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RESEARCH ARTICLE

The Association Between Negative Attributional Style and Working Memory Performance

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Abstract:

Introduction:

It has been proposed that negative attributions contribute to impairment in cognitive task processing. However, it is still unknown whether negative attributions influence task processing in all cognitive tasks.

Methods:

To investigate this, 91 healthy participants completed attributional style questionnaire and performed three Working Memory (WM) tasks, which associated with different functions of WM (*i.e.* Central Executive System (CES) and visuospatial sketchpad).

Results:

The results demonstrated that negative attributions contribute to the impairment in cognitive tasks which is associated with spatial working memory rather than main central executive functions (*i.e.* switching and inhibition).

Conclusions:

It is concluded that negative attributions may selectively disrupt spatial working memory functions, thus a detrimental effect of negative attributions may be task specific.

Keywords: Negative Attributional Style, Working memory tasks, Cambridge neuropsychological test battery, Spatial working memory, Central executive system, Individual differences.

1. INTRODUCTION

Attributional style refers to the way individuals evaluate themselves in circumstances in both positive and negative life experiences [1, 2]. Individuals with a stable negative (likely to persist over time), global (persists throughout life) or internal (the causes of negative events are internal) attributional style burden themselves with blame and negative expectations [2, 3]. Thus, the negative interpretations of individuals concerning past events in terms of these three components of negative attributional style (stable, global and internal) influence their expectation for future events and, subsequently, control their feelings and behaviours [4 - 7]. This may result in a predisposition to certain psychological disorders, such as depression [8], and lower cognitive functioning, such as a lower level of academic achievements and impaired cognitive functions [5, 9]. As negative attributional style is one of the main precipitating factors of psychological disorders such as anxiety and depression [3], it is important to understand cognitive processing in relation to negative attributional style as this will contribute to the determination of treatments that could alleviate the

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cognitive impairments associated with a negative attributional style.

One of the most influential cognitive functions is Working Memory (WM) due to its association with attention to detail, planning, updating, task switching and conflict resolution during the execution of a task [10 - 13]. In this context, the most prominent theory of WM was proposed by Baddeley and Hitch (1974); according to this theory, WM consists of short-term stores (the visuospatial sketchpad and the phonological loop) and Central Executive System (CES) [12, 13]. The visuospatial sketchpad and the phonological loop are involved in storing visuospatial and auditory information [10]. The visuospatial sketchpad consists of two components (the visual cache and inner subscribe) which is involved in encoding, storing and rehearsal of visuospatial information. Also, the phonological loop consists of two components (the phonological store and an articulatory processes), and it deals with auditory and verbal information. The CES plays a supervisory role in short-term memory components by controlling attention and manipulating and monitoring information [12, 14]. To implement these duties, CES has divisible functions. Based on Baddeley and Hitch's WM theory, Miyake *et al*. (2000) were able to show that the CES has different functions, such as switching and inhibition. For instance, the authors suggested that while the Wisconsin Card Sorting Test (WCST) was strongly associated with switching and inhibition functions, the Tower Of Hanoi (TOH) was associated with both inhibition and planning functions [11, 13 - 15]. While switching allows the shifting of one's attention from one task to another, inhibition deals with conflict resolution by preventing task-irrelevant stimuli, which may cause interference [12, 15]. Planning facilitates the assessment and selection of information during task processing [16]. Due to this crucial role of WM, the aim of this study is to explore the association between the negative attributions and distinct functions of WM.

One of the psychological models relevant to negative attributional style is the hopelessness theory [3 - 19]. In this theory, it has been [18] supposed that that higher level of negative attributions is associated with depression and high levels of stress because the inferred negative evaluations and characteristics about the self, contribute to the formation of hopelessness [19, 20]. This means hopelessness acts as a mediator in the relationship among negative attributions, depression and stress. Empirical studies based on these models found a strong correlation between hopelessness and negative attributional style (r= between .68 and .55) [3, 17, 19]. Furthermore, it has been found that people with negative attributional style have a greater risk of depression and anxiety [3, 19, 21, 22], schizophrenia [23, 24], suicidality [3] and lower academic achievements [2, 25].

While the link between negative attributions and psychological maladjustment is well understood in terms of psychological models, knowledge about the association between negative attributional style and WM processing is rare. More generally, it has been shown that high levels of negative attributions are associated with slower performance in some cognitive tasks that include emotional stimuli [4, 5]. The reason for this might be that emotional information activates stress-related representations from long-term memory which in turn increase stress levels and interferes with WM processing in individuals with a greater negative attributional style [7, 9, 26]. In other words, a greater level of stress in people with higher negative attributional styles may lead to greater mental task unrelated activities which overlap with task-related activities [7, 9, 26, 27]. This results in limiting the employment of mental effort within the WM system [27, 28]. This argument appears to be reasonable as it has been found that people with negative attributions have higher stress levels than their positive counterparts [4, 7].

Previously, empirical studies have demonstrated that high levels of negative attributions (*e.g.* pessimists) may impair performance in cognitive tasks compared to the performance of individuals with lower negative attributions [4, 5, 9]. For instance, Levens and Gotlib, (2012) found that people with higher negative attributions (*i.e.* pessimists) were slower to process emotional n-back tasks than individuals with positive attributions (*i.e.* optimists). These findings also support the idea that people with higher negative attributions may be unable to employ sufficient effort into the task due to emotional stimuli inducing stress-related mental representations from long-term memory, thereby leading to task-irrelevant activities interfering with WM processing [5]. However, these findings do not allow for a great understanding of whether higher-level negative attributional styles influence the processing of all cognitive tasks or only specific ones.

In addition, some studies have failed to show the detrimental effect of negative attributions on cognitive tasks, suggesting that these effects may depend on the presence of certain task characteristics [7, 29]. For instance, Szalma (2009) conducted a vigilance task on individuals with higher negative attributional styles; the results demonstrated that negative and positive attributions were not associated with task performance. According to Szalma (2009), negative attributional style only affects specific task performance because WM consists of different components, such as the storage systems (*i.e.* visuospatial sketchpad and phonological loop) and CES, which themselves are divided into separate functions, such as switching and inhibition. The tasks used to measure these components and functions were different. In light of this, negative attributional style may impair only one component of WM, while the other components and functions remain unaffected. Therefore, it seems negative attributional style only affects certain types of tasks because although previous studies have shown performance decrement associated with negative attributional style in WM processing, others failed to show such an association with other WM tasks. The distinction of the current study is to investigate the association between negative attributional style and WM processing from a new and unexplored perspective by employing different WM tasks; each of these will be associated with a different aspect of WM in order to resolve the inconsistencies among the past empirical research.

In the current study, the Attributional Style Questionnaire (ASQ) [22] was used to measure the attribution scores of participants and following by that the participants performed three WM tasks. Thus, we aimed to investigate the associations between negative attribution scores and WM performance. To test this, well-validated and standardised WM tasks were selected, therefore relying on Baddeley and Hitch's WM theory [30] in a highly detailed manner. Furthermore, to test whether negative attributional styles influence WM processing, the Stoking Of Cambridge task (SOC) (assessing inhibition and planning), the Intra-Extra Dimensional Set Shifting task (IED set-shifting task: assessing switching and inhibition) and the Spatial Working Memory task (SWM: assessing visuospatial storage) were utilised [15]. These measures were chosen to demonstrate the influence of negative attributions on the different components and functions of WM, *i.e.* executive functions and the visuospatial sketchpad. To further investigate the association between negative attributional style and CES functions, we selected IED set-shifting and SOC tasks based on the study of Miyake *et al*. (2000), who provided a highly detailed description of how to assess CES functions. We selected the SWM task to measure the visuospatial sketchpad instead of the phonological loop because we preferred to be consistent by using visual tasks. It should be noted that, at present, it is not possible to measure one's functions using purely heterogeneous WM tasks because most tasks involve multiple aspects of WM due to the homogeneity of functions in tasks [14, 15]; however, the magnitude of a function can be considerably greater in WM tasks [14, 15]. Therefore, each task was predominately associated with a different aspect of WM. Taken together, the first aim of the current study was to determine whether negative attributions really impaired WM performance. The second aim was to explore the influence of negative attributions in more detail to see whether negative attributions were indeed associated with impairment in every WM component.

In conclusion, research on the detrimental effects of negative attributional style in relation to WM is limited and somewhat inconclusive. For example, while it has been shown that people with higher negative attributions encounter interference in one study [5], in another study this result could not be confirmed [7]. Importantly, the behavioural correlations of negative attributional style in relation to the different components of WM (*i.e.* executive functions and storage systems) is still unknown. Therefore, the broad aim of the current study is to investigate an association between negative attributional style and WM processing by using three standard and well-validated WM tasks.

2.. METHODS

2.1. Participants

One hundred students were recruited from Brunel University, London. Based on the questionnaires, the following exclusion criteria were employed: presence of any past or current major medical, neurological or psychiatric illness that might have diminished cognitive functioning; use of psychoactive medication; consumption of alcohol; consumption of ≥8 cups or ≥ 900mg of caffeine; a score of over 15 in the Beck Depression Inventory (BDI) [18]; and colour blindness [31]. Thus, seven participants were excluded due to their reports of current or previous depression or anxiety disorders or current psychiatric or neurological disorders. Moreover, two participants were excluded based on their caffeine and alcohol questionnaire. Finally, 91 participants (44 female, 47 male, *i.e.* genders were matched as 48% female and 52% male) aged 18 to 56 (M = 22.54 years, SD = 6.20) took part in the behavioural experiments. All the participants were right-handed, as assessed by the Edinburgh Inventory [32], and had normal or corrected to normal vision. Before participation, each participant gave written informed consent. The participants were paid £10 for their participation in the study, which lasted for approximately one hour. The study was approved by the Department of Life Sciences Ethics Committee at Brunel University.

2.2. Materials

2.2.1. Questionnaires

The ASQ (Seligman, 1984) includes twelve hypothetical events, of which six are positive and six are negative; these were used to determine negative attributional style in all participants through the three dimensions of internality, stability and globality. While internality measures the cause as internal or external, stability indicates whether the cause is perceived to be transient or permanent. Lastly, globality refers to the extent of the cause and whether this affects other parts of the individual's life. In the test administration, first, participants were asked to read and then imagine these scenarios given in the ASQ happening to them. Second, they were asked to write down the major cause for the hypothetical event. Third, they were asked to rate the cause of these events along a 7-point continuum scale (from 1 to 7) for each of the three causal dimensions. Overall, the three dimensions' (*i.e.* internal, stable and global) composite scores were the two components of positive and negative attributional style; negative and positive scores ranged from three (low) to 21 (high), thus referring to the intensity and greatness of the negative or positive attribution. In the current research, we used negative attributional style as the independent variable.

In addition, the BDI [18] was used to prevent the potential confounding effects of depression so that participants who scored 15 or over were eliminated. To exclude participants with a history of psychiatric or neurological illness, a self-designed questionnaire was used. Also, an alcohol and caffeine consumption survey was used to exclude the possible effects of alcohol and caffeine. The Ishihara Colour Blindness Test [32] was used to confirm that participants were not colour blind.

2.2.2. Cognitive Tasks: Cambridge Neuropsychological Test Automated Battery (CANTAB)

The Cambridge Neuropsychological Test Automated Battery (CANTAB; Cambridge Cognition, Cambridge, UK) is a system widely applied in neuropsychiatry, neuropsychology and psychopharmacology to investigate cognitive correlations. The test Administration Guide (Cambridge Cognition, Cambridge, UK) was used to adapt all test descriptions. The current study included three CANTAB (www.cambridgecognition.com/cantab) tasks: (a) Stoking of Cambridge (SOC), (b) the Spatial Working Memory task (SWM); (c) the Intra-Extra Dimensional Shift task (IED). The administered tasks are described briefly below.

2.3. Stoking of Cambridge (SOC)

The SOC task performance is associated with the spatial planning function [33]. In this task, two configurations are placed on top of each other (Fig. **1**). Each configuration consisted of three coloured balls. The participants were asked to replicate the top configuration in the bottom section by moving the coloured balls into the correct location; in other words, they must make the bottom configuration match the top one. Thus, the participants were to select a ball and then move it to the correct location. There were limited moves available to complete the configuration. In the easiest task, participants were required to copy the configuration using two moves. Gradually, the tasks difficulty increased from two to five moves. In this study, the outcome measures (dependent variables) were the time spent completing the tasks for each SOC, which were two, three, four and five moves SOC tasks.

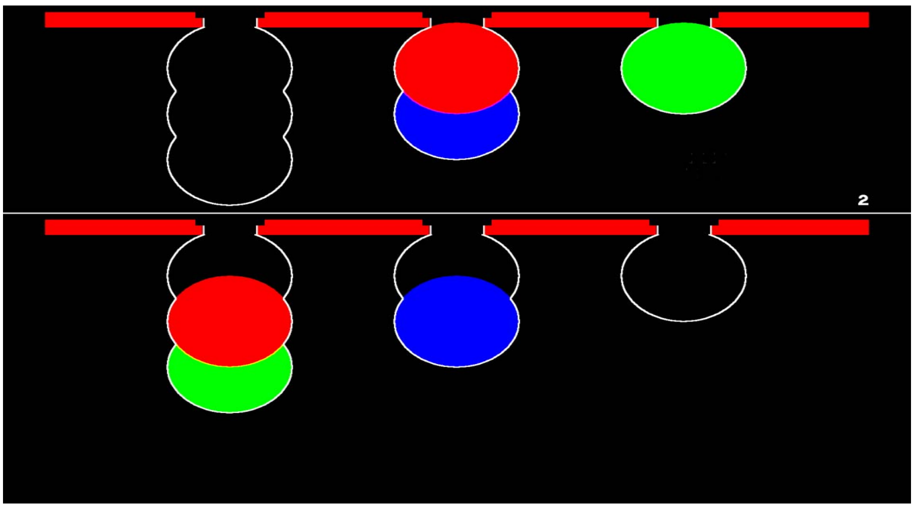

Fig. (1). Shows an example of the SOC task with two moves. The top pattern must be copied in the bottom pattern. Thus, the participant moves the red ball into the empty location in the middle just above the blue ball. Next, they must move green ball into the empty location on the right (the figure is retrieved from CANTAB website: http://www.cambridgecognition.com/ cantab/cognitive-tests/ stockings-of-cambridge-soc/).

2.4. Spatial Working Memory Task (SWM)

An SWM task was used to measure a key storage component of WM: the visuospatial sketchpad. In this self-ordered searching task [33, 34], a number of yellow boxes were presented on a computer screen; these consisted of a hidden blue token in a spatial array beside an empty column. Participants were required to search for the blue hidden tokens by touching yellow boxes (Fig. **2**). They were informed when they found a token in a box, as each box only contained one token. When participants found a token, they must to put it in the column on the right-hand side of the screen by touching that place. All boxes then changed back to yellow and thus participants began another search. Participants did not get any feedback during the task performance. Task difficulty increased as the number of searching boxes increased. In other words, participants started searching for hidden tokens in four boxes, then they progressed to six and subsequently eight boxes. In this study, the outcome measures (dependent variables) were the error rates at each level of difficulty (*i.e.* the error rates for four, six and eight boxes) and the average of the total errors throughout the task performance. Also, we included SWM strategy as one more dependent variable to find out any potential relationship between participants attributional style scores and strategy of task accomplishment.

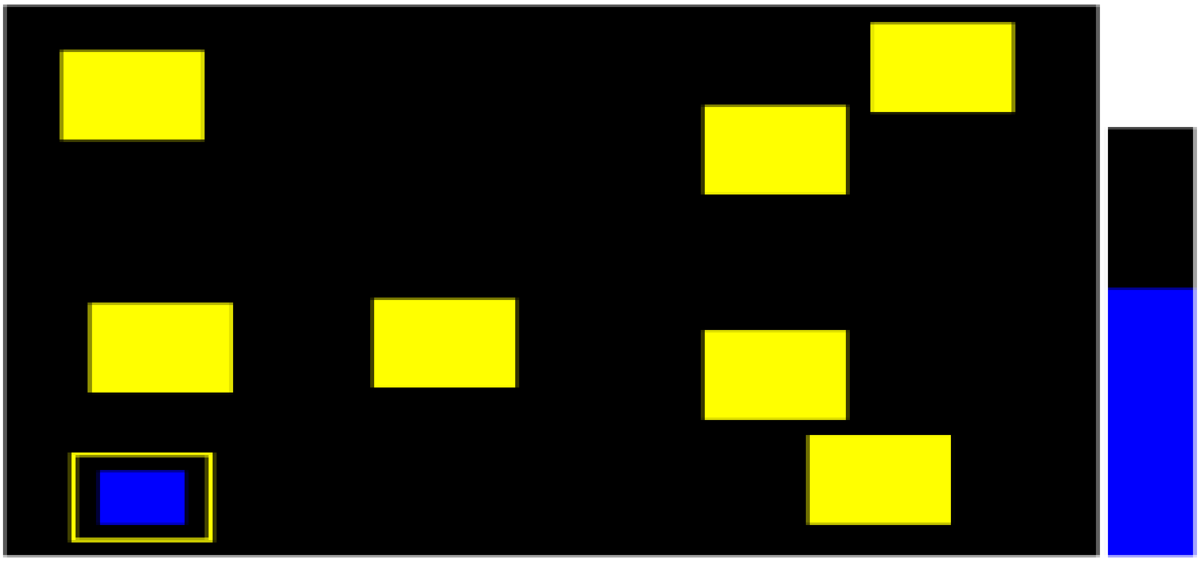

Fig. (2). An example of an SWM task with 8 boxes. The blue token in the left bottom is the target. Participants look for blue tokens by touching yellow boxes. When they find a blue token, they should move it in the column on the right side. Then all tokens become yellow again and they should start for another search again. (the figure is retrieved from CANTAB website: http://www.cambridgecognition.com/cantab/cognitive-tests/memory/spatial-working-memory).

2.5. Intra-Extra Dimensional Shift task (IED)

IED is an attentional set-shifting task (a computerised version of the Wisconsin Card Sorting Test) that is associated with switching and inhibition functions [33, 35]. In the IED task, two compounded figures were presented on a computer screen; one was a coloured shape and one was made up of lines (Fig. **3**). Participants were required to act based on two rules of intra and extradimensional shifts; in the intra dimensional shifts, participants were presented a single figure, which was either a line or a shape, and had to determine rule changes based on this. On the other hand, in the extra-dimensional shift two stimuli, *i.e.* lines and shapes, were compounded; participants had to ignore shapes and respond solely based on lines or *vice versa* [33]. Moreover, the participants were required to touch the compounded figure to learn which rule they had to follow. Feedback (a high auditory tone for giving the correct response and a low one for giving the incorrect response) was heard by participants after each response. Once participants learned to follow a rule, it changed after six correct responses. In this case, participants were required to learn the new rule and correctly respond to the task [33]. In this study, the task had two outcome measures (dependent variables) as follows: 'stages completed', which refers to the successful completion of one of the set tasks (*i.e.* making six correct responses either in the intra or extra-dimensional rules). 'Total errors' refers to the total number of errors made in the trials throughout the task [33].

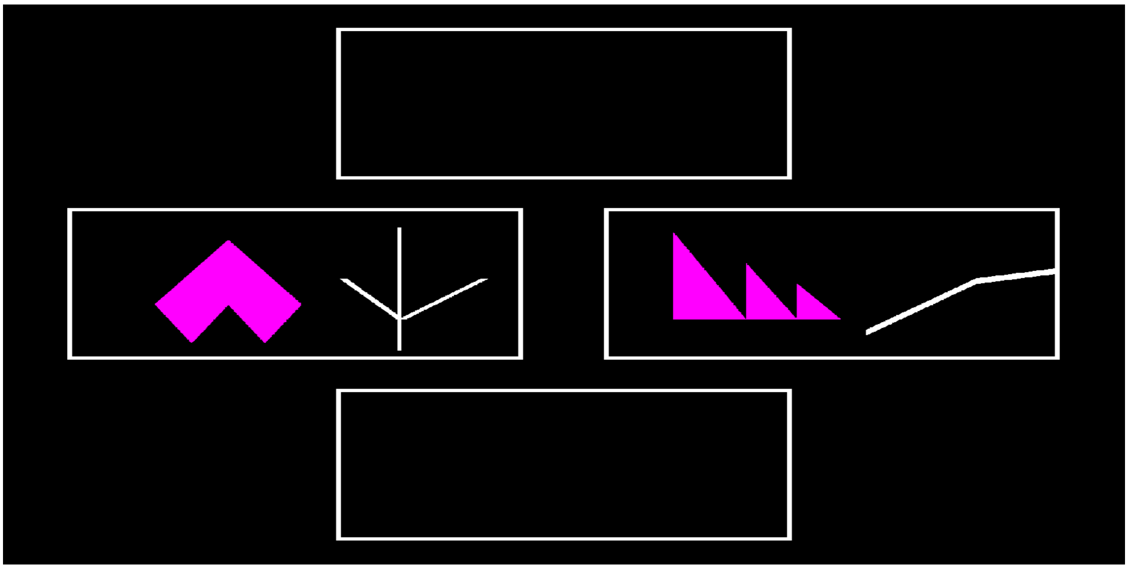

Fig. (3). Shows an example of the IED set-shifting task. (the figure is retrieved from CANTAB website: http://www.cambridgecognition.com/cantab/cognitive-tests/intra-extra-dimensional-set-shift-ied/).

2.6. Procedure

The study consisted of two stages. In the first stage, participants were given time to read and sign their informed consent forms and subsequently filled in the questionnaires, including the ASQ (see materials section 2.2). Eligible participants were selected based on the exclusion criteria detailed in the participants section (see participants section 2.1). In the second stage, the participants were seated in front of the CANTAB computer (Model PP-120-RT) with a 10 ½ inch touch-screen monitor. The SOC, SWM and IED tasks were then presented to the participants. The CANTAB tasks started with a practice session to introduce each task and eliminate any sensorimotor or comprehension difficulties that may have restricted the collection of valid data from the participants. After the participants completed the practice session, the study session commenced. The participants were verbally instructed using a script; additionally, the experimenter gave a demonstration of some of the tasks. If the participants were not clear on how to proceed, appropriate instructions were given. To eliminate the order effect, the CANTAB tasks were counterbalanced. Finally, on completion of all the tasks, a debriefing form was issued.

3. RESULTS

Negative attributional style scores among the participants ranged from 6.17 (min) to 18.33 (max) with mean 12.21 and SD 2.02 and Positive attributional style scores ranged from 11 (min) to 21 (max) with a mean of 15.17 and SD 2.21. Preliminary analyses showed that there is a violation of the assumption of normality and linearity, [kurtosis and skewness> 1 for some l variables e.g. SOC, SWM outcome measures]. Therefore, these data have been transformed by using log which normalized the data. In the final case, the analyses showed that there is no violation of assumption of normality and linearity, [-1 < kurtosis and skewness for all variables> 1; collinearity statistics VIF< 10 and CI> 30; Durbin Watson< 2].

To examine the association between negative attributional style and WM performance, first of all, we presented Pearson correlations coefficients to show correlations among the variables. Subsequently, for significant correlations, we performed multivariate regression analyses as we have one independent variable and multiple dependent variables for each task to find out predicted variances by negative attributional style.

To examine the Table **1**, it can be observed that negative and positive attributional styles are negatively correlated but this correlation did not reach a significant level. Moreover, while positive attributional style did not significantly correlate with WM task variables, negative attributional style and SWM task performance shows that negative attributional style positively correlated with error rates in 6 ($r= .225$, $p< .01$) and 8 searching boxes ($r= .423$, $p< .01$) and total number of errors ($r= .241$, $p< .01$) in SWM task. However, the correlation between negative attributional and SWM 4 boxes and SWM strategy did not reach significant threshold. Negative attributional style did not correlate with the IED set-shifting task and SOC tasks variables. In addition, Table **1**. shows within each task, the variables within a task significantly correlated each other, however, between WM tasks there was no significant correlation all p>.05.

Table 1. Pearson product moment correlation coefficients between variables.

–	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Negative attributional Style (1)		-.152	.080	.225*	.423**	.241*	.044	.097	.159	.062	.010	.155	-.122	-.016
Positive attributional Style (2)		–	.140	.203	.120	.060	.060	.078	.137	.033	-.161	-.041	.047	.062
SWM 4 b. (3)		–	–	-.002	.276**	.105	.009	-.083	-.021	-.138	-.014	.056	-.080	-.030
SWM 6 b. (4)		–	–	–	.296**	.235*	.181	-.055	.049	-.049	-.144	-.077	.021	.054
SWM 8 b. (5)		–	–	–	–	.411**	.166	.020	.198	.069	-.060	.134	-.077	-.029
SWM total errors (6)		–	–	–	–	–	.454**	.125	.122	-.122	-.196	-.152	.190	.155
SWM strategy (7)		–	–	–	–	–	–	.043	-.021	-.104	-.323**	-.246*	.200	.229*
SOC 2 m (8)		–	–	–	–	–	–	–	.488**	.402**	.068	.067	.111	.120
SOC 3 m (9)		–	–	–	–	–	–	–	–	.637**	.363**	.052	.049	.088
SOC 4 m (10)		–	–	–	–	–	–	–	–	–	.644**	.285**	-.134	-.142
SOC 5 m (11)		–	–	–	–	–	–	–	–	–	–	.405**	-.183	-.241*
IED stages completed (12)		–	–	–	–	–	–	–	–	–	–	–	-.650**	-.683**
IED total trials (13)		–	–	–	–	–	–	–	–	–	–	–	–	.923**
IED total Errors (14)		–	–	–	–	–	–	–	–	–	–	–	–	–
Participants N 90 *. Correlation is significant at the 0.05 level (2-tailed).														
**. Correlation is significant at the 0.01 level (2-tailed).														

To examine predicted variances by negative attributional style in SWM task which have been shown with significant correlations, we used multivariate regression in the general linear model because we have one dependent variable (Negative attributional style) and multiple independent variables (SWM variables). Preliminary analyses were performed to ensure there is no violation of assumption of normality and linearity.

Multivariate regression in the general linear model was calculated to predict participants WM performance-based upon their negative attributional scores. Table **2** shows beta values for each variable in linear regression analyses. The strongest beta value has been observed for SWM 8 boxes and then for SWM total errors and SWM 6 boxes respectively. It is known that beta values indicate the strength of contribution in the regression models. In line with that, further results showed significant regression equations between negative attributional scores and SWM task variables which are mainly associated with visuospatial sketchpad storage of WM. In more detail, a significant regression equation was found for SWM 6 boxes [F (1, 90) = 6.37, p=.013 with an R^2 of .067]; SWM 8 boxes [F (1, 90) = 24.87, p=.000 with an R^2 of .218.] and SWM total errors [F (1, 90) = 7.62, p=.007 with an R^2 of .079]. However, the results regarding SWM 4 boxes and SWM strategy did not reach significant threshold p> .05. The results indicated negative attributional style accounted for 6.7% in errors of SWM six boxes, 21.8% of the explained variability in errors of SWM eight boxes and 7.9% in SWM total errors.

Table 2. Shows beta values and t statistics for SWM 6, 8 boxes, total errors and SOC 3 move.

Model	Beta	t	Sig.
SWM 6 boxes	.227	2.201	.030
SWM 8 boxes	.401	4.127	.000
SWM total errors	.241	2.338	.022

4. DISCUSSION

The results showed that negative attributional style associated with impairments in SWM tasks performance as evident by the positive association between negative attributional style and higher error rates in 6, 8 and total errors. However, it has been found that negative attributional style did not associate with SOC tasks performance and IED set shifting tasks. Also, there was a negative correlation between negative and positive attributional style, however this relationship did not reach significant threshold. The other results showed significant association neither between positive attributional and WM task performance nor between WM tasks.

The primary aim of the present study was to test whether negative attributional style leads lower WM tasks performance which associated with different functions of WM. For instance, while some of the empirical research suggest that negative attributions impair cognitive tasks performance [4, 5], others have found no correlation between negative attribution and cognitive tasks performance [7, 29, 36]. The main limitation of these reported studies was that they often investigative negative attributions by employing only one cognitive task *i.e*. either vigilance task [29] or n back task [5] which prevent understanding of the detrimental effect of negative attributional style on all components of WM. Therefore, in the present study, negative attributions were investigated on a broader level by the selection of three different WM tasks, each associated with a different function of WM. The results showed that negative attributions may contribute to impairment in WM performance. However, the task impairment could be explained by negative attributions only on SWM task performance.

It seems that negative attributional style may impair performance during SWM tasks which are purely associated with visuospatial working memory because the impairment in SWM task could be explained to some degree (6.7% to 21.8%) as evident by significant regression equations in 6, 8 boxes and total average of errors in SWM task. In more detail, task impairment increased as difficulty increased (*i.e*. from 4 boxes to 6 and then 8 boxes) in WM tasks. Similar patterns of these results have been found previously in patients with anxiety [37] depression [38] and schizophrenia [39] during processing of various SWM tasks. Generally, it has been suggested that stress-related anxiety with such subjects increases task-irrelevant activities which disrupt SWM function [37]. Previously, it has been indicated that negative attributional style is associated with stress and is a pivotal precipitating factor for such psychological disorders [19, 23]. Therefore, these results indicate that individuals with negative attributional style may be inclined to similar cognitive deficits with those psychological disorders.

The impairment in SWM tasks seems to be related impairment in a visuospatial sketchpad. The reason for that is that negative attributional style found to contribute impairment in errors rates which related to finding visuospatial locations of boxes on the screen. As participants with negative ASQ found to be stressful individuals, such patterns of results have been explained by inverted U curve model in the studies related to stress and performance [26, 40]. Based on the inverted U curve, if the task is very easy, individuals with high and low-stress level may perform similarly [26, 27, 40]. The reason for that is if the task is easy, the arousal level may not reach the threshold level even in stressful individuals [26, 27, 40]. However, if the task becomes difficult, while stress level exceeds a critical threshold in stressful people, it remains below the critical threshold in people with low-stress level [26, 27, 40]. This argument is well fitted for SWM tasks results because while negative attributional style did associate with relatively difficult tasks *i.e*. SWM 6 boxes, SWM 8 boxes, it did not associate with the easiest SWM task *i.e*. SWM 4 boxes performance.

It should be noted that there was no significant association between SWM strategy which somehow may link to central executive functions because people may use different strategies (*i.e*. Top-down or bottom-up) to achieve a goal during task performance [33]. These strategies are related to attention regulation and involves in central executive functions [34]. Current results indicate that negative attributional style did not influence on participants strategy on SWM tasks. Thus, in terms of SWM tasks, the impairments seem to be due to visuospatial sketchpad but not executive functions.

Although we are not able to point out exactly why negative attributional style is associated with impairment in visuospatial sketchpad, there are few studies suggest that anxiety-related traits may selectively impair visuospatial sketchpad due to rehearsal process in inner scribe. The reason is that visuospatial sketchpad storage has been divided into two components, which are the visual cache and inner scribe [10, 11]. While the visual cache is associated with storing information as a passive component, the inner scribe is rather a dynamic component and it deals with the retrieval and rehearsal of information [10, 11]. For instance, when a visuospatial stimulus is demonstrated, it is maintained in the visual cache and refreshed by rehearsal processes. If not refreshed by the inner scribe, the information decays in a few seconds. Therefore, during this retrieval and rehearsal of visuospatial information, task-unrelated activities (*i.e*. anxiety related activities) overlap rehearsal processes (task-related activities) so that limited resources of attention are shared between these activities [41, 42]. In this context, negative attributional may selectively impair function of visuospatial sketchpad because negative attributional style is closely linked to anxiety.

The second aim of the study was to explore whether negative attributional style contributes to task impairment in all WM task. The results regarding the SOC (measures inhibition and planning functions) and IED set-shifting task (measures switching and inhibition functions) showed that negative attributional style does not associate with these tasks performance. IED set-shifting task is a computerized version of WCST and used as one of the most common measures of switching and inhibition functions because task the participants were required to switch their attention from one rule to another [15, 33, 35]. To do that, they were also required to inhibit previous task-relevant information, which had become task-irrelevant information [13, 33, 35]. These two functions are commonly assessed as main functions of

CES [14, 15, 27]. Also, SOC task is a computerized version of Tower Of Hanoi (TOH) and it is generally supposed to measure inhibition tasks. However, some researchers suggest that SOC may involve in planning functions in difficult stages of the tasks because the magnitude of the evaluation and selection of a sequence of actions become greater in difficult SOC tasks *i.e*. SOC 5 moves. It is known both inhibition and planning are functions of the central executive system. Therefore, the current results showed that negative attributional style may not have a significant influence on CES functions in SOC and IED set shifting tasks.

To summarize above paragraphs, it is proposed that negative attributional style contributes to impairments in WM task processing, but this impairment could not be generalized to all WM tasks. The significant impairments may be associated with VSSP component of WM rather than with main functions of CES *i.e.* switching and inhibition. The reason for that is that higher stress in people with negative attributional style may lead to cognitive deficits, particularly in VSSP.

CONCLUSION

In conclusion, the current experimental results indicate that negative attributional style contributes to task impairment when the task associates VSSP components of WM. On the other hand, when the task associates main functions of CES, the negative attributional style has no influence on the task performance. Because the studies regarding the effect of negative attributional style on cognitive processing are rare, it is important that future studies focus on this aspect. Particularly, future research should focus on the reasons behind such impairment specifically in visuospatial sketchpad because although we have shown that negative attributional style contributes to impairments in this storage component, it is still unknown why negative attributions particularly impair this system. Thus, they could draw more strong conceptualization in relation to cognitive deficits in people with high negative attributional style.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Department of Life Sciences Ethics Committee at Brunel University.

HUMAN AND ANIMAL RIGHTS

No Animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Each participant gave written informed consent.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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