# Effect of eye movement on memorization of threat words

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## Background

Human information processing is explained as the following: it begins with stimuli, sensory memory, attention bias, working memory and memory bias, then it ends in the long term memory. Cognitive bias is composed of attention and memory biases. Information processing depends on the size of the working memory. Previous studies showed attention bias is observed with anxious people (Cisler & Koster, 2009), and memory bias is observed with depressive people (Hamman, 2001). Also, regarding relationship between PTSD and information processing, Zeitlin & McNally (1991) reported that cognitive resource was used to process the threatening information and due to attention bias which avoids processing, attention to information was defective, and it leads to memory bias, which tends to recall more threatening stimuli. Hayes et al. (2012) insisted that defectiveness of attention and memory with PTSD clients are related with changes of functional brain activity. Bomyea et al. (2017) mentioned that attention process is abnormal to threatening stimuli, but it may depend on the task and summarized that the clients recalled more trauma related or negative memories if they are explicit memories. Wouds et al. (2017) reviewed that PTSD patients showed memory bias in explicit memory.

EMDR (Eye Movement Desensitization and Reprocessing) was introduced in 1989 by Francine Shapiro, who was American clinical psychologist. This method was recommended by various nations or organizations to treat PTSD. The mechanisms of eye movement used in EMDR are in the stage of assumption, including working memory, interhemispheric interaction and exploratory response hypotheses.

Working memory hypothesis explains that dual tasks, which are composed of adding external stimuli during holding memory, interferes with functions of holding and operating memories, and it leads to decreasing vividness of images and intensity of emotions (Andrade, 1997). On the other hand, inter-hemispheric interaction hypothesis explained that blood flow of both left and right- hemisphere increased, and information transferring between hemispheres can make recalling precise memories possible (Christman, et al., 2003) such as saccadic bilateral movement increase preciseness of information, recalling older memories and more interference of emotional stroop task.

Khoury-Malhame et al.(2011) investigated attention bias at pre- and post- EMDR intervention using emotional stroop task and dot probe task with 19 PTSD patients. They improved to the same level as non-diagnosed control group. Morita and Ichii (2003) measured the size of the working memory by number assignment at pre- and post-EMDR intervention and the results showed significant improvement. Therefore, the number of research investigating changes of cognitive bias or working memory by intervention of EMDR is limited, and I could not find any research, which investigate the information processing during eye movement.

The purpose of the current study is to investigate: (1) that compared with eye fixed condition, eye movement decreased the performance, (2) that memory bias can be observed in depression, anxiety, and trauma of analogue population in the procedure of presenting target words during eye movement, (3) that memory bias can be decreased by eye movement (EM). Dependent variable for hypothesis #1 is total recalled words, and for hypothesis #2 and #3 ratio of the amount of threat words to the amount of all recalled words. The hypotheses #1 and #3 are based on working memory hypothesis. These three hypothesis were based on working memory model.

## Method

**Participants**: Participants are thirty-four undergraduate and graduate students (28 females, 6 males; Mean=28.5 year old, SD=10.88 ).
**Materials**: Ten threat words and 22 neutral words were randomly selected based on emotional value evaluated by Kanai (2003). (Table 1)
**Procedure**: Experiment was administered individually. After they entered the experimental room, they filled the form of the BDI, the STAI-S, the STAI-T, and the IES-R. For the IES-R, we asked them to choose one event which "may affect you and took place more than a month ago". Each participant experienced both EF and horizontal EM conditions. Order was counter balanced. Between two conditions, successive subtracting three from 1,000 for 90 sec. was assigned. Fixed circle in center or horizontal movement circle on display was presented to them (distance 50cm). (Fig.1, Fig.2) They were asked to memorize words, which included neutral (11 words) and threat words (5 words). The words were presented in the circle for 1,000ms between 2,500-7,500ms randomly intervaled. Finally they were asked to write down the memorized words.

Table 1 Stimulus words

| Threat Words | | Neutral Words | | | | |
|---|---|---|---|---|---|---|
| Murder | Annoyance | Wage | Unconcerned | Music | Mail | Display |
| Regret | Lost love | Metal | Hometown | Integer | Industry | Science |
| Robbery | Criticize | Name list | Marketing | Relatives | Sleep | |
| Disaster | Recession | Price | Detergent | Material | Taste | |
| Abuse | Bankruptcy | Number | Barley tea | Cooking | Question | |

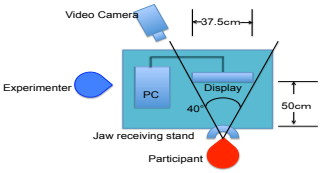


Fig.1 Setting of Experimental Room

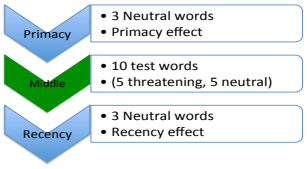


Fig 3. Presented words sequence

Table 2 Descriptive Statistics

| | Mean | SD |
|---|---|---|
| BDI | 5.26 | 3.11 |
| STAI-Trait | 44.2 | 9.80 |
| STAI-State | 41.24 | 7.32 |
| IES-R | 15.47 | 9.61 |

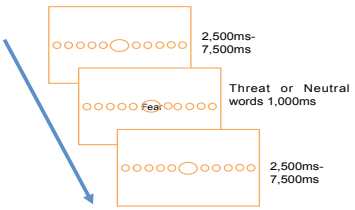


Fig. 2 Sequence of Presentation of Circle and Words

Table 3 Corelation coefficient among 4 variables

| | BDI | STAI-S | STAI-T |
|---|---|---|---|
| STAI-S | .484** | | |
| STAI-T | .583** | .442** | |
| IES-R | .003 | .135 | .065 |

**p<.011

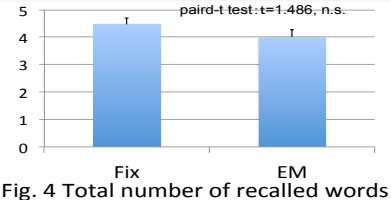


Fig. 4 Total number of recalled words

Table 4 Extracting High and Low group

- BDI, STAI-T, STAI-S, IES-R
- Low group < Mean-0.5SD
- High group>Mean+0.5SD

| | Low group | | | High group | | | Difference |
|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | p value |
| BDI | 11 | 2.36 | 0.67 | 12 | 9.00 | 2.32 | p<.001 |
| STAI-T | 11 | 32.64 | 5.03 | 12 | 54.33 | 3.34 | p<.001 |
| STAI-S | 12 | 33.33 | 4.12 | 11 | 49.00 | 3.85 | p<.001 |
| IES-R | 14 | 7.00 | 2.29 | 9 | 28.00 | 7.63 | p<.001 |

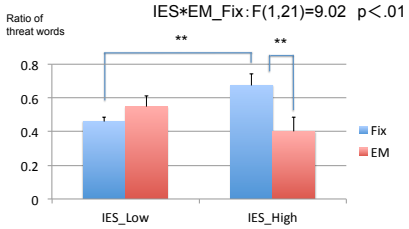


Fig. 5 Effect of EM on Threatening words ration in high vs low IES-R groups

## Result

In order to avoid the primacy and recency effects, we only count the correct answers from middle ten words (Fig. 3).

Statistical analysis are conducted: paired t-test (EF-EM) in hypothesis #1, and t-test (high and low anxious, depressed, or traumatized group) in fixed condition in hypothesis #2, and mixed design of one within (EF-EM) and one between (high and low anxious, depressed, or traumatized group) in hypothesis #3. Dependent variables are the amount of total recalled words for hypothesis #1 and the ratio of amount of recalled threatening words in the total recalled words for both hypothesis #2 and #3.

Table 2 showed descriptive statistics of 4 questionnaires and Table 3 showed correlation coefficient among 4 variables. The IES-R score does not seem to be related with other scores.

For hypothesis #1, we compared total recalled words amount between EF and EM conditions. (Fig. 4) Paired-t test results did not show any significant differences (t=1.468, n.s.). Hypothesis #1 was not supported.

In order to make clear group differences, based on the BDI, the STAI-State, the STAI-Trait, and the IES-R score, they were divided into high (>mean + 0.5SD) and low (<mean – 0.5SD) groups for hypothesis #2 and #3. Table 4 showed mean scores and SD of each groups.

We could not find any memory bias regarding the BDI, the STAI-State, the STAI-Trait variables in the EF condition. However, the ratio of number of recalled threatening words in the total recalled words showed significant difference between the IES-R high and the low group in the eye fixed condition. Trauma could be the promising variable for detecting cognitive bias. Hypothesis #2 was supported only in the IES-R.

Regarding IES-R for which hypothesis #2 was supported, interaction between the IES-R and EM interaction was statistically significant (Fig.5). Compared with the IES-R low group, the high group showed a significantly higher ratio in eye fixed condition. Also the ratio was significantly low in the high IES-R group in the eye movement condition. Hypothesis #3 was not supported. This may indicate that the eye movement does not only taxes cognitively, but also facilitates processing emotional aspects of stimuli.

## Discussion

Hypothesis #1 was not supported. EM may not only tax cognitively, but also facilitate processing information. Therefore, working memory model is not enough to explain the result. If you use inter-hemispheric interaction model simultaneously, the result can be explained better.

Hypothesis #2 was supported only in the people with high score of trauma. Characteristics of threatening words may not reflect depression or anxiety. The effect of trauma on memory bias should be investigated further. Furthermore, to fill out IES-R, participants recalled the traumatic event just before the experimental task. This may affect the result.

Hypothesis #3 was not supported. The interaction between IES-R groups and EM is statistically significant. Memory bias was not observed when adding EM in traumatized people. EM may not only tax cognitively, but also facilitate processing information, which is suggested in hypothesis #1. In order to explain the phenomenon, necessity of inter-hemispheric interaction hypothesis should be considered.

In some studies of CBT, it is reported that exposure with distraction is more effective compared with exposure only (Johnstone & Page, 2004; Oliver & page, 2008; Penfold & Page, 1999). In EMDR therapy, we expose client to negative imagery with distraction, which is led by EM (Leeds, 2016).

Also, Lee et al. (2006) suggested that eye movement can create the distancing effect from the negative imagery, which is related with therapeutic improvement. Moreover, some researchers suggested mindfulness is an aspect of EMDR mechanism. Leeds (2016) insisted that flow of assessment, instructions: metaphor of train, and attitude of observer without judgment, leads to mindfulness state. Leeds (2016) insisted that brain change (normalization of activity both the anterior cingulate gyrus and left frontal lobe) was lead by EMDR, that is "essential to improved attentional flexibility and mindful noticing (p.35)" citing Levin et al. (1999). We found this flexibility is caused during bilateral eye movement, not as result of EMDR procedure. Eye movement can be considered as very unique stimuli for our cognitive processing. This makes clients tolerate facing traumatic imagery.

Eye movement seems to have various roles, taxing cognitively, facilitating processing, distracting, distancing from the information, and leading mindfulness state. We should be careful investigating characteristics of eye movement from viewpoint of clinical benefit.

There are some limits and future issues of the current study. We did not measure the characteristics of words, even though we measure emotional value. The threatening words should be chosen by measuring valence of words along with depression, anxiety or trauma. The current study focused on cognitive measures. Physiological measures including brain activity may bring wide range of findings.

The type of participants is relatively normal even though they were high scoring group. Clinical population should be used as participants for generalizing the result.