleted condition. Moreover, participants in the nondepleted group showed a higher degree of persistence on the problem-solving task as compared to the participants in the depleted condition. The participants in the +EB group attained higher scores on the WM task as well as problem-solving tasks in comparison to -EB group. Hence, the data analysis suggested that the first two hypotheses of the present study were supported, which provided empirical support for the self-control strength model and the process model of ego depletion, respectively.

It was hypothesized that the participants in the nondepleted group would show a higher degree of persistence and higher scores on WM and problem-solving tasks. Results of the current study appeared to be in line with this first hypothesis as it is revealed that the participants assigned to the nondepleted group scored higher on problem-solving and WM tasks. Furthermore, it is also revealed that the depleted group showed less persistence in the tasks of problem-solving skills. These findings are in line with the results of previous research that had revealed that participants having a high level of depletion showed less perseverance on the tasks of WM and problem-solving (Clarkson et al., 2010; Hagger et al., 2010). Ego depletion results from the draining of mental energy reservoirs, therefore, the individual becomes unable to regulate himself/herself. It has also been observed that ego depletion can cause impairment in core cognitive processes and can eventually disturb the functioning of WM (Shamosh & Gray, 2007). Individuals, who experienced failure in the regulation of their affect, were depleted and they showed poor performance on the measures of WM (Schmeichel, 2007).

The second hypothesis suggested that the subjects in the +EB positive group would have a higher degree of perseverance and higher scores on tasks measuring WM and problem-solving. According to Job et al. (2010), the belief of people about their own will power as a limited or unlimited source can influence their self-regulation. The persons who perceive will power as a limited reserve were more vulnerable to the depletion of their resources and the individuals having a firm belief in the unlimited nature of will power had a low proneness to depletion. Keeping in view the importance of belief about nature of will power, positive and negative EBs were provoked in participants of +EB and -EB conditions, while no beliefs were

induced in the participants of the No-EB condition. MANOVA has revealed that participants assigned in No-EB and +EB achieved almost similar mean scores and their scores were significantly higher as compared to the scores of participants of -EB group on the tasks of WM, problem-solving, and perseverance on problem-solving.

In the present research, persistence was operationalized in terms of time utilized for the completion of the anagram task (problem-solving). The previous study conducted on the effects of expectancy revealed that people are inclined to have belief in the limited power of self-control and as a result, they expect to experience failure, therefore, they are more vulnerable to get influence from the self-control demands (Martijn et al., 2002). In the same line, findings of Job et al. (2010) revealed that individuals who had a belief that self-control capacity is limitless are invulnerable to ego depletion and have low sensitivity to ego depletion, which further leads to better performance. The previous literature strongly supports the results of the present study by providing evidence that depletions lead towards less degree of persistence on the tasks measuring problem-solving skills and consequently reveal low scores on the performance of various tasks (Clarkson et al., 2010; Hagger et al., 2010).

The third proposition of the current research predicted that the subjects in the depleted -EB group would have low persistence and poor performance on WM and problem-solving tasks. MANOVA revealed that the interaction effect of EB and depletion was nonsignificant and findings appeared to be contrary to the third hypothesis of the study. According to Muraven (2011), leaving a task without completing is an energetic step, therefore, the individual with depleted reservoir of self-control capability should remain more insistent on the assigned task and may refrain from quitting it because leaving a task demands an initiative power and depleted persons mostly try to avoid taking the initiative to quit the task. Findings of the current study can be justified on the grounds that quitting the task always demand initiative power or responsibility to take a decision, therefore, participants continued the task without quitting despite being depleted.

Conclusion and Implications of Study

The findings of the current research crops enriched material for the contribution to the theory and practice of psychology. It can facilitate understanding of the nature of ego depletion; how it could be avoided, and consequently how self-regulation could be enhanced in any society. Our findings have supported both the self-control strength

model and the process model of ego depletion as the main effects of both ego depletion and the EB were significant. However, contrary to the findings of Clarkson et al. (2010), the present study did not find an interaction between EB and ego depletion. By endorsing the phenomenon of ego depletion in the aboriginal milieu, this study has unbolted new horizons for various types of empirical investigations in the Pakistani context. For instance, in clinical and counseling psychology, it would be interesting to explore whether clients who can exercise better self-regulation of their behaviors with higher degree of resisting their impulses (such individuals are likely to be the ones whose ego depletes relatively at a lower rate) can have more beneficial effects of the intervention program as compared to their counterparts whose ego depletes rapidly. If this proposition is found to be true, ego depletion could be an important individual differences variable that should be taken into account while planning specific interventions for boosting the clients' ego depletion capacity, particularly within the cognitive-behavioral paradigm. The present study has enriched the theoretical knowledge related to the phenomenon of ego depletion by confirming the postulates of the self-control strength model of ego depletion through empirical support. Moreover, through action research, these findings can be applied in academic and work-related settings in order to better understand the reasons behind individual differences in depletion of mental reservoirs. Accordingly, self-efficacy-based interventions may be incorporated in order to enhance the belief in one's ego reservoir for harnessing one's task performance and persistent.

Limitations and Suggestions for Future Research

Some of the salient limitations of the present research has been noted below. One should be cognizant of them while interpreting the findings of the current research.

1. There was no time limit in the execution of the ego depletion tasks, which could have influenced the depletion of resources. Future studies should statistically control the potential influence of the time taken for the ego depletion task.
2. The potential interference of motivational factors such as self-regulation, autonomous motivation, and ego depletion sensitivity might have influenced participants' performance on WM and anagram tasks. Future research on ego depletion should measure and statistically control the potential influence of various motivational factors on the depletion of ego

resources. This means that future research should be focusing on the process model of ego depletion.

3. Future research should explore how changes in attention focus and shifts in the motivational factors may influence the depletion of resources for a better understanding of the processes behind the ego depletion.

4. The sample of the current study was confined to the undergraduate students enrolled in the Department of Psychology so the external validity of the current study would be low. Therefore, it is suggested that future researches should take a diverse sample.

5. Experimental research designs ensure the internal validity of any study but on the other hand, it can also threat external validity. Therefore, the results of experimental research may not have good external validity.

6. Future research can be carried out to find various methods and strategies to enhance mental energy reservoirs and decrease the level of ego depletion. Future research should be conducted in order to explore the reasons of ego depletion. Variables of the current study could have been measured by using various other tasks of ego depletion such as interrupted tasks, writing essays, and online tasks, etc.

7. It is suggested that researchers should focus on exploring sensitivity for ego depletion sensitivity and its correlates, as it is a scarcely explored area of Psychology. Further research may also contribute to the growth of the domain of ego depletion-WM relationship in the academic achievement of pupils. Furthermore, it would be an interesting idea to assess the role of self-regulatory behaviors in relation to personal self-regulation.

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