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UNLEASHING THE POWER OF PROACTIVE THOUGHT CONTROL: AN EXPERIMENTAL STUDY ON INTRUSIVE THOUGHTS IN YOUNG ADULTS

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Article Info

Abstract

Background: Proactive thought control mechanism is an evolving approach for managing intrusive thoughts that needs adaptation and validation in different cultures and populations. Therefore, the current study aims to test the effectiveness of proactive thought control mechanisms on a Pakistani normative sample.

Subject and Method: The repeated-measure experimental research design was employed. Data were collected from 65 participants aged 18 to 25 years, who were randomly assigned to a suppression (experimental) group or a control group. They were subjected to perform a proactive thought control (free association) task in four trials on the computer. Additionally, the effectiveness of the intervention was also assessed with a subjective measure of the Thought Suppression Inventory's (TSI) subscale effective suppression scale (ESS).

Results: The analysis revealed significant results as the thought suppress group took a longer reaction time and significantly higher level of thought suppression as compared to the control group, which revealed that proactive thought control mechanisms significantly facilitate thought suppression.

Conclusion: Our findings highlight the external validity of proactive thought control as it has yielded significant results on the Pakistani normative sample. Hence, rectify the need for further investigation of this approach as a non-pharmacological intervention for intrusive thoughts.

Keywords:
proactive thought control mechanisms, intrusive thoughts, young adults

INTRODUCTION

There is evidence that over the course of one's life, almost everybody is exposed to several serious or dangerous situations (Ozer et al., 2003). But there's a lot of variation in how people deal with these highly unpleasant experiences. Most people report higher levels of psychopathology immediately after a stressful incident, but only a few will later develop chronic PTSD (McNally et al., 2003). Rachman and Silva (1978) found similarity between obsessive compulsive disorder (OCD) patients and normal individuals in the content of intrusive thoughts. Taking these findings into consideration, cognitive theories propose that the appraisal of intrusive thoughts influences whether they disappear quickly or cause distress.

In the realm of cognitive psychology and mental health research, the phenomenon of intrusive thoughts presents a compelling area of study. Intrusive thoughts are defined as cognitions that are spontaneous, disruptive, difficult to control, and unwanted (Rachman, 1981). Rachman introduces the notion of unwanted intrusive thoughts as an etiological factor that contributes to the development of obsessive-compulsive disorder. His study determines three perspectives on whether clinical and non-clinical individuals experience unwanted thoughts, images or impulses that were similar in the content of clinical obsessions which consisted on thoughts of contamination, doubt, aggression or sexuality etc. Frequently, a single precise stimulus can elicit undesirable thoughts or recollections. As an illustration, a specific musical composition or tangible item can evoke memories of a distressing, preceding romantic affiliation, which individuals may prefer to avoid contemplating (Fradkin & Eldar, 2022). However, the research conducted on a clinical and non-clinical population reported the occurrence of 80 to 90 percent clinical population being distressed due to intrusive thoughts, while the non-clinical population reported dealing with them (Clark, 2005).

The proactive and external inference methods of intrusive thought control are an evolving subject matter of research. Especially, the proactive mechanism of thought control has a huge scope of understanding, which is generally regulated by cognitive control functioning. Cognitive control is the capacity to use ideas and behaviors to reach goals effectively (Miller & Cohen, 2001). Cognitive control, according to the dual mechanisms of control framework, is a largely automated process that consists of two separate and independent, but concurrent, components: proactive control and reactive control (Braver, 2012; Gonthier et al., 2016).

In proactive control, task- and goal-related information is kept in mind and then implemented to predict and prevent cognitive conflict or errors before they occur (Braver, 2012). Hence, Proactive control can increase work performance by boosting the efficiency of goal-directed behavior. Proactive control is also thought to be a long-term mechanism characterized by a top-down tendency and continuous prefrontal cortex activity. Thus, factors such as the length of time required to sustain the goal-oriented knowledge, relevance over other goal-oriented tasks, and working memory capacity may influence the utilization of proactive control (Braver, 2012; Locke & Braver, 2008; Redick, 2014).

Proactive mechanism is widely studied in western literature, yet no investigation has been done in Pakistan to evaluate its efficacy in education or clinical settings. While proactive thought control studies have shown consistently promising results for managing intrusive thoughts in previous research. The need for validating this approach may have potential benefits in the assistance of conventional therapeutic

approaches for managing intrusive thoughts. However, available literature highlights various crucial aspects of proactive thought control, as majority of studies tested this method young population, for instance (Fradkin & Eldar, 2022) examined the utilization of proactive and reactive control mechanisms to deal with unwanted unacceptable thoughts and revealed a correlation between the parameters of the model and the self-reported variations in individuals' ability to regulate intrusive thoughts in everyday life. Verwoerd et al. (2009) demonstrated that resistance to proactive interference was associated with a reduction in intrusive memories.

Some other studies link proactive thought control mechanisms with fluid intelligence and prefrontal cortex activation. Burgess & Braver (2010) examine the temporal dynamics of interference control by manipulating interference anticipation and fluid intelligence, which have the potential to impact whether interference control is proactive or reactive in nature. The findings of the study indicated that those with high fluid intelligence exhibited a more prominent proactive control pattern, whereas individuals with low fluid intelligence had a more prominent reactive control pattern. Another study conducted by Braver (2012) suggests that proactive control is linked to the continuous and proactive approach of goal-related information in the lateral prefrontal cortex, which also aids optimal cognitive performance. Verwoerd et al., (2008) discovered a correlation between low inhibitory control and intrusion frequency. Thus, proactive interference is assumed to be the unique inhibitory process that causes this association which means that newly learnt information interferes with the recall of previously learned information.

Gonthier et al. (2016) examined factors affecting Stroop variability, particularly reverse-facilitation (RF), where responses to nonword-neutral stimuli are faster than to congruent stimuli, indicating task conflict. The study found that variability in task conflict is linked to the level of proactive control before the Stroop stimulus appears. Higher proactive control reduces task conflict, resulting in the typical facilitation effect, while lower control increases conflict, slowing responses for congruent and incongruent trials but not neutral ones, contributing to Stroop RF. The authors also introduced a computer model that explains task conflict resolution and proactive control modulation, accounting for various Stroop-RF outcomes and reaction time. Braver (2012) also investigated the regulation of thoughts and actions based on perceived behavioral goals, illustrating the dual mechanisms of control. This research suggests proactive control involves the ongoing management of goal-related information in the lateral prefrontal cortex, enhancing cognitive performance. Stuphorn and Emeric (2012) investigated behavioral and physiological evidence for dual mechanisms of control in response inhibition within the medial frontal cortex of monkeys and humans during stop signal tasks. The study revealed similar proactive and reactive control systems in both species, with increased activation in the pre-supplementary motor region and subthalamic nucleus during reactive inhibition, while the pre-supplementary motor area and adjacent supplementary motor area were linked to proactive changes in response time.

Fawcett and Taylor (2012) conducted an investigation into the regulatory mechanisms of working memory during intentional forgetting. They used a combined methodology, integrating an item-method directed forgetting paradigm with a secondary task requiring participants to identify the color of probe words presented at three-time intervals. The researchers measured response speed to assess cognitive demands linked to remembering and forgetting instructions and examined incidental memory for the probe words. Results showed a significant delay in response discrimination when participants were instructed to forget,

especially at the longer intervals, compared to recall instructions. This study highlights that deliberate forgetting is an active cognitive process that regulates working memory contents. Tomlinson et al. (2009) investigated cue-independent forgetfulness using the think-no-think paradigm, aiming to assess interference predictability. Participants were instructed to quickly press the enter key without conscious thought to modify memory strength before recognition evaluation. Results showed that this rapid pressing caused forgetting similar to when participants were told to avoid thinking about the target cue. This forgetting was linked to a single recall stage, but global memory models indicate that forgetting involves interference and includes both sampling and recovery stages during recall.

Intrusive thoughts and their control through proactive thought control mechanisms are critical aspects of mental health and well-being. Proactive thought control is a comparatively understudied construct that needs further investigation with different methodological approaches. Likewise, in this study, we are trying to test a less intensive approach to test the proactive thought control mechanism. Proactive thought control mechanism has garnered attention in various parts of the world; it's noteworthy that there is a lack of literature in Pakistan. Therefore, this study will be a stepping stone in introducing a new area of interest for researchers because proactive control mechanism has the potential to be incorporated into therapeutic interventions for clinical population, which has been ignored in Pakistan. It is essential to bridge this literature gap to better support the mental well-being of individuals in Pakistan to promote a more inclusive approach to mental health care. The current study encompasses several interconnected objectives, each contributing to a deeper understanding of proactive thought control mechanisms in the context of dealing with intrusive thoughts. There is a compelling need to explore proactive thought control mechanisms comprehensively. This provides a thorough investigation into how individuals can actively influence or regulate their own thought process. The study also seeks to uncover the intricate dynamics of proactive thought control which individuals can employ to deal with intrusive thoughts. The research also sets out to assess the inherent ability of individuals to engage in proactive thought control. Significantly, there is a significant gap in the existing literature concerning proactive thought control mechanisms. This study aims to fill this gap through empirical investigation and analysis and to advance our understanding of how individuals can actively shape their thought processes by engaging in proactive thought control mechanisms for the management of intrusive thoughts.

Objectives

- To examine the effectiveness of proactive thought control mechanisms in reducing intrusive thoughts among participants in the suppression condition.
- To compare the utility of proactive thought control between the suppression and control group.
- To examine whether reaction times on nonrepeated association trials (Trials 2 and 4) differ between the suppression group that receives feedback and the control group that receives no feedback.

Hypothesis

- There will be a significant difference between the reaction times of proactive and reactive thought control responses.

- The suppression group will exhibit a higher frequency of controlling intrusive thoughts than the control group.
- The suppression group will exhibit longer reaction times on repeated association trials (Trials 2 and 4) compared with the control group.

Methods

Study Design

It was a repeated measures true experimental study wherein participants were randomly allocated into different groups and conditions and also the words of stimulus were randomly selected and arranged (see Figure 1). It ensures the study's findings would not have biased responses that raise questions on the internal validity of the study.

Participants

Minimum sample size was determined on the basis of power analysis by reviewing previous studies (Fradkin & Eldar, 2022; Vasterling & Hall, 2018; Woud et al., 2017). That showed that for 64 participants data will be sufficient for detecting a significant effect size. Hence, there were 66 participants from the young adult population, of which 33 participants were included in the suppress (experimental) group and 33 participants were in the control group, as one participant's data was excluded due to outlier values, recruited from Gift University and Global College of Pharmacy, Gujranwala. Participants were selected for this study according to specific inclusionary criteria, such as participants must be above the age of18, proficient in the English language, and have an average typing speed on a computer.

Research Instruments

Thought Suppression Inventory

The Thought Suppression Inventory (Effective Suppression Scale: ESS) evaluates participants' experiences and success in suppressing intrusive unwanted thoughts. This scale has 18 items and it has three subscales. The three subscales measure intrusions, suppression attempts, and effective suppression. In this study, the TSI-r effective suppression subscale, consisting of 6 items, was used, which shows satisfactory psychometric properties and validity in predicting the mental symptoms related to challenges in cognitive control. If participants score high, it shows that they effectively suppress intrusive thoughts (Van Schie et al., 2016).

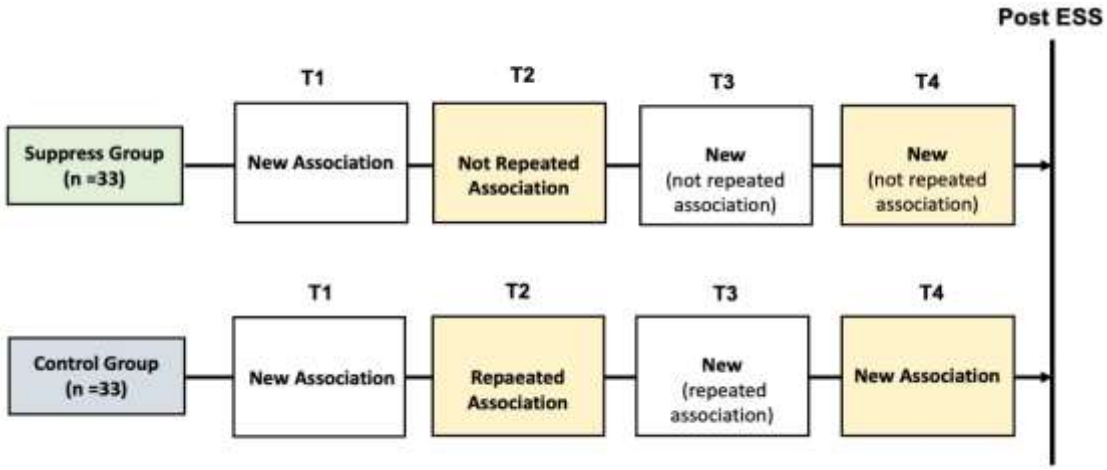
Free Association (Proactive Inhibition) Task

It is basically the technique which is commonly used to explore the unconscious mind and gather the information about the individual's thoughts, emotions, and their associations. The task itself does not have specific psychometric properties, but in some aspects, we tried to ensure its validity and reliability by giving instructions to the participants on how the task is conducted or interpreted. It also depends on the intended measure of the task. The model of the free association also provides the strength distribution that underlies each response, providing a good fit for the data (Nelson et al., 2000). Free association (proactive inhibition) task, adapted with permission from Fradkin and Eldar (2022), was designed on Python, which

offers high accuracy in capturing reaction times and providing feedback on generating new associations on given cues. Cues consisted of 4 to 6 letters, which participants easily read and type an association. Homographs (same spelling with different meanings), grammatical variants (e.g., woman and women), and words likely to cause emotional distress to participants were excluded from the free association task (Nelson et al., 2004). Free association task presented (See Figure 1) in 4 trials, and the 2nd and 4th trials were used for the assessment of effectiveness of proactive inhibition because in the 2nd trial, the suppress group is supposed to produce new associations (words), and the control group doesn't. The difference between group comparisons provides enough information about proactive inhibition.

Figure 1

Schematic Presentation of Four Trails with New and Repeated Association for Suppress Group and control (Non- suppression Group)



Note. This shows repeated measure trial sequence for suppress (experimental) and control group. Both groups provided four trials, at last both groups filled up Effective Thought Suppression Subscale (ESS).

Figure 2

Free Association Trials (Proactive inhibition) Task for Suppress Group

Please respond to the word, "Gym":

hard

Amazing, your current score is 5 which equals to 1.0 star. Keep it up!

****

Please respond to the word, "What":

is

You have already used this answer Please respond again, "Pen":

paper

Amazing, your current score is 20 which is equal to 4.0 stars. Keep it up!

****

Note. It shows the stimulus for suppress (experimental) group in which participants not repeat an association in all trials.

Figure 3

Free Association Task for Control Group

Please respond to the word, "Table":

chair

Please respond to the word, "Nose":

pin

Please respond to the word, "Quick":

fast

Note. It shows the stimulus for control group in which participants repeat association in each trial.

Procedure

The participants were briefed about ethical guidelines and informed consent was obtained. Each participant was selected according to inclusionary criteria, and then selected participants were randomly allocated into suppress and control groups. Both groups were subjected to perform 4 trials (New/Repeated RT/New/New RT) of the word association task. The free association task was entailed 4 trials, each trial included 20 word cues and 80 cue words were given in four trials. The black screen with white Ayuthaya style, 12-point font size was used for instructions and cues presentation on the computer screen (See Figure 2). Trial 1 included new associations, in which both the supress group and control group had a chance to type any word. But in trial 2 (not a repeated association trial) suppress group participants must generate new words on given word cues, which were used in trial 1; they could not generate words responses that they had used in trial 1. For example, the statement appears on the screen "Please respond to the word, 'Gym':" and the participant has to type a new word like "hard". On successive new word generation, participants get written positive feedback and points, for instance, "Amazing! Your current score is 5, which is equal to 1 star. Keep it up! *". Participants earn 1 point on new word generation and 1 star (*) after scoring 5 points in each trial. Whereas on repeated or old word generation, participants did not get any points and had to retype a new word with this message: "You have already used this answer, please respond again, "pen". Words presented in trial 1 were used again in random order in trial 2. While words cue from the 1 and 2 trials were repeated along with a new word cue in random order in trial 3 and 4 (see Figure 2). On the other hand, the control group didn't follow any instructions except to generate

associations that were most appropriate for them on given cues on each trial, and neither did they get any feedback or points as shown in Figure 3. Thus, at the end of the fourth trial, both group participants must fill out the Effective Suppression Scale ESS. This measure used the assessment of participant's subjective rating of thought suppression.

Ethical Statements

This study was conducted according to the guidelines of the institutional ethical review committee and after approval of the supervisors of the academic institute.

Results

In first stage of analysis initial screening of data include normality testing and outlier detection in data (one response were removed from control group), which indicate all measure scores are normally distributed across all the trials and Thought Suppression Inventory (TSI) scores in both groups such as the p values of Shapiro-wilk remained above .05 almost in all trials or in TSI score that indicated a normal distribution. Moreover, the statistical values of skewness and kurtosis were also less than ± 1.0. In trials, almost all values of skewness and kurtosis computed below ± 1.0 in both groups, but TSI scale skewness and kurtosis values were negative, which showed ESS scale data distribution was slightly negatively distributed in both groups. Thus, the potential bias in data was handled and met the assumption of the parametric test, which may raise questions on the validity of results.

Table 2

Independent Sample t-test of Across the Trial's Reaction Time Differences for Suppress and Control Group

	Suppress (*n*=33)		**Control (*n*=32)**				**95% CL**		
Analysis	*M*	*SD*	*M*	*SD*	*t(df)*	*p*	*LL*	*UL*	*Cohen's d*
T1	185.17	94.32	170.86	91.63	.62(63)	.53	-31.80	60.42	0.15
RT2	195.06	87.20	126.93	58.59	3.68(63)	.001	.39	1.42	0.91
T3	186.74	83.51	128.86	57.27	3.24(63)	.002	22.40	93.36	0.80
RT4	163.59	72.42	120.57	44.95	2.86(63)	.006	.20	1.21	0.71

Note: T=trial, RT= repeated trial, ***p<.001, **p<.01

An independent sample t-test was presented in Table 2 to determine the mean difference between all trials in both suppress (experimental) and control group. Results indicated that there was a mean difference in suppress (experimental) group between T1 (M=185.17, SD=94.32, p<.53), T2 (M=195.06, SD=87.20, ***p<.001), T3 (M=186.74, SD=83.51, p<.002) and T4 (M=163.59, SD=72.42, **p<.006). In control group there was also mean difference between T1 (M=170.86, SD=91.63, p<.5), T2 (M=126.93, SD=58.59, ***p<.001), T3 (M=128.86, SD=57.27, **p<.002) and T4 (M=120.57, SD=44.95, **p<.006) which shows suppress (experimental) group have highly significant difference which indicates

effectiveness of proactive thought control mechanisms. Reaction time variation of suppress group clearly elucidated the control on practice effect because the trial words were presented in random order and new words were also added to the list. Whereas visible practice effect was observed in control group by consistent reduction in reaction time across the trials.

Table 3

Paired Sample t-test Across the Trial's Reaction Time Differences for Suppress and Control Group

	T2		T4				95% CL		
Analysis	*M*	*SD*	*M*	*SD*	*t(df)*	*p*	*LL*	*UL*	*Cohen's d*
Suppress	195.06	87.20	163.59	72.42	6.11(32)	.001	20.98	41.96	0.39
Control	126.93	58.59	120.57	44.95	1.02(31)	.31	-6.28	19.00	0.12

Note. T=trial, ***p<.001.

T2 and T4 were the main indicators of the accuracy of intervention for suppress group because, in both trials, they were presented with repeated words from previous trials. Paired sample t-test presented computed (see Table 3), providing comparison between reaction time of two trials such as T2 and T4. The findings of the study revealed mean difference between T2 (M=195.06, SD=87.20) and T4 (M=126.93, SD=58.59) were significant (***p<.001) in suppress (experimental) group with small effect size (Cohen's d =.39). Moreover, in control group mean differences between T2 (M=163.59, SD=72.42) and T4 (M=120.57, SD=44.95) were not considered significant (p<.31). It showed that suppress (experimental) group significant mean difference between trials than control group, as we expected to observed high reaction time in T2 as participant were not habituated to create new association. But in T4, reaction time was reduced as they were used to generate alternative associations. However, this difference was not obvious among control group participants.

Table 4

Repeated Measure ANOVA Across the Trial's Reaction Time Differences for Suppress (experimental) and control group

	T1		T2		T3		T4					
Analysis	M	SD	M	SD	M	SD	M	SD	df	f	p	η^2
Suppress	185.17	94.32	195.06	87.20	186.74	83.51	163.59	72.42	1	6.86	.013	.17
Control	170.86	91.63	126.93	58.59	128.86	57.27	120.57	44.95	1	16.83	.001	.35

Note. T=trial, *p<.013, *** p<.001

Repeated analysis of variance (ANOVA) (see Table 4) revealed a significant mean difference across four trials in suppress and control groups. Results indicated that there is a significant disparity of mean scores

between trials in both groups. Reaction time of T1 (M=185.17, SD=94.32), T2 (M=195.06, SD=87.20), T3 (M=186.74, SD=83.51), T4 (M=163.59, SD=72.42) is significantly (*p<.013) different in suppress group with a small effect size (η2 = .17). This clearly indicates less variation observed between trials in suppress group which seems logical. However, in control group reaction time of between trials such as T1 (M=170.86, SD=91.63), T2 (M=170.86, SD=87.20), T3 (M=128.86, SD=57.27), T4 (M=120.57, SD=44.95) were also highly significantly different (***p<.001) with a moderate effect size (η2 = .35).

Pairwise comparison analysis was carried out to see the distinct differences within all trials. It indicates that in suppress group mean scores of T2 vs T4, T3 vs T4 and T4 vs T3 were significantly different (***p<.001). In control group, T1 has a significant (***p<.001) difference within all trials, also T3 vs T1, T4 vs T1 were significantly (***p<.001) different in reaction time. It also revealed that in control group practice effects were prominent, but practice effects were successfully suppressed in suppress group, as their reaction time fluctuated across the trials, showing clear control over stimulus presentation and recording.

Table 5

Independent Sample t-test of ESS for Suppress (Experimental) and Control Group

Suppress(n=33)			Control(n=32)				95% CL		
Analysis	M	SD	M	SD	t(df)	p	LL	UL	Cohen's d
ESS	22.30	3.69	13.90	5.81	6.97(63)	.001***	1.15	2.29	1.72

Note. ESS=Effective Suppression Subscale, ***p<.001

Thought suppression was finally assessed with effective suppressive subscale of the thought suppression inventory. Independent sample t-test analysis revealed (see Table 5) that the suppression group effectively suppressed their thought as compared to the control group as ESS mean score was significantly (***p <.001) high in suppress (M=22.30, SD=3.69) group as compared to control group (M=13.90, SD=5.81) with a large effect size (Cohen's d = 1.72). The results showed that the suppress group effectively controlled intrusive thoughts than control group, and also justified our acceptance of the hypothesis.

Discussion

Individuals employ several ways to regulate their cognitive processes. Certain ideas can be unpleasant, which distracts, and causes distress in an individual's life. These thoughts are kind of unproductive and unwanted which frequently provoke thoughts in an individual's mind. The aim of the study was to investigate the ability of the participants to control their intrusive thoughts with proactive thought control mechanisms. The idea under consideration has been derived from a study on intentional forgetting, whereby it was proposed that individuals had the ability to effectively diminish the artificial connections they acquired in laboratory settings, without necessitating considerable practice in suppression (Delaney et al., 2020). The findings of our study revealed that individuals engaged with proactive thought control mostly refrain from the intrusive unwanted thoughts subsequent after their occurrence. This finding can also qualify the previously reported findings such as the ability of individuals for proactive thought control

(Fradkin & Eldar, 2022). This is the novel paradigm and the novel research presented here to provide a more challenging and precise method for assessing proactive thought control in relation to long-term associations or intrusions. This is achieved by the measurement of such associations or intrusions via recollection. Our findings also indicate that proactive thought control mechanisms have the ability to enhance long-term associations or intrusions. Verwoerd et al. (2009) have also shown that resistance to proactive interference is associated with a decrease in the frequency of intrusive memories.

The aforementioned studies provide insight into the distinctive attributes of mental control. The present study examines the enhanced probability of proactive control for both external and internal stimuli. Specifically, we focus on the challenges associated with determining this likelihood for associations, since it is more complex due to the increased number of cues and their random variation throughout each trial. The findings of our study suggest that there is a distinct pattern in the occurrence of associations, as evidenced by the immediate recollection of an association. However, a correlation between low inhibitory control and intrusion frequency has been established by Verwoerd et al., (2008). The specific inhibitory process that causes this association is assumed to be proactive interference, which means that new information interferes with the recall of previously learned information. De Jong et al. (2011) stated that interference control ability is inversely associated with intrusive thoughts about stressful experiences. He found that greater ability to control proactive interference is associated with fewer intrusive memories after an analogue traumatic stressor. Some studies have shown that that better working memory capacity performance is linked with a reduction in intrusive thoughts when individuals tend to suppress their negative and neutral personal thoughts (Brewin & Beaton, 2002; Brewin & Smart, 2005).

Exploring proactive thought control as a potential intervention in PTSD can extend our understanding of alternative effective treatment options in various ways. The benefits of the eight-session PTSD education program have been examined (Verwoerd et al., 2009; Verwoerd et al., 2011), and it has shown improvement in working memory while decreasing intrusive symptoms for patients. However, PTSD-related symptoms of intrusive memories and distress improved consistently across training conditions. Some evidence suggests that training in proactive interference control may positively influence working memory capacity and alleviate symptoms associated with intrusive re-experiencing (Vasterling & Hall, 2018; Woud et al., 2017).

Limitations and Recommendations

Several limitations were acknowledged while interpreting the results. First, the sample size was relatively small, due to the resource constraints and non-serious behavior of individuals regarding to participation in research. This may limit the generalizability of our findings to a larger population. Second, we reduce the number of words to make it possible in our education setting because original task was lengthy. Third, creating stimuli in Python has proven to be a challenging task for us due to the lack of technical assistance.

In future research endeavors, it is recommended that efforts should be directed toward the inclusion of larger and more diverse samples. This strategic approach serves the purpose of bolstering the generalizability of research findings, making them more applicable to a wider range of contexts and populations. Conducting research related to it in Pakistan, which holds significance for both clinical and

non-clinical populations, is essential. This research can serve as a valuable resource for multiple reasons, benefiting diverse aspects of society.

Supplement Material

The experiment set is available for peer evaluation, and it will be available on the public domain website upon the acceptance of this paper.

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