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Research paper

Can increased cognitive load help people with subthreshold depression to forget negative information?

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ABSTRACT

Background: Given that major depression is a global public health problem, and that sub-threshold depression (SD) has been shown to be a significant risk indicator of major depression disorder, the awareness of SD interventions has increased. The current study explored the effect of increasing cognitive load on the forgetting of unwanted and negative memories of sub-threshold depression individuals (SDs) (Study 1) and proposed a cognitive load intervention (CLI) (study 2).

Methods: 53 SDs and 52 normal participants were recruited to explore the effect of cognitive load on the directed forgetting of negative items (Study 1). The treatment effect of CLI on 62 SDs was investigated. SDs completed up to 8 CLI/control sessions over an 8-week period while regularly recording their depression symptoms (Study 2).

Results: The results showed that it is more difficult for SDs to forget negative 'to-be-forgotten' items than normal controls (F (1, 99) = 27.98, $p < 0.001$, $\eta^2 = 0.22$). In study 1, increasing cognitive load promoted directed forgetting for negative items in SDs. Study 2 showed that there were significant reductions in depression symptoms of SDs over the 8-week CLI (e.g. BDI-II scores: F (1, 60) = 99.93, $p < 0.001$, $\eta^2 = 0.63$).

Limitations: Small sample size and lack of verification by neuroimaging may limit the generalizability of these results.

Conclusions: The study revealed that increasing cognitive load can promote SDs to forget negative information, while the CLI project effectively reduced the depression level of SDs, thus providing encouraging initial support for its use in the treatment of SD.

1. Introduction

As one of the world's most common and multifaceted mental disorders, major depression disorder often results in greatly impaired cognitive function and high rates of comorbidity and overlapping symptoms (Kessler et al., 2003; Knight et al., 2018). Major depression disorder is predicted to become a leading cause of disability by the year 2030 (World Health Organization [WHO] 2019). Given the significant burden and considerable suffering linked to depression (Avenevoli et al., 2015), it is crucial to evaluate protocols aimed at initiating early identification and symptom-reducing interventions.

Subthreshold depression (SD) refers to a condition in which individuals have certain depression symptoms (e.g. depressed mood or loss of interest) without meeting the full criteria for major depression disorder (Bertha and Balazs, 2013; Tuithof et al., 2018). SD has been shown to be a significant risk indicator of major depression disorder (Cuijpers and Smit, 2004; Takagakia et al., 2016), thus putting the subjective well-being and psychosocial functioning of individuals with SD at risk (Chachamovich et al., 2008; Yang et al., 2020). Although the adverse effects of the illness are greater for people with clinical depression than for people with subclinical symptoms, SD has a higher prevalence at the population level (Davidson et al., 2015). Its proportional contribution to disability, use of medication, and use of medical emotion consultations equals that of clinical depression (Tuithofa et al., 2018). Moreover, in contrast to major depression disorder, there has been a relative lack of consensus in the literature focusing on the effectiveness of psychological treatments for SD. Accordingly, it is important to explore the sensitivity and specificity of SD in terms of its association with major depression disorder, and to develop a proactive type of intervention that is shown to be both clinically effective and

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cost-effective (van Zoonen et al., 2014).

A growing number of studies have indicated that a difficulty of forgetting negative memories is a core feature of individuals with SD (Joormann et al., 2007). It appears that depressed individuals are often affected by the frequent occurrence of uncontrollable negative thoughts and memories (Berman et al., 2011), as supported by the facilitated retrieval of negative materials under experimental conditions (Power et al., 2000). Yang et al. (2020) investigated the differences in behavioral and neural mechanisms between SDs and healthy individuals in suppressing unwanted information using functional magnetic resonance imaging (fMRI), and found that it is difficult for SDs to inhibit the extraction of negative and unwanted memories. One noteworthy explanation for such findings is that unwanted negative thoughts might be associated with surplus cognitive resources, which provide conducive conditions for depressive individuals to process and remember negative stimuli. According to the limited cognitive resources theory, the processing of emotion stimuli by individuals is affected by their cognitive resources capacity and working memory load (Kahneman, 1973). For instance, van Dillen and Koole (2007) examined whether cognitive load can attenuate negative mood from the perspective of working memory. They found that loading working memory and cognitive resources could prevent emotion-congruent processing. In sum, individuals at risk of depression may be more likely, when faced with a surplus of cognitive resources, to apply these resources towards the recollection and processing of negative stimuli, thereby increasing their risk of becoming depressed.

Building on the possibility that forgetting might be negatively correlated with the cognitive resources available during encoding, it seems feasible to develop an intervention method that increases load appropriately. In the current study, we deliberately increased the cognitive load of participants so as to deplete the use of remaining cognitive resources, thereby inhibiting SDs from encoding negative information. This kind of cognitive load intervention (CLI) could potentially facilitate the development and implementation of meaningful interventions to improve the mental health outcomes of SDs. By definition, cognitive load is the working memory load required from a learner for performing a cognitive task (Plass and Kalyuga, 2019). Cognitive Load Theory is a learning-related psychological theory grounded in an understanding of human cognitive architecture (Sweller, 2011). Central to the Cognitive Load Theory is the premise that working memory is limited in both capacity and duration (Feldon et al., 2019). This means that working memory must be used to selectively filter information to be coded into long-term memory, and that instructions that exceed working memory capacity will be ineffective (Miller, 1956; Sweller, 2004). Given that SDs report certain impairment in their cognitive function (Hwang et al., 2015), their cognitive resources or working memory capacity may be exhausted or reduced more easily following an increase in cognitive load, such as when asked to perform an additional secondary task (Lee, 2011). CLI may thus turn out to be an effective method for training individuals with SD to suppress the processing of negative information and events.

1.1. Pilot experiment to investigate the efficacy of cognitive load

Although many studies have explored the mechanisms of cognitive load, the question of whether individuals with SD can really inhibit negative memories through increasing their cognitive load has not been resolved. Given that verifying the efficacy of cognitive load in promoting forgetting is an important prerequisite for any associated intervention program, our first experiment aimed to explore this question.

To better understand the influence of cognitive load on the forgetting of SDs, an appropriate experimental paradigm must be applied. The directed forgetting paradigm (Woodward and Bjork, 1971) is often used in laboratories to investigate how inhibitory control at the level of encoding influences intentional forgetting (Anderson and Hanslmayr, 2014; Yang et al., 2020), with accumulating research investigating the effect of directed forgetting from multiple perspectives (e.g. Power et al., 2000; Yang et al., 2016). Indeed, the effect of directed forgetting is closely consistent with working memory capacity (Taylor et al., 2018), wherein the encoding process of directed forgetting requires that individuals utilize limited-capacity resources to ensure that relevant items are processed and committed to long-term memory (Bastin et al., 2012; Hauswald et al., 2010). This paradigm requires participants to actively withdraw cognitive resources from a set of to-be-forgotten items, and then redirect their attention towards a preceding set of to-be-remembered items (Fawcett and Taylor, 2012). Even though individuals no longer rehearse to-be-forgotten items after receiving forgotten instructions, as long as available cognitive resources remain, individuals might still process the to-be-forgotten items unconsciously (Lee, 2011), especially those with SD who are more likely to concentrate on negative materials. The directed forgetting paradigm is suitable for the current experiment, as it allows for the monitoring of cognitive resource utilization.

Using this paradigm, we intended to investigate the directed forgetting effect of cognitive load on emotional materials, and compare the differences between normal individuals and SDs. Specifically, we aimed to evaluate whether high cognitive load can promote the directed forgetting of negative emotion materials in SDs. When exploring the role of cognitive load, other relevant influencing factors might have potential effects. An important variable that should be considered during directed forgetting-based experiments is the time interval between target stimulus and instructions. Given that mental context is known to fluctuate over time, the essential role of memorizing might be overshadowed by time (Abel and Bäuml, 2017). In order to explore the role of cognitive load more clearly, it may be necessary to comprehensively consider the effect of time when setting cognitive load conditions. In the present work, we investigated this influence by setting two different low cognitive load conditions within the directed forgetting paradigm. Under the 'low cognitive load-same interval time as high cognitive load' condition and 'high cognitive load' condition, the interval time after the instruction was set to 500 ms. For the 'low cognitive load-same total experiment time as high cognitive load' condition, the interval time after the instruction was changed from 500 ms to 2500 ms.

1.2. The cognitive load intervention project

In addition to experimentally investigating the directed forgetting effect of negative information with high cognitive load, it's also important to investigate whether the depressive symptoms of SDs can be reduced in a clinical setting through increasing cognitive load. Accordingly, the present study also includes a CLI project for SDs, which involved a practical intervention.

As SD symptoms tend to be diffuse and nonspecific, it's essential for SDs to avail of universal and well-accepted interventions (Buntrock et al., 2015). Accordingly, our CLI aimed to complement existing therapies, as opposed to offering a standalone treatment, by improving the feasibility and effectiveness of daily therapies, such as behavioral activation. As a treatment that has gained prominence in the arena of broadly-conceived therapies for depression (Cipriani et al., 2018), behavioral activation aims to assist SDs to become more active in developing support systems and social skills that are meaningful to improve their mood and quality of life (Lewinsohn et al., 1980). The focus of behavioral activation is to arrange adaptive activities for SDs, increase participation in these activities, and finally let them get rid of depression symptoms (Chartier and Provencher, 2013). Unlike the mastery and potentially rewarding activities arranged in behavioral activation (Kanter et al., 2010), CLI involves specific training sessions, with SDs required to complete actual CLI tasks and daily training as part of the homework assignments associated with behavioral activation. Whereas behavioral activation identifies arranged activities to be included in SDs' daily routines (Jacobson et al., 2001), CLI tasks can be applied in a more focused manner when depressive emotions appear, potentially providing a fast and effective means for SDs to manage their immediate emotional state. During CLI, SDs do not focus on eliminating negative feelings. Instead, the aim is to dissipate negative emotions through increasing cognitive load. The purpose of CLI is not to explore and analyze the events that cause depressive emotions, but to dilute the original experience of negative emotion by adding other unrelated neutral events when such negative emotions appear. In short, applying CLI strategies in behavioral activation could potentially provide a useful tool for helping SDs to control their emotional state. Such strategies offer SDs an opportunity to deal directly with depressive emotions by following a variety of behavioral activiation activities, thus enriching the set of available interventions.

Given that no study has yet explored the intervention effects of cognitive load in SDs, or proposed intervention programs based on this paradigm, our proposal of a CLI presents a crucial first step in cognitive load intervention research. Our CLI is intended, not only to consume the remaining cognitive resources of SDs, but also to free up the deployment of those cognitive resources, by changing and distracting the focus of their attention from emotional words to cognitive load tasks, thereby regulating the associated emotion intensity. From this perspective, the proposed CLI helps SDs to achieve emotional regulation by means of distracting attention.

The present study adopted an item-method directed forgetting paradigm to examine whether cognitive load influences the directed forgetting effect of emotional words in SDs. Different cognitive load conditions were controlled, and the directed forgetting effect differences of emotional words were compared for healthy individuals and SDs. In particular, we assumed that, compared with SDs with low cognitive load, high levels of cognitive load for SDs would result in stronger forgetting for negative memories. A further goal of the present study was to extend prior findings by investigating the effect of CLI on SDs. Finding support for the efficacy of directed forgetting in a sample of individuals with SD could reveal fruitful new directions for improving the understanding and early treatment of complicated clinical conditions such as the depression disorders.

2. Study 1

The item-method directed forgetting paradigm was adopted to explore the effect of cognitive load on the directed forgetting of emotional words among SDs and normal participants.

2.1. Methods

2.1.1. Participants

All participants (N = 105) were college students (average age = 22.14) diagnosed by Beck's Depression Inventory-II (BDI-II, Beck, Steer, & Brown, 1996) and the Center for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977). Participants (N = 54) scoring 10 to 19 points on BDI-II and 16–21 points on CES-D were considered as having SD (Martinović et al., 2006). Normal participants (N = 60) were required to score less than 9 on BDI-II and less than 14 on CES-D. All the assessments were performed at an initial appointment after participants provided informed consent. Participants that met the following criteria were excluded from the experiment: (1) major depressive episode within the past one year, (2) a lifetime history of depression disorders, (3) taking psychopharmacological or psychological treatment within the past year, and (4) possibility of acute suicide attempts. All procedures involving human participants in this study were in accordance with the ethical standards of the Academic Board of Shandong Normal University, and the 1964 Helsinki Declaration and its later amendments. Participation was voluntary and anonymous, based on written informed consent with the right to withdraw participation at any time.

A priori power analysis using G*Power (Faul et al., 2007) indicated that a minimum of 54 participants were required to detect a medium effect size, $d = 0.25$, with an alpha set at 0.05 and power set at 0.95. The number of participants involved in study 1 met this standard.

2.1.2. Study design and materials

We conducted a 2 × 2 × 3 × 3 mixed-design study. The within-subject factors were instruction (remember vs. forget) and words valence (positive vs. neutral vs. negative), and the between-subject factors were group (SD vs. Normal) and load level (low cognitive load-same interval time as high cognitive load vs. low cognitive load-same total experiment time as high cognitive load vs. high cognitive load). The dependent variable was the recall accuracy for the items. Both of the two groups were randomly assigned to any of the three cognitive load levels.

A list of 90 words with three kinds of emotional valences was drawn from the Chinese Affective Words System. To control the recency and primacy effects (Capitani et al., 1992), two words were randomly selected from the three groups of different valences to form six buffer words, all of which were required to be remembered, and excluded from data analysis. Subsequently, four words composing the practice phase were randomly selected from each of the three groups. The remaining 72 words were also randomly divided between the remember or forget instructions, following a ratio of two to one.

Under the conditions of low cognitive load-same interval time as high cognitive load and low cognitive load-same total experiment time as high cognitive load, all participants were randomly presented with 54 words (24 to-be-remembered words, 24 to-be-forgotten words and 6 buffer words). Under the condition of high cognitive load, all participants were randomly presented with 78 words (48 to-be-remembered words, 24 to-be-forgotten words and 6 buffer words). The font size of all words was 80 points. All the materials mentioned here are available in the appendix.

2.1.3. Assessments

The BDI-II measures three dimensions of well-being: (1) negative attitude or suicide, which relates to negative emotions such as pessimism and helplessness, (2) physical symptoms, which relates to fatigue, poor sleep, and (3) difficulty in operation, that is, feeling that work is more difficult than before. Higher scores indicate a greater sense of depression. The CES-D reflects the following six aspects of depression: depression, guilt and worthlessness, helplessness and hopelessness, psychomotor retardation, loss of appetite, and sleep disturbance. The total scores range from 0 to 60, and higher scores indicate more depressive symptoms.

2.1.4. Procedure

At the start of the formal experiment, instructions appeared on the computer monitor. Each trial began with a 500 ms fixation in the center of the screen, with words appearing immediately following fixation offset. Under the conditions of low cognitive load-same interval time as high cognitive load and high cognitive load, the study word was followed by the "$\surd$" or " × " instruction for 2000 ms. Each trial ended with a 500 ms interval, and the whole experiment lasted either 243 s or 351 s. Under the condition of low cognitive load-same total experiment time as high cognitive load, the interval after presenting the "$\surd$" or " × " instruction was 2500 ms, with the fixation stimulus then immediately replaced by the presentation of the study word for 2000 ms. To balance the influence of time, the interval was designed to last 2500 ms in the low cognitive load-same total experiment time as high cognitive load condition. We carefully counterbalanced the study words and instructions, which were presented in a pseudo-random order, so that the same instruction would not appear repeatedly more than three times. Participants were told to remember or forget words as required, and that the to-be-remembered items would be tested. They were also asked to forget the first stimulus and to focus on the next one coming up instead. After the presentation of all study trials, participants were asked to write down as many of the words they had just learned as possible, disregarding the previous instruction. The experimental process is shown in Fig. 1.

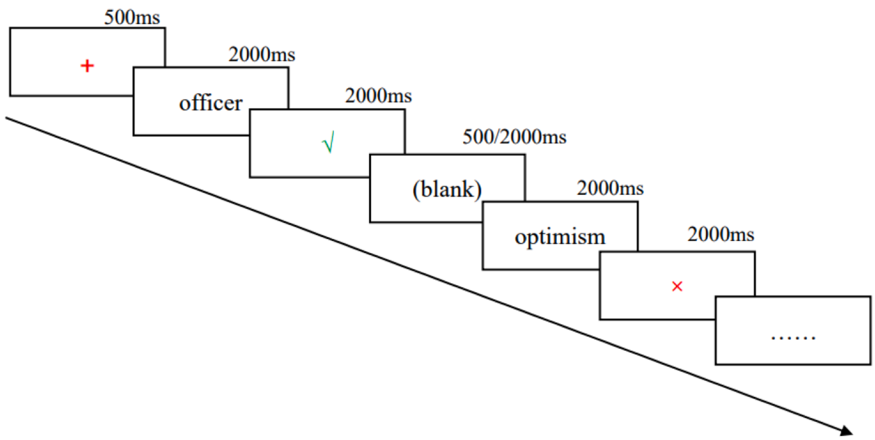


Fig. 1. Experimental procedure.

2.2. Statistical analysis

All the analyses were conducted using SPSS 22.0.

2.3. Results

Table 1 presents the mean and standard deviation of recall accuracy under the three different cognitive loads conditions.

A 2 × 2 × 3 × 3 mixed factors analysis of variance (ANOVA) was performed on the entire sample. This showed a significant main effect of instruction, $F(1, 99) = 149.01$, $p < 0.001$, $\eta^2 = 0.60$. The recall accuracy of to-be-remembered ($M = 0.20$) items was significantly higher than that of to-be-forgotten items ($M = 0.07$). The main effect of valence was also significant, $F(2, 99) = 13.64$, $p < 0.001$, $\eta^2 = 0.12$, with participants recalling significantly more positive ($M = 0.16$) and neutral items ($M = 0.14$) than negative items ($M = 0.10$). Furthermore, there was a main effect of cognitive load, $F(2, 99) = 19.66$, $p < 0.001$, $\eta^2 = 0.28$). Recall accuracy was significantly higher under the conditions of low cognitive load-same interval time as high cognitive load time ($M = 0.14$) and low cognitive load-same total experiment time as high cognitive load ($M = 0.16$) than under the condition of high cognitive load ($M = 0.09$). No significant differences were found between normal individuals and SDs.

The interaction between instruction and group was also significant, $F(1, 99) = 27.98$, $p < 0.001$, $\eta^2 = 0.22$, indicating a significant difference in recall accuracy between normal individuals ($p < 0.001$) and SDs ($p < 0.001$). In contrast with normal participants, SDs recalled more to-be-forgotten items ($p < 0.001$) and fewer to-be-remembered items ($p < 0.001$). The interaction between instruction and load was also significant, $F(1, 99) = 10.53$, $p < 0.001$, $\eta^2 = 0.18$. Recall accuracy under the condition of high cognitive load was lower than under the condition of low cognitive load-same interval time as high cognitive load ($p < 0.01$) when the instruction was "F", and it was also lower than both of the low cognitive load conditions when the instruction was "R" ($p < 0.01$). The significant interaction between instruction and valence was significant, $F(2, 99) = 11.97$, $p < 0.001$, $\eta^2 = 0.11$, reflecting the fact that participants recalled significantly more positive items than negative ($p < 0.001$) and neutral items ($p < 0.001$) when the instruction was "F", with no significant difference found between the negative and neutral items ($p = 0.856$).

We also found that the interaction between instruction, group and load was significant, $F(2, 99) = 3.17$, $p < 0.05$, $\eta^2 = 0.06$. The results revealed that the difference in recall accuracy of SDs given the "R" instruction and "F" instruction was significant under the conditions of low cognitive load-same total experiment time as high cognitive load ($p < 0.001$) and high cognitive load ($p < 0.05$), as compared with the condition of low cognitive load-same interval time as high cognitive load ($p = 0.091$). Normal individuals, by contrast, showed significant differences in all three conditions ($p < 0.001$). When the instruction was "F", SDs recalled fewer items under the condition of high cognitive load than for the other two conditions ($p < 0.01$) as compared with normal individuals. Moreover, under the conditions of low cognitive load, the recall accuracy for to-be-remembered and to-be-forgotten items was significantly different for both groups ($p < 0.001$), while there was no significant difference under the condition of high cognitive load ($p = 0.762$). In addition, we found that the interaction of instruction, valence and load was significant, $F(4, 99) = 3.35$, $p < 0.05$, $\eta^2 = 0.06$. A simple effect analysis indicated that only the negative items were recalled significantly less under the conditions of high cognitive load ($p < 0.05$) and low cognitive load-same total experiment time as high cognitive load ($p < 0.05$) than under the condition of low cognitive load-same interval time as high cognitive load.

Based on the results above, the directed forgetting of emotional items under different cognitive load conditions for SDs was compared using a paired-samples *t*-test. We found that the directed forgetting effect of negative items was not significant under the conditions of low cognitive load-same interval time as high cognitive load, $t(1, 15) = 1.29$, $p = 0.216$, and low cognitive load-same total experiment time as high cognitive load $t(1, 17) = 1.66$, $p = 0.116$, while neutral items were all significant, $t(1, 15) = 3.72$, $p < 0.05$; $t(1, 17) = 7.08$, $p < 0.001$. Under the condition of high cognitive load, however, a significant DF effect was observed for the negative items, $t(1, 15) = 3.09$, $p < 0.01$.

2.4. Discussion

This preliminary randomized controlled trial has provided evidence that increasing cognitive load has positive effects on the directed forgetting of negative materials for SDs. The results of the experiment are in line with our hypothesis, and identify a novel approach for the clinical treatment of SDs and depressed individuals. The next step is to develop relevant intervention programs from the perspective of cognitive load.

3. Study 2

3.1. Methods

3.1.1. Participants

Via face-to-face surveys and on-line press, a total of 520 college participants from Shandong Normal University began a screening questionnaire, of whom 98 ultimately met the eligibility criteria and were invited to complete the baseline assessment. 36 participants withdrew from the study prior to the start of the intervention for various reasons, and hence were excluded from the analyses. All of the remaining 62 individuals (31 female, average age = 20.85) were

Table 1
Recall performance of emotional items under different conditions (M±SD).

	low cognitive load- same total experiment time as high cognitive load									low cognitive load - same interval time as high cognitive load								
	TBF items			TBR items		TBF items	to-be-remembered items			to-be-forgotten items			to-be-remembered items					
	Negative	Negative	Positive	Neutral	Negative	Positive	Neutral	Negative	Positive	Neutral	Negative	Positive	Neutral	Negative	Positive	Neutral	Negative	Positive
Healthy	0.04±0.06	0.01±0.04	0.11±0.14	0.14±0.09	0.12±0.08	0.19±1.22	0.02±0.05	0.00±0.00	0.06±0.12	0.35±0.19	0.26±0.19	0.29±0.25	0.02±0.05	0.02±0.06	0.11±0.12	0.33±0.20	0.17±0.14	0.21±0.24
Subthreshold depression	0.05±0.09	0.02±0.06	0.08±0.12	0.09±0.11	0.09±0.09	0.14±0.11	0.07±0.06	0.08±0.11	0.17±0.11	0.30±0.13	0.15±0.14	0.22±0.13	0.05±0.06	0.12±0.55	0.19±0.14	0.2.0 ± 0.15	0.15±0.08	0.15±0.11

included and randomized to either treatment or no treatment by drawing lots. A priori power analysis using G*Power (Faul et al., 2007) indicated that a minimum of 44 participants were required to detect a medium effect size, $d = 0.25$, with an alpha set at 0.05 and power set at 0.95. The number of participants involved in study 2 met the required standard.

Fig. 2 displays a flowchart depicting the various steps involved in the study. All procedures involving human participants were in accordance with the ethical standards of the Academic Board of Shandong Normal University, and the 1964 Helsinki Declaration and its later amendments. Participation was voluntary and anonymous, with the right to withdraw participation at any time. After being informed about the intervention's goals and procedures, and being given the opportunity to ask questions, all participants signed a written informed consent form. At baseline, depression characteristics and scores on BDI-II and CES-D were assessed using the same judgement standard as in study 1. In addition, all participants were screened for psychopathology. The interviews were conducted by therapists who had received training in the Composite International Diagnostic Interview (CIDI). The CIDI is a structured and fully standardized interview for DSM-V diagnosis, which is used to assess psychopathology.

Any participants who met the four criteria used in study 1, after CIDI was conducted by evaluators blind to assigned group, were excluded from this study. One week later, SDs were randomly allocated to an intervention group or a control group for the first session. This allocation followed a 1:1 ratio using a sequential assignment list after participants had completed the CIDI and self-report questionnaires. Fig. 2 displays the study flowchart.

3.1.2. Study design

A 2 × 2 repeated measures design was used to explore whether there were significant changes in depressive symptoms based on the format of the intervention. The within-subject factors were time (Pre vs. Post), and the between-subject factors were group (intervention vs. control). The dependent variable was participants' scores on the BDI-II scale, CES-D scale and the 12-item General Health Questionnaire (GHQ-12) scale.

3.1.3. Assessments

Primary measures directly examined depressive symptoms. For the primary outcomes, the depressive symptoms in each week were measured with the BDI-II scale and the 20-item CES-D scale. Secondary measures comprised standard measures, such as psychopathology and well-being. GHQ-12 is a screening questionnaire that identifies physical and mental health problems, and assesses the probability of developing a psychiatric disorder (Goldberg and Hillier, 1979). For all these items, higher scores indicate worse physical and mental health severity. The scale score can be used as an auxiliary reference for SD symptoms.

3.1.4. Procedures

The therapists that offered the interventions were psychological professionals that had been extensively trained in these interventions. Participants met with one of the four therapists individually for 45–60 min once a week, and the CLI part took 20–25 min. The intervention period was 8 weeks. During CLI, therapists focused on teaching CLI strategies by arranging daily activities for participants. Participants were encouraged to deploy cognitive load skills during in-session and out-of-session exposures, and to share their feelings.

The intervention was similar for the control group, except for the CLI component. Participants assigned to the control group received behavioral activation routine treatment once a week to assess clinical status and were offered encouragement while they completed assessments, with the CLI component being replaced by regular behavioral activation activities. During these sessions, therapists inquired about participants' symptoms and general functioning. If evidence was obtained during any of these sessions that significant clinical deterioration had occurred, the therapist assisted them in obtaining alternative treatment. Table 2

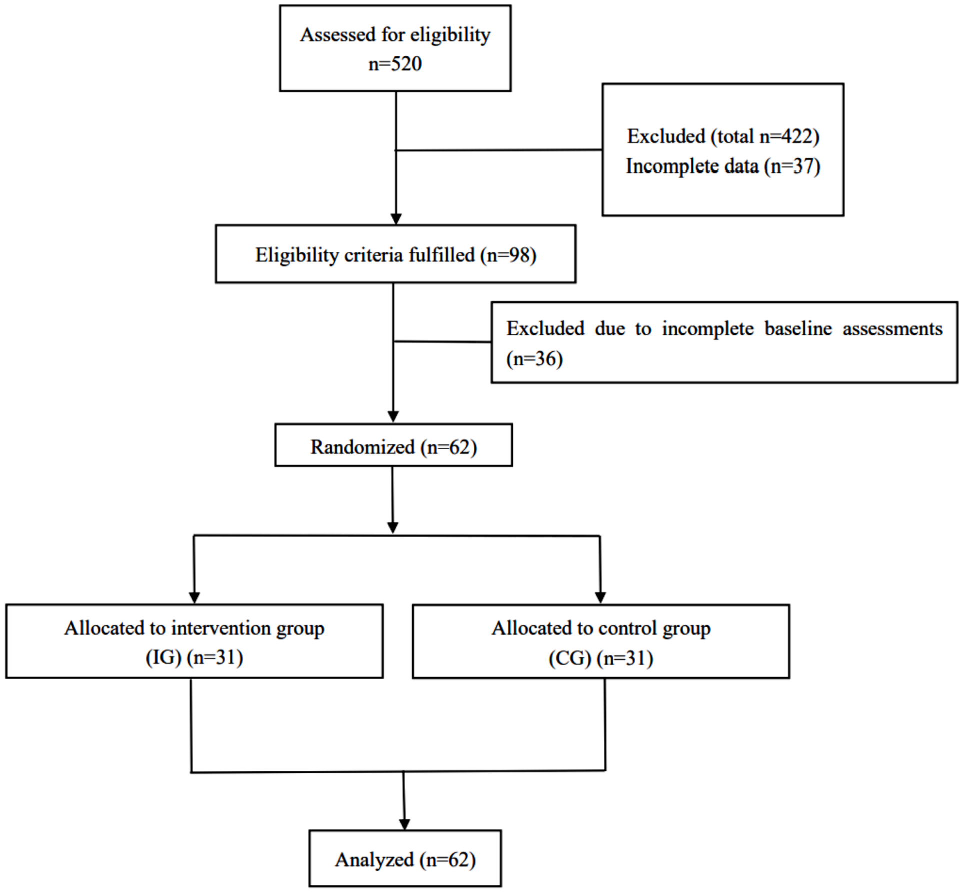


Fig. 2. Participant flow through study 2.

presents details of the intervention.

3.2. Intervention

The purpose of CLI was to reduce the amount of time that participants spent experiencing negative emotions on a daily basis. The CLI developed in this research followed the cognitive load model, in which participants are coached to complete specified tasks by applying cognitive and behavioral skills in their daily activities. In particular, CLI tasks were arranged in participants' schedules in line with BA activities, and were regarded as key activities. The specified tasks included two components: (a) continue writing an unfinished story based on a given background when feeling bad, (b) imagine some concrete situations before bedtime (following guided practice in the consulting room). Therapists were allowed to use their judgment in placing emphasis on certain tasks over others, depending on the characters of each participant. The results of our first experiment showed that CLI tasks can significantly increase the cognitive load of participants, thus supporting the appropriateness of the CLI tasks used in study 2. These CLI tasks underwent group audit and appraisal by an expert-multidisciplinary

Table 2
Cognitive Load Intervention program: Session Content for participants.

Participants allocated to intervention		Participants allocated to control	
Session	Content	Session	Content
1—2	Preliminary interview (feelings, exposure)	1—2	Preliminary interview (feelings, exposure)
3—6	CLI training with behavioral activation	3—6	Behavioral activation
7—8	Integration of skills, preparing closure	7—8	Preparing closure

Table 3
Baseline characteristics of the participants ($N = 62$).

Characteristic	Total (N = 62) (N = 62)	Intervention Group (IG) (N = 31)	Control Group (CG) (N = 31)
Age, years			
Mean (SD)	20.85(1.40)	20.90(1.49)	20.84(1.44)
Range	7	7	7
Gender, n (%)			
Male	32(51.6)	15(48.39)	17(54.84)
Female	30(48.4)	16(51.61)	14(45.16)
Initial scale score (BDI-II)			
Mean (SD)	14.61(1.50)	14.90(1.62)	14.32(1.33)
Range	6	6	4
Initial scale score (CES-D)			
Mean (SD)	20.08(0.84)	20.08(0.84)	20.19(0.70)
Range	3	3	2
Initial scale score (GHQ)			
Mean (SD)	29.94(2.70)	29.94(2.70)	29.68(2.41)
Range	13	13	7
Location (%)			
City	36.55	38.7	34.4
Town	20.1	19.4	20.8
Rural	43.35	41.9	44.8
Grade (%)			
Freshman	12.90	16.13	9.7
Sophomore	25.81	22.58	29.03
Junior	32.26	29.03	35.48
Senior	29.03	32.26	25.81

Table 4
Primary and secondary outcomes across time and groups.

Measures	Pre Intervention					Post Intervention				
	intervention group		control group		F, P-value	intervention group		control group		F, P-value
	Mean	*SD*	Mean	*SD*		Mean	*SD*	Mean	*SD*	
Primary Outcomes										13.46, 0.001*
BDI-II	14.90	1.62	14.32	1.33	2.39, 0.13	8.58	3.70	11.52	2.47	17.56, < 0.001*
CES-D	19.97	0.95	20.19	0.70	1.13, 0.29	14.10	3.87	17.77	2.99	
Secondary Outcomes										9.02, 0.004*
GHQ-12	30.19	2.98	29.68	2.41	0.56, 0.46	18.45	7.65	23.87	5.35	

*significant at $p < 0.05$.

team, which took place before the intervention.

3.2.1. Statistical analysis

Descriptive data are reported, with differences in baseline demographic and clinical characteristics investigated using chi-square and t tests in later variance analysis. All analyses were conducted using SPSS 22.0. The current project applied intention-to-treat analysis (ITT), and only reports ITT findings.

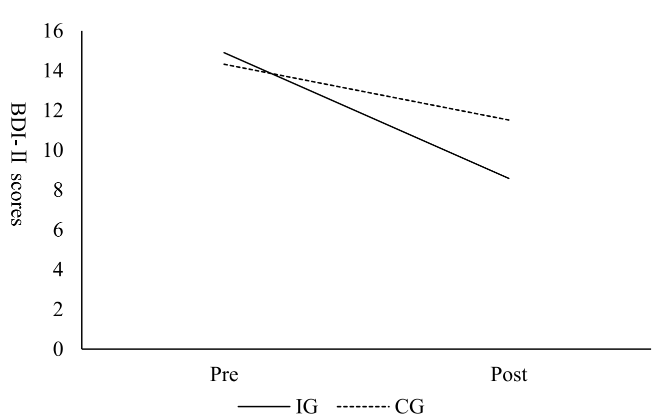
3.3. Results

3.3.1. Participant characteristics (see table 3)

Gender was evenly distributed across groups, X^2 (1, 61) = 0.26, $p >$ 0.05. There were no differences in age between the two groups, t (2, 60) = −1.32, $p > 0.05$.

3.3.2. Effects of cli intervention on depressive symptoms (see table 4)

3.3.2.1. Primary outcomes. The scores of BDI-II and CES-D during the 8 weeks project were analyzed using a 2 (group: intervention vs. control) × 2 (time: Pre vs. Post) repeated measures ANOVA. For BDI-II, there was a significant main effect of group, F (1, 60) = 7.61, $p < 0.01$, $\eta^2 = 0.11$, with the BDI-II scores of the intervention group being significantly lower than the control group. The main effect of time was also significant, F (1, 60) = 99.93, $p < 0.001$, $\eta^2 = 0.63$; BDI-II scores decreased from baseline to the last week of intervention across all groups. The interaction of time × group was significant, F (1, 61) = 14.82, $p < 0.001$, $\eta^2 = 0.20$. A further simple effect analysis found that at the beginning of the intervention, the difference between the intervention group and the control group was not significant, $p > 0.05$. Following the intervention, the difference between the intervention group and the control group was significant, $p < 0.001$, which indicated that the BDI-II scores decreased more significantly between the two measurements in the intervention group than in the control group. The results are shown in Fig. 3.



IG: Intervention group; CG: Control group.

Fig. 3. The BDI-II Results. IG: Intervention group; CG: Control group.

For CES-D, there was a significant main effect of group, F (1, 60) = 18.77, $p < 0.001$, $\eta^2 = 0.24$, where the CES-D scores of the intervention group were significantly lower than those of the control group. The main effect of time was also significant, F (1, 60) = 83.99, $p < 0.001$, $\eta^2 =$ 0.58, with the CES-D scores decreasing from baseline to the last week of intervention across all groups. The interaction of time × group was significant, F (1, 60) =14.56, $p < 0.001$, $\eta^2 = 0.20$. A further simple effect analysis found that, at the beginning of the intervention, the difference between the intervention group and the control group was not significant, $p > 0.05$. After the intervention, the difference between the intervention group and the control group was significant, $p < 0.001$, which indicated that the CES-D scores decreased more significantly between the two measurements in the intervention group than in the control group. The results are shown in Fig. 4.

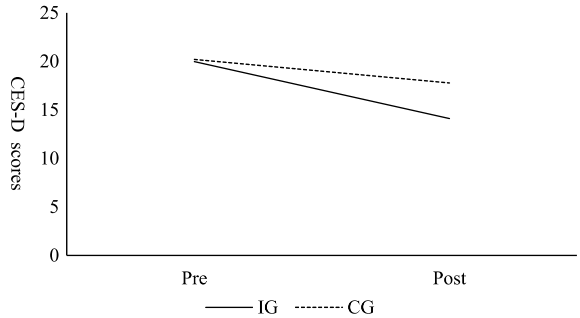
3.3.2.2. Secondary outcomes. The scores of GHQ during the 8 weeks project were analyzed using a 2 (group: intervention vs. control) × 2 (time: Pre vs. Post) repeated measures ANOVA. There was a significant main effect of group, F (1, 60) = 5.54, $p < 0.05$, $\eta^2 = 0.08$, with the GHQ scores of the intervention group being significantly lower than those of the control group. In addition, the main effect of time was significant, F (1, 60) = 102.20, $p < 0.001$, $\eta^2 = 0.63$, with the GHQ scores decreasing from baseline to the last week of intervention across all groups. The interaction of time × group was significant, F (1, 60) = 10.68, $p < 0.01$, $\eta^2 = 0.15$. A further simple effect analysis found that, at the beginning of the intervention, the difference between the intervention group and the control group was not significant, $p > 0.05$. Following the intervention, the difference between the intervention group and the control group was significant, $p < 0.001$, which indicated that the GHQ scores decreased more significantly between the two measurements in the intervention group than in the control group. The results are shown in Fig. 5.

3.4. Discussion

This study examined the effectiveness of increasing cognitive load on reducing SD in real life situations for the first time. The intervention involved incorporating the CLI project into behavioral activation activities, featuring specific tasks for reducing the depressive symptoms of SDs. The goal of this training was to help SDs to intentionally control their negative memories. The results revealed that SDs who received CLI reported greater reductions in depressive symptoms compared with SDs in the control group, thus supporting the efficacy of the intervention.

4. General discussion

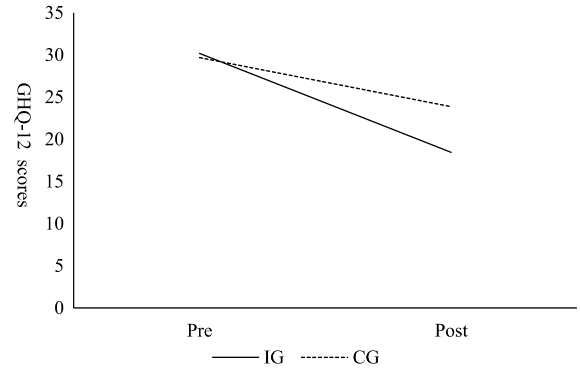
The current study is the first systematical trial conducting two studies for assessing the effect of cognitive load on SDs. In study 1, a positive effect of increasing cognitive load on the directed forgetting of negative materials was shown in SDs. Based on this finding, we created the CLI for SDs in study 2, which proved to be effective in reducing depressive symptoms. Taken together, the two studies highlight that the intervention of increasing cognitive load can promote SDs' forgetting of negative information and address their depressive condition, suggesting



IG: Intervention group; CG: Control group.

48

Fig. 4. The CES-D Results. IG: Intervention group; CG: Control group.



IG: Intervention group; CG: Control group.

49

Fig. 5. The GHQ-12 Results. IG: Intervention group; CG: Control group.

a novel means of treatment for SDs.

In study 1, we found that, compared with normal individuals, SDs remembered fewer to-be-remembered items and more to-be-forgotten items, indicating that SDs may have impaired cognitive inhibition function and cannot easily eliminate unwanted information from their memory (Power et al., 2000). According to the retrieval-inhibition account, the inhibition mechanism can block the effective extraction of information (Fawcett and Taylor, 2008; Woodward and Bjork, 1971). For individuals with SD, the process of information extraction cannot be effectively blocked when the inhibitory function is impaired, with the result that to-be-forgotten words are more likely to appear in memory and occupy limited cognitive resources. As a result, SDs remember fewer to-be-remembered words and more to-be-forgotten words than normal individuals. Also, with the increase in cognitive load, only SDs showed a significant directed forgetting effect on negative words. This finding suggests that high cognitive load inhibits SDs from focusing on negative words, thereby correcting their negative memory bias. Emerging studies using fMRI have noted that the mechanism of inhibition plays an essential role in the forgetting of SDs, and that the process of inhibiting negative information occupies high frontal control resources (Yang et al., 2020). SDs who are faced with a high cognitive load situation find it harder to extract information. With less cognitive resources available, they encode fewer negative memories and demonstrate lower recall accuracy.

Exploratory intervention in study 2 revealed that SDs who received CLI reported greater reductions in depressive symptoms than the SDs in the control group. This finding demonstrates that, through increasing cognitive load and scheduling cognitive resources, CLI tasks can reinforce emotion inhibition strategies and enhance SDs' ability to exert control over their thought processes. The primary intention of CLI tasks is to modify and disengage negative emotion situations by increasing cognitive load and occupying the cognitive resources needed to encode negative memories. Taking into account the specific cognitive deficits of SDs (Santangelo et al., 2014), CLI tasks can be carefully chosen so as to consume as much cognitive resources as possible, thereby blocking the immersion process of negative emotions. Given the fact that SDs who received CLI reported better physical and mental comfort and behavioral recovery compared with SDs in the control group, CLI emerged as a valuable and effective emotion adjustment method.

Although traditional intervention methods (e.g., behavioral activation) are efficacious in treating SD (Stice et al., 2008), the CLI tasks used in study 2 could improve the intervention flexibility of behavioral activation. Whereas other interventions seek to increase well-accepted activities, and to replace negative with positive cognitions (Takagaki et al., 2016), CLI emphasizes that, in addition to a fixed weekly interview time, SDs can choose to finish their CLI tasks anytime and anywhere they want, thereby giving them independent control over gradually adjusting their emotions. As well as addressing the details and emotions experienced at different points in time, CLI also helps individuals with SD plan how to move forward and acquire the ability to respond appropriately to negative emotions. Relative to SDs in the control group, the CLI facilitated a decrease in dependency (less dependency on therapists) and an increase in expressiveness (more self-disclosure). In trying to better understand this result, we checked the responses and feedback levels of participants in study 2. We found that SDs who received CLI had a higher degree of activation, higher enthusiasm in completing CLI tasks and greater positive changes in their daily activities, showing that the CLI tasks were conducted smoothly and effectively.

Findings from both studies require further interpretative description. Accordingly, we created different time arrangements to balance the time factors between different cognitive load conditions under directed forgetting. Apart from the significant directed forgetting effect under the condition of high cognitive load, we found that SDs recalled fewer to-be-forgotten items under the condition of low cognitive load-same total experiment time as high cognitive load in study 1. Although participants recruited more cognitive resources to inhibit to-be-forgotten items under the low cognitive load-same interval time as high cognitive load time condition, the SDs could not easily inhibit the negative to-be-forgotten items. Given their inhibitory dysfunction and the limited time available, the directed forgetting effect could not be observed. However, when time intervals increased under the condition of low cognitive load, the inhibition mechanism was removed, giving SDs more time to further process the to-be-remembered items under the condition of forgetting. This resulted in a high recall rate and a significant directed forgetting effect. In light of the strong influence of the time interval evident in study 1, time conditions were strictly controlled in the execution of CLI tasks in study 2. After the occurrence of negative events, therapists asked SDs not to perform CLI tasks immediately, but to start after a period of calming down, so as to optimally deploy cognitive resources, and allow the inhibition mechanism to take effect.

Despite these promising findings, certain limitations should be noted, which may suggest directions for further research. First, the sample sizes in both studies were relatively small. Given that the current sample was made up largely of college students, future investigations involving larger samples with a greater diversity of ages and identities would be valuable for establishing whether CLI effects generalize across individuals suffering with SD. Second, although self-reports of word recall in the experiment, and depressive symptoms during the CLI, are considered reliable, it would be valuable to deliver converging evidence from a neuroimaging perspective, thus allowing an explanation of the underlying neural mechanisms involved. Lastly, to avoid any potential bias in participants' interpretation of this assignment process, future studies might consider using "active CLI training with BA" versus "inert CLI training with BA" for the intervention group and the control group respectively.

Notwithstanding these limitations, the study has strengths in terms of study design, rigorous experimental implementation and practical intervention. The study is systematically and adequately powered, and succeeds in identifying the potential contribution of cognitive load to the treatment of SD. Our findings from study 1 broaden the understanding of cognitive functioning in relation to SD, and explore the characteristics of directed forgetting under three cognitive load conditions (low cognitive load-same interval time as high cognitive load time, low cognitive load-same total experiment time as high cognitive load, high cognitive load), capturing the complexity of cognitive load effects. A noteworthy innovation of this study is the deployment of the CLI project in the treatment of SD, which can be incorporated with behavioral activation as an independent component, thereby enriching the existing intervention methods and concepts.

To conclude, the findings of our two studies have added to a small but accumulating body of literature which suggests that increasing cognitive load can help SDs forget unwanted memories. The CLI was used to operationally help participants increase their cognitive load and to track the changes that followed. Consistent with our predictions, we found that SDs who received CLI improved their psychological well-being, thus supporting the idea that CLI can be an effective treatment in relieving depression for SDs. Building on these encouraging findings, an important next step will be to consolidate the efficacy of this intervention, and to establish whether it can be used effectively in the treatment of depression disorder. Given that it remains unclear whether our findings can be conceptualized to represent an adjunctive treatment or generalized to broader samples, our findings might be considered as first steps for identifying mechanisms which increase and decrease recall of negative information in persons with subthreshold depression. Ultimately, these results might be valuable for informing the development of a more user-friendly and flexible treatment for patients and providers.

Data availability statement

Research data are not shared.

CRediT authorship contribution statement

Yixin Hu: Conceptualization, Writing - original draft, Funding acquisition. **Xiao Wu:** Investigation, Writing - original draft, Data curation. **Xu Chen:** Investigation, Formal analysis, Validation. **Phil Maguire:** Visualization, Investigation, Writing - review & editing. **Dawei Wang:** Conceptualization, Methodology, Validation, Investigation, Writing - review & editing, Supervision.

Declaration of Competing Interest

The author declares no conflicts of interest associated with this manuscript.

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Appendix

6 buffer words

1	Justice	2	Recognition	3	Suicide	4	Disease
5	Assault	6	Officer				

The remaining 72 words

1	Wonderful	2	Smile	3	Countermeasure	4	Reveal
5	Rumor	6	Bitter	7	Blockage	8	Policemen
9	Despair	10	Gift	11	Contempt	12	Calm
13	Joy	14	Strike	15	Shame	16	Glorious
17	Exaggeration	18	Fair	19	Destroy	20	Wretched
21	Silent	22	Dominate	23	Seriously injured	24	Excellent
25	Beautiful	26	Drug trafficking	27	Enemy	28	Delusion
29	Marriage	30	Fierce	31	Suffering	32	Singing
33	Share	34	Devil	35	Still	36	Train
37	Circling	38	Application	39	Selfless	40	Reunion
41	Smuggling	42	Punctual	43	Resentment	44	Hard
45	Search	46	Vacation	47	Collection	48	Robbery
49	Rural	50	Pretty	51	Scorching	52	Scar
53	Passion	54	Cover	55	Ominous	56	Frank
57	Brother	58	Sister	59	Adjustment	60	Cheap
61	Coincidence	62	Unlucky	63	Charge	64	Emperor
65	Love	66	Optimism	67	Lonely	68	Proud
69	Demeanor	70	Urge	71	Immigration	72	Confidence

References

Abel, M., Bäuml, Karl-Heinz.T., 2017. Testing the context-change account of list-method directed forgetting: the role of retention interval. J. Memory Lang. 92, 170–182.

Anderson, M.C., Hanslmayr, S., 2014. Neural mechanisms of motivated forgetting. Trends Cogn. Sci. (Regul. Ed.) 18 (6), 279–292.

Avenevoli, S., Swendsen, J., He, J.P., Burstein, M., Merikangas, K.R., 2015. Major depression in the national comorbidity survey-adolescent supplement: prevalence, correlates, and treatment. J. Am. Acad. Child Adolesc. Psychiatry 54 (1), 37–44.

Bastin, C., Feyers, D., Majerus, S., Balteau, E., Degueldre, C., 2012. The Neural Substrates of Memory Suppression: a fMRI Exploration of Directed Forgetting. PLoS ONE 7 (1), e29905.

Berman, M.G., Nee, D.E., Casement, M., Kim, H.S., Deldin, P., Kross, E., Gonzalez, R., Demiralp, E., Gotlib, I.H., Hamilton, P., Joormann, J., Waugh, C., Jonides, J., 2011. Neural and behavioral effects of interference resolution in depression and rumination. Cognitive, Affective Behav. Neurosci. 11 (1), 85–96.

Bertha, E.A., Balazs, J., 2013. Subthreshold depression in adolescence: a systematic review. Eur. Child Adolesc. Psychiatry 22, 589–603.

Buntrock, C., Ebert, D., Lehr, D., Riper, H., Smit, F., Cuijpers, P., Berking, M., 2015. Effectiveness of a Web-Based Cognitive Behavioural Intervention for Subthreshold Depression: pragmatic Randomised Controlled Trial. Psychotherapy and Psychosomatics, 84 (6), 348–358.

Capitani, E., Sergio, D.S., Logie, R.H., Spinnler, H., 1992. Recency, primacy, and memory: reappraising and standardising the serial position curve. Cortex 28 (3), 315–342.

Chachamovich, E., Fleck, M., Laidlaw, K., Power, M., 2008. Impact of major depression and subsyndromal symptoms on quality of life and attitudes toward aging in an international sample of older adults. Gerontologist 48 (5), 593–602.

Chartier, I.S., Provencher, M.D., 2013. Behavioural activation for depression: efficacy, effectiveness and dissemination. J. Affect. Disord. 145 (3), 292–299.

Cipriani, A., Furukawa, T.A., Salanti, G., Chaimani, A., Atkinson, L.Z., Ogawa, Y., Leucht, S., Ruhe, H.G., Turner, E.H., Higgins, J.P.T., Egger, M., Takeshima, N., Hayasaka, Y., Imai, H., Shinohara, K., Tajika, .A.., Ioannidis, J.P.A., Geddes, J.R., 2018. Comparative efficacy and acceptability of 21 antidepressant drugs for the acute treatment of adults with major depressive disorder: a systematic review and network meta-analysis. Lancet 391 (10128), 1357–1366.

Cuijpers, P., Smit, F., 2004. Subthreshold depression as a risk indicator for major depressive disorder: a systematic review of prospective studies. Acta Psychiatr. Scand. 109, 325–331.

Davidson, S.K., Harris, M.G., Dowrick, C.F., Wachtler, C.A., Pirkis, J., Gunn, J.M., 2015. Mental health interventions and future major depression among primary care patients with subthreshold depression. J. Affect. Disord. 177, 65–73.

Faul, F., Erdfelder, E., Lang, A.G., Buchner, A., 2007. G*power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav. Res. Methods 39 (2), 175–191.

Fawcett, J.M., Taylor, T.L., 2008. Forgetting is effortful: evidence from reaction time probes in an item-method directed forgetting task. Mem. Cognit. 36 (6), 1168–1181.

Fawcett, J.M., Taylor, T.L., 2012. The control of working memory resources in intentional forgetting: evidence from incidental probe word recognition. Acta Psychol. (Amst) 139 (1), 84–90.

Feldon, D.F., Callan, G., Juth, S., Jeong, S., 2019. Cognitive Load as Motivational Cost. Educ. Psychol. Rev. 31, 319–337.

Goldberg, D.P., Hillier, V.F., 1979. A scaled version of the general health questionnaire. Psychol. Med. 9.

Hauswald, A., Schulz, H., Iordanov, T., Kissler, J., 2010. ERP dynamics underlying successful directed forgetting of neutral but not negative pictures. Soc. Cognit. Affect. Neurosci. 6, 450–459.

Hwang, J.W., Egorova, N., Yang, X.Q., Zhang, W.Y., Chen, J., Yang, X.Y., Hu, L.J., Sun, S., Tu, Y., Kong, J., 2015. Subthreshold depression is associated with impaired resting-state functional connectivity of the cognitive control network. Transl. Psychiatry 5, e683.

Jacobson, N.S., Martell, C.R., Dimidjian, S., 2001. Behavioral Activation Treatment for Depression: returning to Contextual Roots. Clin. Psychol. 8 (3), 255–270.

Joormann, J., Talbot, L., Gotlib, I.H., 2007. Biased Processing of Emotional Information in Girls at Risk for Depression. J. Abnorm. Psychol. 116 (1), 136–143.

Kahneman, D., 1973. Attention and Effort. Prentice-Hall, Englewood Cliffs, N.J).

Kessler, R.C., Berglund, P., Demler, O., Jin, R., Koretz, D., Merikangas, K.R., Rush, A.J., Walters, E.E., Wang, P.S., 2003. The epidemiology of major depressive disorder: results from the national comorbidity survey replication (NCS-R). JAMA 289 (23), 3095–3105.

Knight, M.J., Air, T., Baune, B.T., 2018. The role of cognitive impairment in psychosocial functioning in remitted depression. J. Affect. Disord. 235, 129–134.

Lee, Yuh-shiow., 2011. Cognitive load hypothesis of item-method directed forgetting. Q. J. Exp. Psychol. 65 (6), 1110–1122.

Lewinsohn, P.M., Sullivan, J.M., Grosscup, S.J., 1980. Changing reinforcing events: an approach to the treatment of depression. Psychotherapy Theory Res. Prac. 17 (3), 322–334.

Miller, G.A., 1956. The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychol. Rev. 63, 81–97.

Plass, J.L., Kalyuga, S., 2019. Four ways of considering emotion in cognitive load theory. Educ. Psychol. Rev. 31, 339–359.

Power, M.J., Dalgleish, T., Claudio, V., Tata, P., Kentish, J., 2000. The directed forgetting task: application to emotionally valent material. J. Affect. Disord. 57 (1–3), 147–157.

Radloff, L.S., 1977. The CES-D scale a self-report depression scale for research in the general population. Appl. Psychol. Meas. 1 (3), 385–401.

Santangelo, G., Vitale, C., Trojano, L., Angrisano, M.G., Picillo, M., Errico, D., Agosti, V., Grossi, D., Barone, P., 2014. Subthreshold depression and subjective cognitive complaints in parkinson's disease. Eur. J. Neurol. 21 (3), 541–544.

Stice, E., Rohde, P., Seeley, J.R., Gau, J.M., 2008. Brief cognitive-behavioral depression prevention program for high-risk adolescents outperforms two alternative interventions: a randomized efficacy trial. J. Consulting Clin. Psychol. 76 (4), 595–606.

Sweller, J., 2004. Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. Instruc. ence 32 (1–2), 9–31.

Sweller, J., 2011. Cognitive Load Theory and E-Learning. International Conference on Artificial Intelligence in Education. Springer, Berlin, Heidelberg.
Takagaki, K., Okamoto, Y., Jinnin, R., Mori, A., Nishiyama, Y., Yamamura, T., Yokoyama, S., Shiota, S., Okamoto, Y., Miyake, Y., Ogata, A., Kunisato, Y., Shimoda, H., Kawakami, N., Furukawa, T.A., Yamawaki, S, 2016. Behavioral activation for late adolescents with subthreshold depression: a randomized controlled trial. Eur. Child Adolesc. Psychiatry 25 (11), 1171–1182.
Taylor, T.L., Quinlan, C.K., Vullings, K.C.H., 2018. Decomposing item-method directed forgetting of emotional pictures: equivalent costs and no benefits. Mem. Cognit. 46 (6), 1–16.
Tuithof, M., Have, M.T., Dorsselaer, S.V., Kleinjan, M., Beekman, A., Graaf, R.D., 2018. Course of subthreshold depression into a depressive disorder and its risk factors. J. Affect. Disord. 241, 206–215.
Van Dillen, L.F., Koole, S.L., 2007. Clearing the Mind: a Working Memory Model of Distraction From Negative Mood. Emotion 7 (4), 715–723.
van Zoonen, Kim., Claudia, B., Daniel, E.D., Filip, S., Charles, R.F., Aartjan, B.T.F., Pim, C, 2014. Preventing the onset of major depressive disorder: a meta-analytic review of psychological interventions. Int. J. Epidemiol. 43 (2), 318–329.
Woodward, A.E., Bjork, R.A., 1971. Forgetting and remembering in free recall: intentional and unintentional. J. Exp. Psychol. 89 (1), 109–116.
World Health Organization (WHO). (2019). Depression. Retrieved from: https://www.who.int/news/item/30-03-2017-depression-let-s-talk-says-who-as-depression-tops-list-of-causes-of-ill-health.
Yang, W.J., Chen, Q.L., Liu, P.D., Cheng, H.S., Cui, Q., Wei, D.T., Zhang, Q.L., Qiu, J., 2016. Abnormal brain activation during directed forgetting of negative memory in depressed patients. J. Affect. Disord. 190, 880–888.
Yang, W.J., Liu, P.D., Zhuang, K.X., Wei, D.T., Anderson, M.C., Qiu, J., 2020. Behavioral and neural correlates of memory suppression in subthreshold depression. Psychiatry Res. 297, 1–10.