

Original article / Araştırma**Neural correlates of dispositional pessimism and optimism on dual-task performance**Rahmi SAYLIK¹**ABSTRACT**

Objective: Behavioral studies found that dispositional pessimism (DP) impairs cognitive task performance (i.e. dual task) such as in dual task processing as compared to dispositional optimism (DO). However, neuroanatomical correlates of these performance decrements are still unknown. Therefore, the current study aims at investigating neural correlates of pessimism and optimism on dual task performance. **Methods:** To test for this, two hundred participants were screened to create extreme groups of DP (i.e. 10 participants) and DO (11 participants) based on Life Orientation Test (LOT). The participants performed auditory and visual single tasks and dual tasks while their brain activity by means of functional magnetic resonance imaging (fMRI) was recorded. **Results:** Behavioral results showed that the groups have similar performance on single task performance whereas DP group slowed down on dual task performance as compared to DO group. Imaging results showed that DP group showed less dual task specific activations in inferior parietal and occipital cortices particularly in posterior cingulate gyrus, extending into precuneus and cuneus. **Discussion:** It has been concluded that DP impairs cognitive processing on dual task performance and this impairment accompanied by reduced activation in parietal and occipital cortices as compared to DO. (*Anatolian Journal of Psychiatry* 2018; 19(6):545-550)

Keywords: pessimism, optimism, dual task, multitasking, fMRI, brain, executive functions

Bilişsel ikili görev testinde karamsarlık ve iyimserliğin nöroanatomik ilişkileri**ÖZ**

Amaç: Bilişsel psikoloji alanında yapılan davranışsal çalışmalar, karamsarlık eğiliminin iyimserlik eğilimine göre bilişsel testlerin uygulanması sırasında daha düşük performansa neden olduğunu göstermiştir. Bu düşük performansın nöroanatomik ilişkileri henüz bilinmemektedir. Bu çalışmanın amacı ikili görev testinde karamsarlık ve iyimserliğin nöroanatomik ilişkilerini incelemektir. **Yöntem:** Bunu test etmek için, 200 katılımcı Yaşama Uyum Testi kullanılarak tarama yöntemiyle yüksek düzeyde 10 karamsar ve 11 iyimser katılımcı seçildi. Bu katılımcıların beyin aktivasyonları incelenerek MRI içinde tekli ve çoklu görevler içeren testler uygulandı. **Sonuçlar:** Davranışsal sonuçlar karamsar katılımcıların iyimser olanlara göre ikili görev testinde daha yavaş olduklarını gösterdi. MRI, karamsar katılımcılarda iyimser olanlara göre pariyetal ve oksipital kortekslerde, posterior singulat girustan başlayıp prekuneus ve kuneusa kadar uzanan daha düşük aktivasyonlar gösterdi. **Tartışma:** Tartışmada karamsarlığın iyimserliğe göre bilişsel performans düşüklüğüne neden olduğu ve bu bilişsel düşüklüğün pariyetal ve oksipital alanlarda daha düşük aktivasyonlara eşlik ettiği değerlendirildi. (*Anadolu Psikiyatri Derg* 2018; 19(6):545-550)

Anahtar sözcükler: Karamsarlık, iyimserlik, ikili görev, çoklu görev, fMRI, beyin, yürütücü işlevler

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INTRODUCTION

Dispositional pessimism (DP) refers to evaluation of events and future expectation pervasively and permanently in a negative manner so that it is involved in lower psychological adjustment that is a route to poorer outcomes.^{1,2} On the contrary, dispositional optimism (DO) is associated with interpretation of events and future expectations in a positive manner so that it is rather involved in better psychological adjustments.^{1,2}

Pessimistic and optimistic interpretations of events influence feelings and behaviors which may lead differences in cognitive processing.¹ For instance, it has been suggested that DO is associated with proactive control,¹ which is involved in sustained representation of cognitive task relevant goals and increased activations in cognitive control regions.³ Conversely, pessimism is associated with reactive control¹ which is involved in transient representations of stimulus related activities and decreased activations in cognitive control regions due to disruption of negative affects related activities during task processing.³ In line with that, previous behavioral studies have found that DP leads performance decrements on working memory tasks (i.e. dual tasks, N-back tasks).^{2,4} While DP and DO related differences about behavioral findings are well understood, the information about their functional neuroanatomical correlates is sparse. More generally, it has been shown that while DO is associated with increased activations in parietal-occipital areas (i.e. precuneus, cuneus, posterior cingulate cortex-PCC (BA23)),⁵ pessimism is more associated with increased activations in emotion related regions (i.e. amygdala, rostral anterior cingulate cortex (rACC), thalamus) during presentation of negative emotional stimuli and resting state.⁶ The parietal areas such as PCC, cuneus and precuneus have often been associated with executive functions as well during processing of working memory (WM) tasks such as in dual tasks,^{7,8} switching tasks.⁹

Since DP and DO related differences have been reported rather in emotion tasks,^{1,5,10} the current study assessed two groups of healthy volunteers (i.e. DP and DO groups) with fMRI during the processing of dual tasks which is associated with executive functions.⁷ The tasks consist of two single tasks (auditory and visual) and simultaneous presentation of these single tasks in the form of dual tasks.¹¹ The hypothesis to be tested is that DP will associates with decreased activations as compared to DO on dual task pro-

cessing in cognitive control regions. The reason for that is DP is more likely to associate with strong emotional activations, which may disrupt focus of attention and lead to decreased activations on dual task related regions.

METHODS

Participants

Two hundred fifty participants were screened by using 10 item Life Orientation Test (LOT)¹² to create groups of high in DP and DO. Among those screened people, 21 participants took part MRI study: 10 (five female) were in DP group (mean DP score=18.50, range=16-24) and 11 (five female) were in DO group (mean optimism score:18.00, range:16-24). Cutoff values for each dimension have been determined as 15 based on previous studies which often used top and bottom quartiles of scales.^{4,13,14} Two groups were similar regarding age (DP=21.30±2.58 and DO=21.50±2.32) and gender (DP %50 f and DO %45 f). The subjects were right-handed based on the Edinburgh Inventory¹⁵ and had normal or corrected to normal vision by wearing appropriate spectacles in the MRI. Before the experiment, each participant read and signed a written informed consent and they were paid £20 for one-hour fMRI study participation. The study was approved by the Department of Life Sciences ethics committee at Brunel University.

Questionnaires

Ten items Life Orientation Test (LOT)¹² is a continuum scale and used to measure DP and DO. DP and DO scores are ranged from minimum 0 to maximum 24. Basically, participants were selected from top quartiles of each calculation for DO and DP so that actually, for example, DO participants indicate individuals who are lower on DP scale (e.g. high DO scores (16-24) indicates low DP scores (0-8)). Because the DP and DO scores calculated separately, participants who scored over 15 in a scale were grouped in either DP or DO. The cut-off for sample selection method has been applied based on top and bottom quartiles of the scale which has been previously used in the DP-DO,⁴ anxiety¹⁶ and personality investigations.^{13,14} In addition, to avoid potential confounding effects, Beck Depression Inventory,¹⁷ alcohol and caffeine survey, test of current or past history of psychological and neurological history,¹⁷ and Color Blindness Test¹⁸ were used. In more detail, Beck Depression Inventory (BDI) was used to confirm participants have no current depressive

mood (i.e. lower than score of 15). To find out participants had no current or past history of psychological and neurological history, a survey based on MINI neuropsychiatric interview¹⁹ was used. Alcohol and caffeine consumption survey were used to eliminate participants who consumed alcohol or caffeine ≥ 8 cups or ≥ 900 mg in last 24 hours. Finally, participants with color blindness were excluded based on Ishihara Color Blindness Test.¹⁸ All these exclusion criteria were employed during screening procedure so that participants who do not meet the criteria were excluded in advance during screening procedure. The reason for employing these exclusion criteria was that these factors known to affect cognitive mechanism.^{20,21} Therefore, we aim at avoiding potential confounding effects due to these factors.

Tasks and procedure

Participants lay supine in the MRI scanner and wore MRI compatible headphones. They viewed a screen via a mirror system while holding MRI compatible response pads in each hand. Three conditions, which are related to current study, were presented in the fMRI block designed. These are auditory single task, visual single tasks and dual task. Auditory single tasks were consisted 30 syllables with different tones (15 ha-ha/ 15ya-ya). Participants heard a syllable for 345 ms, which is randomly presented. If they hear ha-ha, then they must press the button, which is employed, on fMRI compatible pad with left middle finger. If they hear ya-ya then they must respond by pressing an employed button with left index finger. They had to respond in 3075 ms as soon as the stimuli presented. After that, they saw either as fixation cross which indicates they responded correctly or an error feedback as 'error' for 250 ms on the middle of the screen. In the visual single tasks, there were 120 different black and white images, which consisted of 60 men and 60 women faces. Participants required deciding whether the randomly presented face is women or men. If the image is man, they must respond by pressing the employed button with right index finger and if it is women then they must respond by pressing the other button with right middle finger. The rest of characteristics regarding timing were identical as in auditory single task. Finally, dual task trials consisted of simultaneous presentation of auditory and visual single tasks. In this condition participants have to execute two responses and key mappings were identical as in single tasks. In more detail, in half of dual task blocks partici-

pants had to respond to auditory task at first and then visual task as fast and correctly as possible and in other half of block was vice versa. In a dual task trial there was 3325 ms in total and trials, and stimuli were presented randomly.

Three conditions of the task were related to the current study. Each condition presented 8 times in a randomized order. There were 2 more conditions which are not related to the aim of current study. Each block included 8 trials which took 26.6s. Before presentations of the blocks, information about tasks was presented on the screen for 5.9s (e.g. auditory single task or dual tasks auditory $\geq$ visual).

MRI procedure

Brain imaging took place at Royal Holloway University in CUBIC center. A 3T MRI scanner (Trio, Siemens, Erlangen, Germany) which is equipped with a 12-channel array head coil was used to acquire brain images. Participants were supine on the scanner and for reducing their head motion cushions were put in each side of their head. They wear earphones, which allow hearing syllables and reducing MRI noise. A BOLD-sensitive gradient echo EPI 8 sequence (TR 2.5 s, TE 31 ms, 85° flip angle) was used with 35 axial slices (192×192 mm FOV, 64×64 matrix, 3×3 mm in-plane resolution, 3 mm thickness, no gap, interleaved slice acquisition). A T1-weighted MPRAGE sequence (TR 1900 ms, TE 3.03 ms, 11° flip angle, 176 slices, 256×256 mm FOV, 1×1×1 mm voxel size) was used to acquire high resolution whole brain images of each participant. There were two functional runs with 364 volumes.

Data analysis

SPM 12 was used to analyze the MRI data. In the first step, the origins of all images (i.e. structural and functional images) were set up to the anterior commissure. Afterward, 'realign & unwarp' was applied to correct head motion. Anatomical and functional images were normalized to MNI space using unified segmentation. Gaussian kernel with a FWHM of 8 mm was used to smooth all functional data spatially. Next, normalization and registration processes were completed. In terms of serially auto correlated observations, general linear model was used for statistical analyses relied on a voxel least-squares estimation.²² For modeling the BOLD responses a boxcar function, convolved with a canonical HRF without derivatives was used. Cutoff frequency was set up as 1/70 in the temporal high pass filter.

Contrast maps related to dual task activations for each participants were set up (i.e. dual-task - auditory single task - visual single-task, i.e. [1 -1 -1]). Furthermore, in the second level statistics independent t-test was selected to compare DP and DO participants. The significance threshold was adjusted at $p < 0.005$ (uncorrected). In the current study, we consider the significant clusters with $p < 0.05$ (FWE corrected). Previous research has shown that using such parameters for cluster level inference often lead accurate results.²³ The Automated Anatomical Labeling toolbox was used to find out Brodmann areas and anatomical regions.²⁴

RESULTS

Behavioral results

Independent t-test was used to analyze behavioral performance in DP and DO participants (DP vs DO). Dual task related variables were created by subtracting the average of response time of single tasks from averages of the second response time of dual tasks (i.e. DT - ST). The results showed that pessimist participants were slower than optimist participants as evident by higher mean i.e. mean DP: 1558 and DO: 1140, $t_{(21)} = 2.87$, $p = 0.05$). A similar pattern of this result was found for error rates however, it did not reach significance threshold $p > 2$.

Neuroimaging results

To investigate differences between groups regarding neuroimaging results, the contrast images were compared via independent t-test

(i.e. (contrast [Dual Task - Single Task Auditory - Single Task Visual] DO - [Dual Task - Single Task Auditory - Single Task Visual] DP). This contrast allows test potential differences in anatomical activations between DP and DO participants regarding dual task performance. Therefore, the brain activations during processing of dual task performance are dual task specific.²⁵

Results demonstrated stronger activations in inferior parieto-occipital cortices in DO as compared to DP (Figure 2, Table 1). In more detail, the cluster in the left inferior parietal cortex extended mainly along the posterior cingulate gyrus (BA 31), extending into the precuneus (BA31) and cuneus (BA17/18). The cluster in the right inferior parietal cortex started from the right posterior cingulate gyrus (BA 23/31) to the occipital lobe in right cuneus (BA17). The contrast was reversed for comparing DP vs DO groups (i.e. contrast [DT - STAuditory - STVisual] DP - [DT - STAuditory - STvisual] DO) the results showed no significant voxels.

DISCUSSION

Behavioral results showed that while pessimist and optimist participants did not differ on single task performance, pessimist participants slowed down as compared to optimists on dual task performance. These behavioral costs in pessimists were accompanied with decreased dual task related activations in inferior parietal and occipital regions. In more detail, decreased dual task specific activations are observed in the

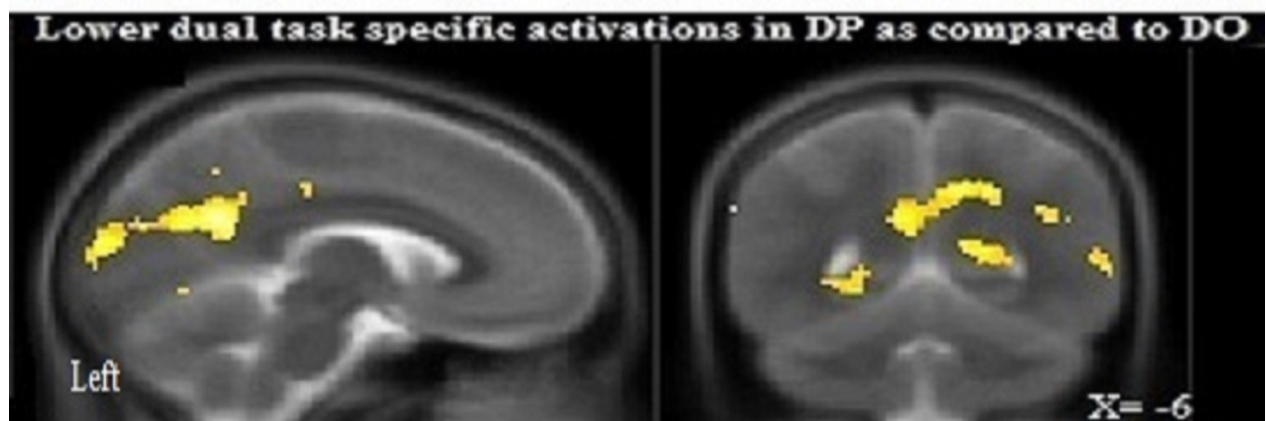


Figure 1. Imaging data. Results of the contrast [Dual Task - Single Task Auditory - Single Task Visual] DO - [Dual Task - Single Task Auditory - Single Task Visual] DP) showed Lower dual-task specific activation in the parieto-occipital cortices in left and right regions for DP as compared to DO. Maps thresholded at $p < 0.005$ (uncorrected), clusters significant at $p < 0.05$ (FEW corrected)

Table 1. Areas exhibiting significantly stronger dual-task specific activation in low neurotics as compared to high neurotics (contrast [DT - STauditory - STvisual] optimism - [DT - STauditory - STvisual] DP)

Anatomical area	BA	x, y, z	t/p(uncorr)	Cluster-level p (FWE)	Cluster volume (mm ³)
Cluster 1				0.002	9384
PCG	31	-6, -56, 26	5.33/0.0002		
Precuneus	31	-4, -68, 28	4.75/.00012		
Cuneus	17	-4, -96, 14	5.18/.00029		
Cluster 2				0.035	2256
PCG	23/31	16, -52, 14	3.75/0.001		
PCG	18	22, -64, 12	3.67/0.001		
Cuneus	17	16, -68, 18	3.42/0.002		

the inferior parietal cortices mainly through the posterior cingulate gyrus, extending into precuneus as well as cuneus.

These brain regions in parietal and occipital cortices, in addition to prefrontal regions, have been often reported to be associated with dual task processing⁷ and other tasks relevant to executive functions.^{8,9} Several studies suggested that more common areas in parietal cortices rather than frontal regions mainly involve in mediating main executive functions such as switching, inhibition, updating and dual tasking.^{8,9} It has been suggested that these regions involve in resolving interference and task coordination in executive tasks.^{7,9} In this context, DP related decreased activations in these regions on dual task performance might be considered as involving to executive function lesser than DO participants.

Decreased brain activations previously found in anxious,¹⁶ neurotic¹³ and psychotic subjects²⁶ on dual tasks and set shifting task performance in parietal regions. It has been indicated that negative affectivity associated with these traits limits investment of higher mental effort into the task which leads decreased activations in dual task specific areas.^{13,16} As DP is also associated with negative affectivity,^{1,10} behavioral decrements on dual tasks accompanied with decreased dual task specific activations might be due to investing less mental effort into the task.

This interpretation is consistent with the theory of dual mechanism of control which suggests

decreased activations occur if reactive control mechanism is activated during a cognitive task processing.³ As it has been indicated, DP is suggested to be involved in reactive control mechanism due to its association with negative affectivity.¹ Conversely, optimism supposed to be involved in proactive control mechanism due to its association with psychological well-being.¹ In line with that, it has been reported that the higher activations in PCC (BA 17, 18, 23, 31) associated with proactive control.²⁷ Hence, higher activations in these areas may involve in interaction between short- and long-term memories to facilitate faster and easier responding.²⁷ In this regard, negative affectivity related thoughts may interrupt cognitive task processing which in turn activates reactive control mechanism in pessimist subjects and lead decreased dual task specific activations as compared to optimist participants.

In conclusion, to our knowledge, this is the first study exploring neural correlates of DP and DO on dual task performance. The results indicate that DP participants were slower than DO participants and this performance decrement was accompanied with decreased dual task specific activations in parietal and occipital regions. These finding has been assessed as DP related dual task specific activations as compared to DO. The impairment may be caused by DP related negative affects which in turn awaken reactive control mechanism and lead to decreased activations in parietal cortices as compared to optimism.

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