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EFFECT OF STATE ANXIETY ON ATTENTION AND VIGILANCE USING ANTI-VEA TASK

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ABSTRACT
Anxiety differently affects attentional functions and vigilance. But these two were not measured together previously. That's why the current experimental study aimed to measure the effect of state anxiety on executive and arousal vigilance and different attentional functions in a single task. The on-campus participants were initially screened with STAI-T by Spielberger to know their level of trait anxiety. The participants with a moderate level of trait anxiety were requested to participate in the experiment. They were divided into two groups and were randomly assigned to each group. The positive and negative mood was induced through video clips. The ABA experimental design was used and the mood was checked with PANAS by Watson, Clark, and Tellegen, and state and trait anxiety was checked with STAI before and after mood induction. The two experimental groups performed the task of ANTI-Vea by Luna and his colleagues to check their attention. The results showed that executive and orienting control of the positively mood-induced group was less efficient. There was a significant difference in the accuracy and reaction time of both groups. But, executive and arousal vigilance remain the same. The current study provides future evidence for both vigilance and attention.

Keywords: attention, state anxiety, executive vigilance, arousal vigilance, attentional network test.

INTRODUCTION
Attention is a very old field in psychology. According to Titchner (1902), attention is the heart of the psychological enterprise. American Psychological Association defines attention as the state in which cognition focuses on something in the environment while ignoring other features and the cerebrospinal nervous system responded to that stimuli. It is supposed that individuals can give attention to limited items in their surroundings (VandenBos, 2007). But this may be the subjective definition of attention and neither will it give any clue to know about the mechanism of attention nor will we know about the physiological process and pathologies of it. Peterson and Posner (1990) first described that orienting, alerting and executive are the networks of attention. While there is arousal in the brain stem and right hemisphere in the alerting system in association with sustained vigilance. Whereas the parietal cortex is involved in orienting network and the midline frontal/anterior cingulate cortex is involved in the executive network.

Vigilance is the capacity for long-term perception of critical events (Warm et al., 2008). So, vigilance decrement occurs when we try to remain vigilant for long period and show a decline

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in detecting critical signals. The cognitive ability to remain attentive over some time while observing and differentiating in critical situations is executive vigilance (Warm et al., 2008). The behavioral response at the time of arousal and maintaining quick reaction over some time having no control over responses is arousal vigilance (Lim & Dinges, 2008).

Anxiety can be defined as the emotional state which every individual feels at different intensities. It can be aversive and temporary and can be differentiated by tense feelings and physiological responses like a rapid heartbeat (Spielberger, 2013). State anxiety can be defined as any temporary situation in which the individual perceives a threatful situation and feels anxiety in this present situation (Caumo et al., 2000).

The attentional control theory focused on anxiety and cognition. Also, it focused on normal individuals rather than individuals with clinical anxiety. According to attentional control theory, the efficiency of executive functions is affected by anxiety. Anxiety has an extended effect on attention's stimulus-driven system and decreased effect on attention's goal-directed system (Eysenck & Derakshan, 2011). For example, when there is anxiety it extends the attention's stimulus-drive system by automatic processing, while it decreases the attention's goal-directed system.

The three attentional components can be measured in a single task of attention network test to differentiate among components (Fan et al., 2005). Attention was measured in healthy individuals as well as in neuropsychiatric patients who had autism (Fan et al., 2012), attention deficit hyperactivity disorder (ADHD) (Mogg et al., 2015), and schizophrenia using attention network tasks. Research conducted by Caeyenberghs and his colleagues (2014)concluded that patients with brain injury due to trauma and amnestic mild cognitive impairment (aMCI) showed decreased working memory, which led to decreased activity of executive functions.

Several types of research conducted on vigilance, attention, and anxiety. The study concluded that there was increased activity of vigilance and executive control due to the use of caffeine (Bruny et al., 2010), whereas there was a decreased activity of vigilance and EC due to sleep deprivation (VandenBos, 2007). It was also concluded that sleeplessness leads to fatigue which eventually affects executive functioning (Killgore, 2012), whereas sleep deprivation leads to a strong decline in vigilance. The dose of caffeine increase alertness and executive control functions (Bruny et al., 2010). Social anxiety, depression, and anxiety have a negative relationship with orienting network of attention, while there is no relationship found with executive function for non-emotional stimulus (Moriya & Tanno, 2009). It was concluded that alerting and orienting networks become over-function during anxious mood (Pacheco-Unguetti et al., 2010).

Some parts of attention are developed during infancy, whilst others are developed during middle and late childhood (Rueda et al., 2004). There is evidence of the presence of attentional functions since birth (Colombo, 2001) while boys improved more in their alerting response and older children improved more in their orienting response (Rueda et al., 2004). A recent study found patients having Wilson's disease have an abnormality in the thalamus, when examined through cerebral MRI, as a result, their alerting network was affected whereas orienting and executive networks remain unaffected (Han et al., 2014). Another study found that thalamus and left parietal gyrus are involved in alertness (Xu et al., 2015).

Several neuropsychological researchers found that children with ADHD take more reaction time as compared to adults and show a deficiency in executive functioning. It was concluded that lower accuracy and lower vigilance showed when ADHD adults perform attention network tasks but there was no difference in the three attention measures (Lundervold et al., 2011). Other developmental research claimed that the executive network developed since childhood. When 2 to 7 years old perform the conflict task of identity and location, they were able to resolve conflict (Gerardi-Caulton, 2000). Rueda et al. (2004) concluded in their study that orienting scores remain the same with age but evidence of change in alertness was found after age 10. In state anxiety, alerting and orienting networks showed over-functioning (Pacheco-Unguetti et al., 2010) while

other studies proposed that there was increased activity in certain areas of the brain during high-state anxiety (Bishop, 2009).

Significance of the study

The impact of state anxiety on three networks of attention was tested earlier with the ANTI task. The ANTI task was updated and the new version of the task measured three attention networks together with arousal and executive vigilance. Also, the effect of state anxiety was not previously measured with arousal and executive vigilance. Therefore, the purpose of this study was to evaluate whether vigilance and attention were affected by state anxiety with this new task. In Pakistan, there was not a single experimental study that measure the effect of state anxiety on vigilance and three attentional networks. This study provides good evidence about the reaction of the Pakistani people to perform attentive tasks when they are positively and negatively anxious.

Objective of the study

1. To determine how orienting, alerting and executive control which are three components of attention are impacted by state anxiety.
2. To find the effect of state anxiety on two components of vigilance which are arousal and executive vigilance.
3. To investigate the relation of executive vigilance decrement with increased response biasness.
4. To investigate the relation of arousal vigilance decrement with increased reaction time.

Hypothesis of the study

1. In contrast to no-tone conditions positive and negative anxious groups perform faster in tone conditions.
2. In contrast to invalid and no cue conditions, positive and negative anxious groups will perform accurately in the valid cue conditions.
3. Positive and negative anxious groups will perform faster in congruent conditions in contrast to incongruent conditions.
4. In contrast to the negative anxious group, the positive anxious group will perform faster in orienting, warning signals, and executive control.
5. In contrast to the negative anxious group, the anxious group will perform accurately in orienting, warning signals, and executive control.
6. The negatively anxious group will show arousal vigilance decrement in contrast to the positively anxious group.
7. Arousal vigilance decrement will cause reaction time increment.
8. The positively anxious group will perform well on Hits in the contrast to the negatively anxious group.
9. In contrast to the negatively anxious group, the positively anxious group will have increased response biasness in executive vigilance.

METHODS

To determine the impact of state anxiety on vigilance and attention, an experimental study was conducted. As this study was conducted during COVID-19, the data was collected following all SOPs.

Research Design

The present study was mixed experimental design, including within-group designs for executive control (incongruent/congruent), alerting (tone/no tone), and orienting network (valid cue /no cue/invalid cue), as well as between-group designs for positive and negative state anxiety.

Participant's Characteristics

The sample size was calculated by a statistical power analysis (G* power). The fifty-six psychology students (age: 19-28 years; 44 females and 12 males) were selected through the purposive sampling technique from Bahauddin Zakariya University, Multan. The selection criteria were their scores on STAI-T (Spielberger et al., 1982). Those who scored 38 to 44 on the scale participated in the study.

Procedure

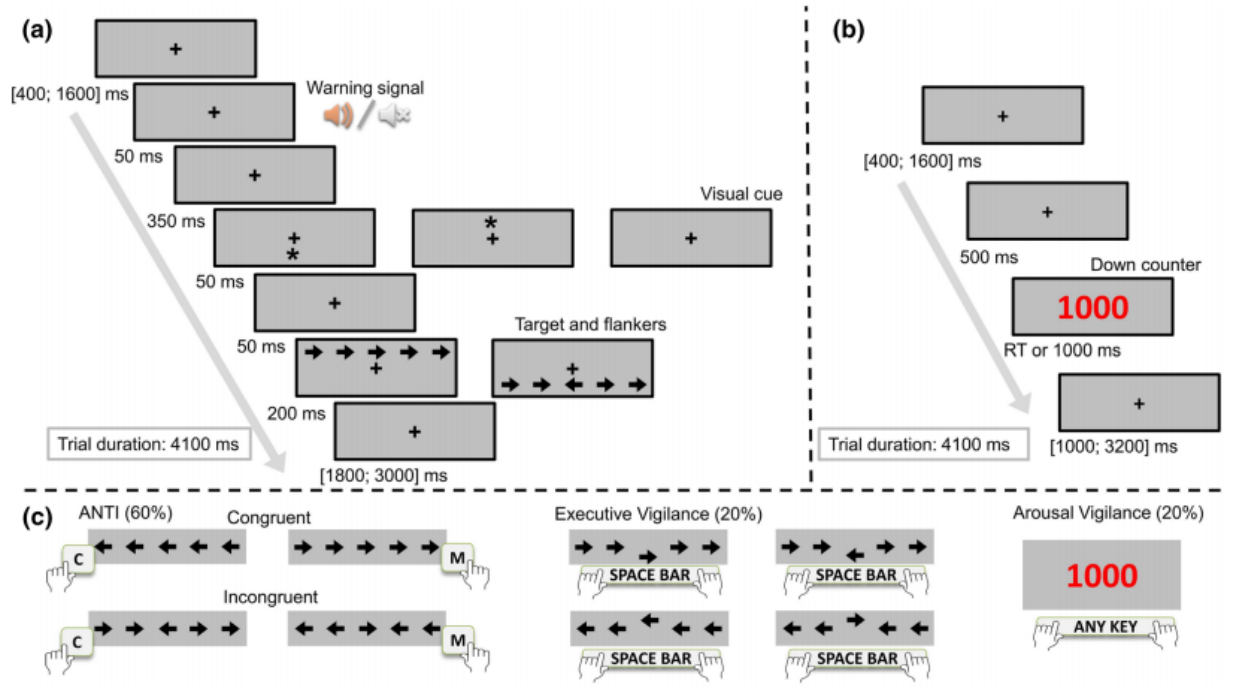
The experiment was performed in proper laboratory settings. The participants were divided into two groups with an equal chance of placement in each group, one group being given positive mood induction and the other receiving negative mood induction. Each participant filled STAI State subscale before and after the mood induction. After filling STAI-S first time, the mood was induced using funny and stressful videos. The participants saw positive and negative videos according to their group type and were instructed the participants to be emotionally involved in them. After the mood induction, STAI-S was again administered to check whether the mood was successfully induced or not. Then, participants performed the ANTI-Vea task.

The participants were told to keep their eyes fixed on the laptop screen while listening to the alert tone through headphones. To prevent any interruptions, the participants were asked to put their phones on silent or turn them off. The practice trials were first finished by the participants. The practice trials included 16 trials of ANTI, 32 trials of ANTI and EV, and 48 trials of EV, AV, and ANTI randomly while each trial followed by feedback. Then, there were randomly 40 practice trials with 24 trials of ANTI, 8 of EV, and 8 trials of AV with no feedback.

There was a plus sign shown on the screen which was a fixation point for 400 MS to 1600 MS in ANTI trials. The target stimulus was an arrow which was presented after 50 MS and it was pointed in either the right or left direction. There were four arrows which were flanked arrows two on each side of the target stimulus in the ANTI trials. Congruent trials were those in which the flanked arrows presented in the same direction as the arrow pointing at the central target, and incongruent trials were those in which the flanked arrows presented in the opposite direction from the central target. By designating either a right or left central arrow, the participants had to push C if the central direction was left and M if it was right. These congruent and incongruent conditions measured attentional executive control. Additionally, the trials that assess alertness of attention had a condition with an alerting tone in half of them and a condition without alerting tone in the other half. By displaying an asterisk as a visual cue for every 400 MS, the orienting network of attention was measured. For 50 MS, the asterisk was either displayed below the fixation point in 1/3 of the trials, above the fixation point in the other 1/3 of trials or there was no asterisk present in the last one-third of the trials. After 400 MS, a valid cue condition was when the asterisk was shown in the same location of the arrow, an invalid condition was when the asterisk was shown in the opposite location of the arrow, and there was no cue condition if there was no asterisk. Then the asterisk was disappeared and the fixation point left behind.

The whole procedure was the same in the EV trials as it was in ANTI trials but only the central arrow was displayed slightly approximately 8 PX either downward or upward. Whenever the central arrow was displaced the participant had to press the spacebar button from the laptop. For this, the participant was instructed to remain extremely vigilant.

A millisecond red countdown from 1000 to 0 was displayed on the screen for AV trials. The participants were told to push any key to immediately stop the countdown. After practicing on the practice trials, the participants started the actual experiment without pause or feedback. It contains 4 blocks of trials, whereas there were 80 random trials in each block with 48 ANTI trials, 16 EV trials, and 16 AV trials. After the task was completed, the students had to fill out the STAI and PANAS and debrief them if required.



Instruments

State and Trait Anxiety Inventory

State and trait anxiety is a reliable self-report measure that is widely used in clinical settings and research. It includes two subscales of 20 items each. Scores vary from 20 to 80, with higher numbers indicating greater anxiety (Spielberger C. D., 1983).

The Scale of Positive and Negative Affect

The scale of positive and negative affect is a widely used self-report measure of mood. It is highly reliable and valid. In it, emotions and sentiments are described using a variety of words. On a 5-point scale, participants score these terms from very slightly to an extreme level. The total scores, which range from 10 to 50, are calculated by adding the values for each negative and positive item. Higher scores represent high positive affect, whereas lower scores represent low negative affect.

Attention Network Task Interaction – Vigilance (Executive and Arousal)

The test of attention network for interaction and vigilance is a computer-based test to measure attentional networks such as alerting, orienting, and executive along with arousal and executive vigilance. There are three different kinds of trials included. (a) Executive, orienting, and alerting networks of attention are measured in ANTI trials; (b) executive vigilance is measured in EV trials; and (c) arousal vigilance is measured in AV trials (Luna et al., 2018).

Techniques used for Mood Induction

The mood induction technique was used to change the participant's mood on the spot in an artificial and controlled way and it was supposed that the induced mood had the same effect as the original mood. For mood induction, two positive and two negative video clips were used to induce positive and negative moods respectively. The clips were 4 to 5 min long and previously used for this purpose (Fatima, Batool & Manzoor, 2020).

Data Analysis

The inclusive criteria were the completion of four blocks in the task. The outliers were individuals whose accuracy in ANTI trials was less than 75% and whose reaction time was less than 0.25 SD. The outliers were then eliminated. Only one participant was eliminated from the group experiencing negative state anxiety, but five participants were eliminated from the group experiencing positive state anxiety as outliers.

The three repeated measure ANOVA analyses were conducted. The between-group was mood induction and within the group were (a) warning signals with tone/no tone condition, (b) visual cues with valid/invalid/no cue condition, and (c) executive control with congruent/incongruent. Whereas, reaction time and % of error were dependent variables in the first repeated measure analysis to measure networks of attention. The mood induction was a between-group factor and the performance of participants in 4 blocks was a within-group factor whereas false alarm (FA), hits, response bias (B"), and sensitivity (A') were dependent variables in the second repeated measure analysis to measure executive vigilance. To measure arousal vigilance, the mood induction measured as a between-group was variable, and the performance in four blocks was measured as a within-group variable, whereas the mean RT, % of lapses, and ST of reaction time were measured as the dependent variable.

RESULTS

IBM SPSS version 23 was used for data analysis. The repeated measure mixed model ANOVA was conducted to examine the performance of various participants under two different experimental conditions. The different experimental conditions were positive and negative mood induction. The paired sample of t-test was conducted to find out the difference in the mean scores of positive and negative mood induction groups.

Following are the results.

Table no.1: For all ANTI conditions in Groups 1 and 2, the mean RT and percentage of error are shown

			Tone			**No Tone**		
			Valid	**Invalid**	**No Cue**	**Valid**	**Invalid**	**No Cue**
RT								
	Negative State Anxiety	Congruent	.0300 (.03574)	.0321 (.04736)	.0537 (.05974)	.0728 (.08892)	.0369 (.04602)	.0791 (.07387)
		Incongruent	.0529 (.08338)	.0931 (.10518)	.0638 (.08393)	.0610 (.07836)	.1152 (.10503)	.0785 (.10755)
	Positive State Anxiety	Congruent	.0268 (.04159)	.0362 (.06250)	.0187 (.03452)	.0293 (.04376)	.0329 (.05193	.0328 (.05052)
		Incongruent	.0369 (.06141)	.0671 (.06711)	.0410 (.09126)	.0281 (.03799)	.0557 (.06760)	.0368 (.05161)
Accuracy								
	Negative State Anxiety	Congruent	.0365 (.04265)	.0384 (.05520)	.0559 (.06126)	.0913 (.10083)	.0560 (.06274)	.1020 (..7976)
		Incongruent	.0572 (.09140)	.0990 (.10246)	.0622 (.08098)	.0717 (.08299)	.1406 (.11526)	.0894 (.10533)
	Positive State Anxiety	Congruent	.0380 (.04156)	.0404 (.06353)	.0294 (.04121)	.0345 (.04345)	.0565 (.06028)	.0575 (.05402)
		Incongruent	.0446 (.07384)	.0808 (.06803)	.0468 (.09057)	.0404 (.04376)	.0736 (.07318)	.0653 (.06357)

Note: Reaction Time (RT) in MS, in parentheses, is the standard deviation (SD).

Table No. 2: T-test for a paired sample of Negative State Anxiety Group

Group	Phase	Scale	N	Mean	Std. Deviation	t	Sig. (2-tailed)
Negative State Anxiety Group	Pre Middle	STAI-S	28	1.3696 2.5252	.38329 .34311	-11.880	.000***
	Middle Post	STAI-S	28	2.5252 2.0948	.34311 .40558	5.256	.000***

Note: p<.05*, p<0.01**, p<0.001***

The table shows that pre and middle mean score differences and middle and post-mean score differences are significant. The pre and middle mean scores represent before and after mood induction scores, while middle and post-mean scores represent before and after task conduction scores. The significant difference in the mean scores means that mood was successfully induced and it affect state anxiety.

Table No. 3: T-test for a paired sample of Positive State Anxiety Group

Group	Phase	Scale	N	Mean	Std. Deviation	t	Sig. (2-tailed)
Positive State Anxiety Group	Pre Middle	STAI-S	28	2.5393 1.4982	.48311 .38453	11.113	.000***
	Middle Post	STAI-S	28	1.4982 2.0089	.38453 .51838	-5.000	.000***

Note: p<.05*, p<0.01**, p<0.001***

The table shows that pre and middle mean score differences and middle and post-mean score differences are significant. The pre and middle mean scores represent before and after mood induction scores, while middle and post-mean scores represent before and after task conduction scores. The significant difference in the mean scores means that mood was successfully induced and it affect state anxiety.

Fig. 1a: Visual cue (invalid/no cue/valid), executive control (congruent/incongruent), and warning signal (no tone/tone) in RT (MS) in the negative/positive state anxiety group are represented graphically

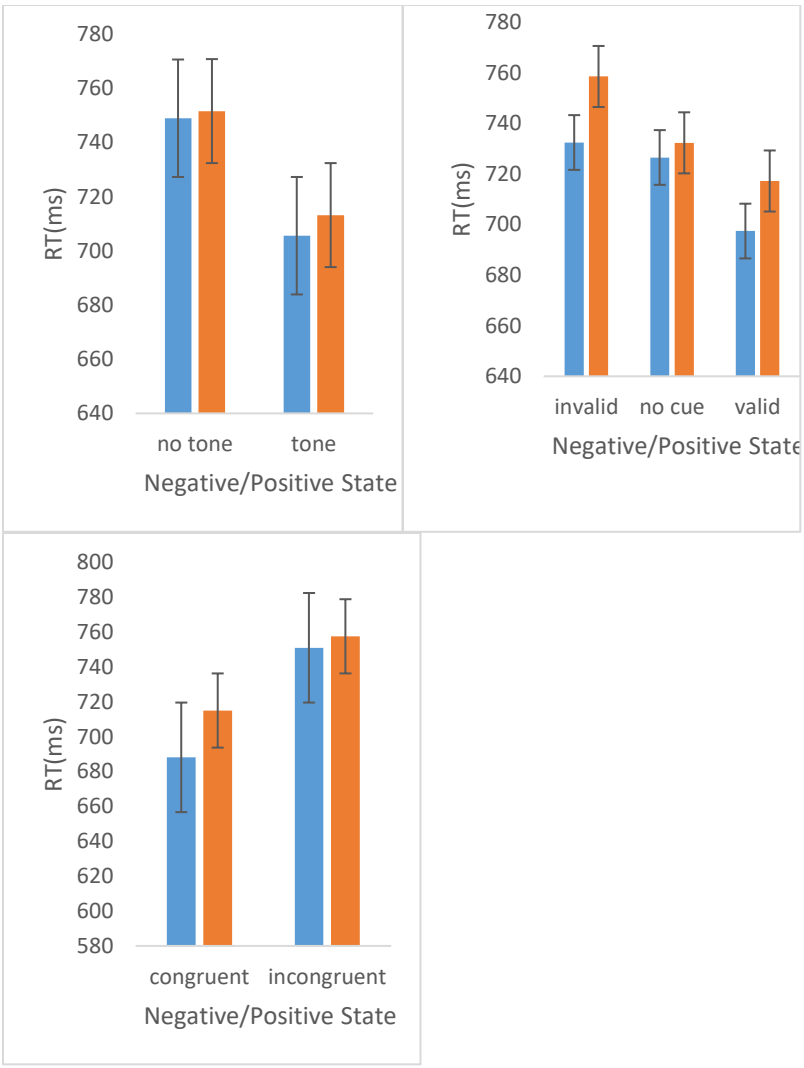


Fig. 1b: Visual cue (invalid/no cue/valid), executive control (congruent/incongruent), and warning signal (no tone/tone) in % of error (MS) in the negative/positive state anxiety group are represented graphically

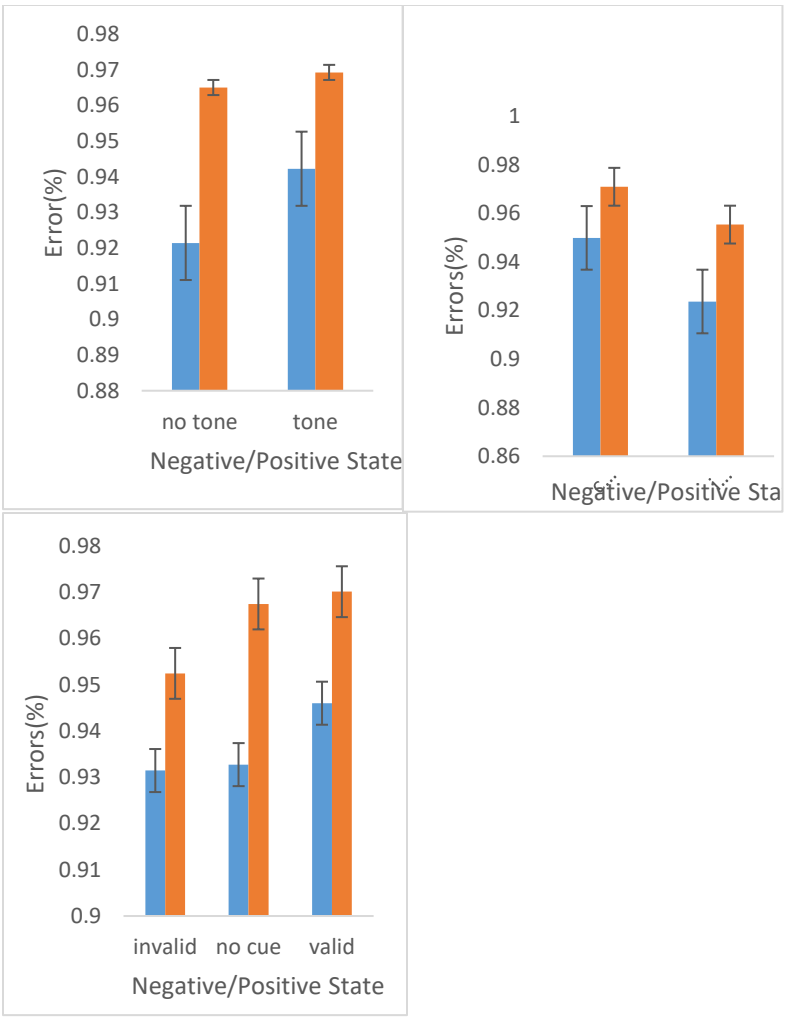
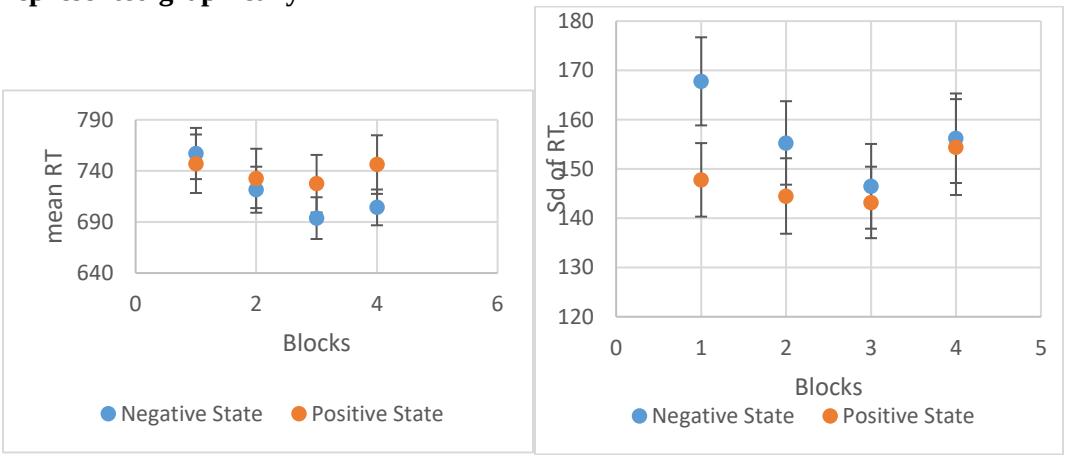
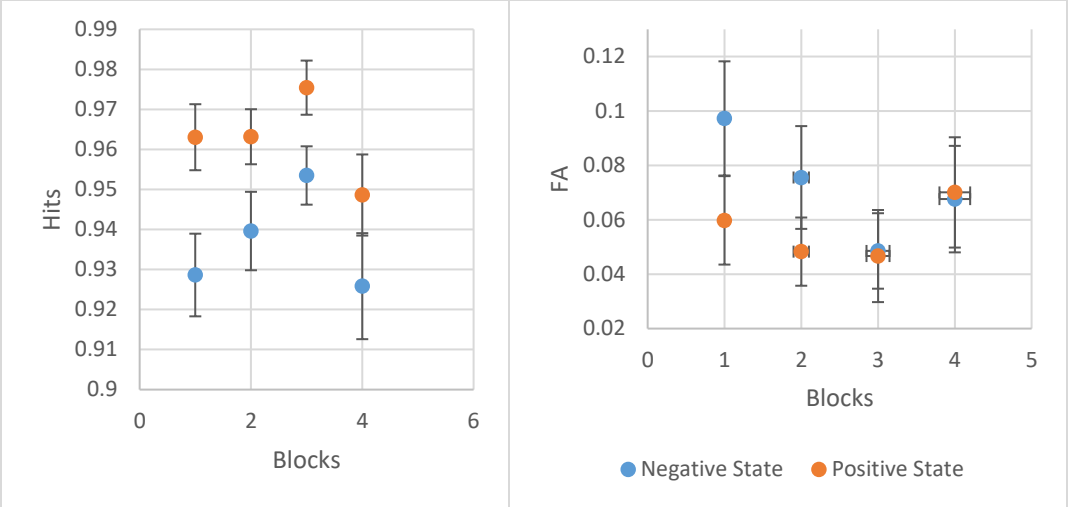


Fig. 2a: Mean RT and SD of RT on AV in the negative/ positive state anxiety group are represented graphically



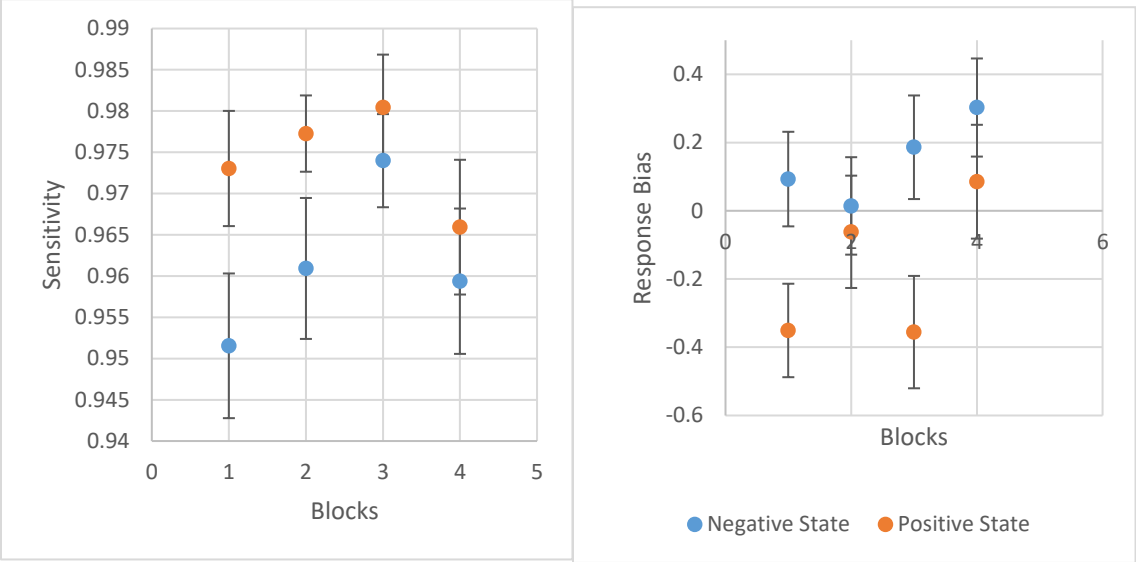
Note. SD of reaction time (Standard deviation of RT), arousal vigilance (AV), reaction time (RT)

Fig. 3a: Hits, FA on EV in the negative/ positive state anxiety group are represented graphically



Note: executive vigilance (EV), false alarm (FA)

Table 3b: A', B" on EV in the negative/ positive state anxiety group are represented graphically.



Note: executive vigilance (EV), A' (sensitivity), B" (Response bias)

DISCUSSION

The vigilance decrement was previously measured in a simple task. Attention network task for interaction and vigilance - executive and arousal (ANTI-Vea) was recently designed to measure the phenomenon of vigilance along with attentional components. That's why the goal of the present study was to observe the effect of positive and negative state anxiety on attention and vigilance. The earlier and later scores of mood induction measures revealed that there is a significant difference which indicates that the mood was successfully induced. It had an impact on participants' anxiety levels as well. The executive control, visual cue, and warning signal also had an impact on % of error within the group.

It was hypothesized that the positive & negative anxious groups would perform faster in tone conditions. The group with negative state anxiety performed more accurately in the absence of tone than in the presence of tone condition. The hypothesis was rejected.

It was hypothesized that in contrast to invalid and no cue conditions, positive and negative anxious groups will perform accurately in the valid cue conditions. In invalid cue conditions, the positive anxious group performed better than in the valid cue and no cue conditions. The hypothesis was rejected but the findings concur with the previous literature which demonstrated that invalid and no cue conditions yield better results for the negative anxious group than valid cue conditions (Luna et al., 2020).

It was hypothesized that the positive and negative anxious groups will perform faster in congruent conditions in contrast to incongruent conditions. The results revealed that in contrast to congruent conditions, both positive and negative anxious groups perform better under incongruent conditions. The interaction of executive control and visual cue showed the effect. Visual cues and executive control both differ significantly for RT. The current findings are consistent with the previous literature which showed that the positive and negative groups performed more quickly under congruent conditions than incongruent conditions and also in the valid cue conditions than under no cue and invalid conditions (Posner, 2016; Luna et al., 2020). However, when there was a tone condition both groups perform more quickly than no tone (Luna et al., 2020). The interaction of visual cues and executive control also differ significantly.

Positive and negative anxiety groups show a substantial difference in % of error and RT but it was presumed that the positive anxious group will perform faster in attentional conditions. The results showed that the negative group performs faster in valid, congruent, and tone conditions. Thus, the hypothesis is rejected. Additionally, compared to the positively anxious group, the negatively anxious group accurately responds to invalid, incongruent, and no-tone conditions. The other hypothesis was also rejected.

Only the mean RT for AV significantly differs within the groups, indicating that both groups respond faster in the third block. With time passing, there was no evidence of arousal vigilance decrement in either group. The hypothesis was rejected. Also, neither arousal vigilance decreases nor reaction time increases in either group.

Hits for EV reveal a significant difference between and within groups, indicating that both groups show a little decrement in the first three blocks' performance but an overall decline in performance was not seen, rejecting the hypothesis. Additionally, decreased hits were observed in the negative anxious group.

A significant difference between the anxiety groups with positive and negative states is also shown by B". Response biasness just slightly increased in the anxious groups, but there was no significant increment found. So, the hypothesis is rejected which is supposed that in EV response biasness will increase in the positive group.

So, it is concluded that the positively anxious group has less efficient executive control and orienting than the negatively anxious group. Even though positive and negative state groups significantly differ from one another between ANTI. The fact that the task was completed by healthy adults with low and high anxiety levels rather than by clinical patients may be the cause; maybe they behave differently in ANTI. Therefore, future studies should be planned to determine how anxiety affects attention in clinical samples.

CONCLUSION

There was no remarkable impact of anxiety on attention in the current study. The small sample size could be the reason. Because it was carried out during a pandemic, the size of the sample was slightly small. Even though the institutions were only open for a short time, just a limited number of students were present on campus because half of the classes were being held online. It is concluded that measuring attentional functioning and its interaction is a valid and reliable task because both groups of state anxiety exhibit result in it and show the interaction between them.

In the present study, it was no evidence of a decline in arousal and executive vigilance. The participants performed 4 blocks in the current study as prior research has demonstrated that employing 4 blocks results in a vigilance decrement (Román-Caballero et al., 2020). Additionally,

it was mentioned in the instructions of task would be considered complete if a participant completed at least 80 trials in the first four blocks. Each participant met these criteria. As there were practice trials before the experiment started and the task itself was rather time-consuming, there were 4 blocks used in this study.

Additionally, participants in the state anxiety group had to first complete the PANAS and STAI questionnaires, watch the mood-inducing video clips, and then complete the questionnaire to determine whether the mood was induced and whether it had any impact on the participants' state anxiety. The participants then had to complete the practice trials before beginning the main task. Given the length of the entire process, it was decided to use 4 blocks in this study. The results demonstrated that the primary goal of this task—measuring vigilance decrement—cannot be achieved by just completing 4 blocks.

RECOMMENDATIONS FOR FUTURE STUDIES

To measure vigilance decrement, future research should be planned to finish at least 5 or 6 blocks. The results of this study were also impacted by a few other factors. The majority of research that used the ANTI-Vea task was carried out in developed countries like Spain. It was the first experimental study carried out in Pakistan to test the impact of anxiety on attention using ANTI-Vea.

It provides a novel type of findings. People in this region have diverse personalities, outlooks on life, diets, and levels of mentality. Additionally, the economic problems differ from those in developing countries. Several issues like suicide bombing, terrorism, inadequate health infrastructure, unemployment, and illiteracy were faced in previous years. Moreover, most of the population in this region is Muslims, they fully believed in Allah in both good and bad circumstances. Therefore, it can be concluded that Pakistanis are capable of maintaining good attention even in anxious situations and don't exhibit executive and arousal vigilance.

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