THE INFLUENCE OF POSITIVE AFFECT AND ANXIETY ON ATTENTION AND CREATIVITY

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Thesis presented in partial fulfillment of the requirements for the degree of Master of Arts (Psychology) at the City College of New York.

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April 2012
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Dedication

I dedicate my master’s thesis work to my family and many friends. A special feeling of gratitude to my loving mother Alicja Anna Furtak and my fiancee Roza Pondo. Without their continued support it would have been very difficult to finalize this project.
Acknowledgement

It is with immense gratitude that I acknowledge the support and help of my thesis committee, Dr. Vivien C. Tartter, Dr. Robert D. Melara, and Dr. Jeffery Rosen. Their guidance and encouragement throughout this process was tremendous. In particular, I would like to thank Dr. Tartter, for her limitless support and her constrictive responses to all of my questions.

Also, I would like to thank the team in Dr. Melara’s lab: John Moses, Raquel Bibi, Dave Britton, Eva Garcia, Miguel Briones and Dr. Melara for their time and help.

Finally, I would like to thank my American friends, Dr. Tartter, John Moses, Ruthie Bornstein and Sari Glazer for their help in editing.
Abstract

The study examined naturally occurring effects of positive affect and anxiety (exam stress at different points in the semester) on attentional performance and creative abilities of undergraduate students. The mood of participants was measured by PANAS and STAI questionnaires. Their attention was tested on the Eriksen Flanker Task, and creativity on the Remote Associates Test (RAT) and Compound Word Problems (CWP). One of the main goals of this study was to verify the prediction based on the Broaden and Build theory of positive resources by Fredrickson (2001). Although the mood manipulation used in this study, that is, placing both testing session in non-stressful and stressful periods of the Fall term was successful, the actual findings are far from the predictions based on the theory. There was an effect of Anxiety Trait on the subjects’ performance in the two creative tasks, showing an advantage for people characterized as low in anxiety trait over those characterized as highly in anxiety trait in solving word problems only in the session conducted at the end of the semester. Furthermore only in the first testing session did subjects characterized as highly positive and with low level of anxiety state benefit from greater space between the targets and distractors in the Medium and the Far spacing conditions of the flanker task. Therefore, they showed better inhibitory skills than participants with high anxiety state score and with low level of Positive affect. The project proposes the load theory of attention by Lavie (1995) as an alternative explanation of the achieved results.
**Introduction**

Emotions have always seemed central to the human experience; their role and function in human life have been debated by philosophers and scientists from Aristotle to Darwin (see Oatley & Jenkins, 1996 for review). From a psychological point of view, one of the most important publications in the nineteenth century about emotion was *The expression of emotions in man and animal* by Charles Darwin (Oatley & Jenkins, 1996; Fox 2008). In this book, Darwin describes examples of animals’ facial expressions that are related to particular emotional states, comparing them to the expression of emotion in human faces in order to draw conclusions about their evolutionary origins (Darwin, 1872/1998). Darwin pointed out that there is a link between emotions and behaviors in psychology itself William James (1884) stated that an emotion is comparable to other mental processes that occur separately from the behavior. In other words, an emotion is an inner reaction to a stimulus, independent of a particular behavior. Controversially, Sigmund Freud believed that emotions integrate both internal (mental) and external (behavioral) responses to emotionally significant events (Oatley & Jenkins, 1996).

Nowadays, many scientists highlight the fact that both James and Freud were right in many aspects of their opinions about emotions (Oatley & Jenkins, 1996; Fox 2008). It is commonly accepted that emotions affect both behavior and “rational” thoughts, but at the same time many researchers conclude that any emotional state needs to be integrated with other brain processes in order to affect a subject’s behavior in a particular way (Fox, 2008). As Oatley and Jenkins (1996) and Fox (2008) pointed out, modern emotion scientists are mostly interested in the quality of the influence of emotion on inner (cognitive processes) and external human life.
(the social world). In this master’s thesis the main focus will be on the internal effects of emotion on human cognition and behavioral performance.

**Defining emotions and moods**

When individuals speak about their feelings sometimes they use the term ‘emotional state’, for example, “I was in a state of love, joy or sadness.” The term *emotional state* is not a precise one because many times if one is in a sad or anxious state, everything around him or her seems to be sad or anxious respectively. Therefore, an *emotional state* can be related to a wide range of emotion effects that occur over a long period of time and affect more things than a particular object or event. In contrast, it is common for individuals to make comments such as, “this movie made me laugh,” or “this show made me cry.” In this case, it is clear that a particular object is perceived as triggering a particular *emotional state or feelings* of happiness or sadness.

According to Fox (2008) emotions that are not related to particular objects are defined as moods, while feelings that were triggered by a particular external object are called emotions. In particular, she pointed out that emotions are “coordinated reactions to a number of different objects and situations which are often called emotionally competent stimuli” (p.25). Additionally, as Rolls (2005) pointed out, moods result from emotions that were triggered by a specific object or situation, and that “a mood state is different from an emotion in that there is no object in the environment towards which the mood state is directed” (p.13). For Rolls (2005), emotions produce an emotional state that is related to reinforcing or punishing properties of a given stimulus. Confusingly, moods can also produce an emotional state, but in the absence of a clear punishing or reinforcing object in the environment (Fox 2008; Rolls, 2005). Davidson (1994) made an interesting point about moods and emotions. He believes that moods are always
present in human life by creating an emotional background. That is why particular moods encourage the performance of positive or negative actions.

The distinction between the terms “emotion” and “mood” is important in order to highlight the specificity of the term emotion, and lack of such specificity in the case of the term mood. It is also important to know that the term mood refers to a wide range of emotional effects that can occur over a long period of time, while the term emotion refers to a specific feeling that occurs in relation to a specific object.

**Emotional state in the body and brain**

Solms and Thurnbull (2002) made very important points by describing emotions as states in opposition to other brain functions that are channels. For example, there are visual channels that provide direct information between the left visual field and right hemisphere (right side of the visual cortex) and the right visual field and left hemisphere (left side of the visual cortex). When emotions such as joy, sadness, or fear are being felt they spread out into the brain affecting many brain functions at the same time. It is important to note that emotional states not only affect the brain but also the body, which is why Solms and Thurnbull (2002) define emotions as a visceral response to those events that we feel emotionally. For example, it can be noticed that a person is in a state of sorrow by observing his body reactions and by listing his/her thoughts.

Many emotion scientists believe that the brain is a center of those emotions called basic, discrete, or modal emotions (Fox 2008). Solms and Turnbull, (2002) proposed a categorical approach to basic emotions by defining them as ‘hardwired’ connections between certain external situations and/or stimuli of biological significance and the subjective response they evoke. The basic emotions are bonded with motor responses that are located in the perceptual memory system. Interestingly, as part of the evolutionary process humans have learned and
coded motor responses to significant emotional events. For example, most mammals, including humans, can quickly react when something dangerous is close to their position in space. However, as Solms and Turnbull (2002) indicated, human experiences can modify the strength of the response towards these events. It should be noted that the frontal lobe in the brain is responsible for inhibition processes in such situations.

In her textbook of the emotion science, Fox (2008) writes of the controversial approach to basic emotions that was started by Magda Arnold who proposed the appraisal theory (p. 84). In this, Magda Arnold defined appraisal as “the crucial immediate evolution of situations,” (Fox, 2008, p.114). Emotions are experienced on the basis of the specific action tendencies in a particular situation. As a result, emotions are evoked by one’s specific perception and judgment of a particular situation and a particular appraisal is built on the basis of this judgment (Fox, 2008). Therefore, “there are as many different emotions as there are reliably differentiated appraisals” (Fox 2008, p.115). Scherer (2002) agrees that since appraisals are determined by situations throughout the life of every individual, many emotions are indeed created on the basis of these different appraisals. Contradicting the point of view of Magda Arnold, he pointed that there are a small group of emotions that are crucial for survival and they possess critical meaning for each organism.

A compromise between these two approaches is proposed by Oatley and Johnson-Laird (1995) who firstly defined emotion by their functional nature; that is, each emotion is associated with a specific goal that can be pursued in a particular environment. Thus, positive emotions can be generated in an environment that allows an organism to reach a goal, and negative emotions will occur in an environment in which the goal cannot be achieved. Secondly, they highlighted that emotions are evaluated through millennia and their meaning is shaped by many events in the
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history of species. Therefore, people and animals experience basic emotions, but this experience is shaped by both inherent factors and the level of appraisal. Furthermore, appraised events are associated with different goals and many times this appraisal occurs without conscious awareness, such as in the case of initial attraction.

**Dimensional understanding of affect**

In the previous section the biological and evolutionary implications of emotions, and basic emotions in particular, were described. However, in everyday life most people have difficulty describing feelings or a particular emotion, and are poor at differentiating even one basic emotion from another similar emotion, such as fear from being scared.

In light of the above, many researchers prefer the dimensional approach while studying emotions. According to Fox (2008) “affect can be described along two broad dimensions. These have been variously called arousal and valence, approach and avoidance or positive and negative affects” (p.119). Arousal is considered an index of the physiological state at any given time, depending on a variety of environmental factors. Arousal can be relaxed or excited. Valence is an attribute of a stimulus or situation that can be either positive or negative. Valence is also shaped by both the cultural and individual experiences of a human. The next bipolar concept is approach versus avoidance. There are two motivational systems and one is related to pleasant experiences (approach), while the other coincides with unpleasant ones (avoidance). As Fox (2005) pointed out “these two systems can account for the valence dimension in our subjective experience and the arousal accounts for variations in the activation in both systems” (p.120). Interestingly, these two concepts (arousal-valence and approach-avoidance) are not clearly demarked. Some emotions that for example have a positive valence, such as excitement, have properties that are shared with negatively valenced emotions such as fear. Therefore, even when
one notices a high level of positive affect (PA), it does not mean that one’s negative affect (NA) level will be also low (Fox, 2008). According to Davidson (1992, 1998) and Fox (2008) the degree to which we experience PA or NA is dependent upon the individual appraisal and subsequent emotional reactivity of a particular situation. The range of this difference is called affective style.

As Fox (2008) pointed out, using a dimensional approach makes investigating emotion much easier, particularly due to standardized questionnaires that relate to affective experience such as the Positive Affect Negative Affect scale (PANAS), which will be described in detail in the methods section. The important techniques in studying emotion are both physiological indicators and subjective reports or questionnaires. The physiological measurements can help define individual differences in the experience of different emotions. As was pointed out above, even when a feeling is verbally described as positive it does not mean that it will relax or excite a particular person in the same manner that other positive emotions do. While it is true that people have some common innate responses to emotional situations, such as in the case of threatening stimuli, personal experience in a social environment causes individuals to attribute subjective meaning to their emotions. In other words people create an individual level of both valence and arousal during their life span. Fortunately, many of these characteristics of emotions can be matched and usually there is a positive correlation between questionnaires and physiological indictors of emotional affects (Fox, 2008).

**State-trait approach to anxiety**

Much research concludes that feelings of anxiety are associated with both physiological and psychological responses. These feelings are generated by a state of anxiety and produce feeling of stress, higher rate of blood flow, and the feeling of worry (Eysenck, 1983).
Spieleberger (1972) defines anxiety as “unpleasant, consciously-perceived feelings of tension and apprehension, with associated activation or arousal of the autonomic nervous system” (p.29). However, much research shows that some people are more prone to generate anxiety states than others and there are two main theories that explain this situation.

According to Eysenck (1983) the State-Trait approach predicts that those people who are unusually anxious in one stressful situation will tend to manifest anxiety in other stressful situations. Mischel (1973) proposed the social learning approach. Accordingly, people learn how to behave in a particular situation and they gain particular experience from that situation. Therefore, the individual response to a given situation depends upon the particular conditioning history of that individual in the same or similar situation. As Eysenck (1983) pointed out, the problem with the social learning approach is the lack of concern about different levels of stress in similar situations in the history of an individual. The State-Trait approach suggests that the differences between individuals are relatively stable. Furthermore, the states of anxiety are interactively determined by the individual’s susceptibility to anxiety, that is, the trait anxiety, and by the degree of stress inherent in the situation (Eysenck, 1983).

Finally, it should be noted that state of anxiety affects cognitive and behavior functions of an organism more directly than trait anxiety because “the influence of trait anxiety is mediated by state anxiety” (Eysenck, 1983). Importantly, state anxiety is affected by the level of environmental stress. Therefore, if a situation is stressful it will affect the level of anxiety. Furthermore, as Eysenck (1983) pointed out, one of the best predictors of increased levels of anxiety is threat to self-esteem, which is often manipulated in experiments as a threat of failure. In other words, manipulating threat to self-esteem by artificially decreasing performance of a subject in a particular test can increase his/her anxiety level.
The interplay between emotions and cognition

The meaning of emotion in everyday life seems to be crucial for proper functioning, and it is not surprising that emotions are important for cognition or more specifically for cognitive processing. Moreover, as Smallwood, Fitzgerald, Miles, & Phillips (2009) pointed out, currently in the field of psychology it is often accepted that emotion and cognition are inseparable. Additionally, Eich and Schooler (2000) state that “modern cognitive researchers regard emotions with respect, finding in them predictable effects on tasks as diverse as episodic recall, word recognition, and risk assessment” (p.3).

Mood and memory

Probably one of the most investigated cognitive areas related to emotion is memory (Eich & Schooler 2000; Oatley & Jenkins, 1996). Bower (1981; 1992) proposed a theoretical model called the emotional memory network. The theory suggests that once we experience an emotion, this activates nodes of all other similar emotions and their attendant associations in a memory network. Bower (1981) pointed out this system is similar to the semantic network where one node of a word activates the nodes of other words. As Bower (1981) suggests, each emotion is linked with a proposition describing events from one’s life during which that emotion was aroused. Therefore, an emotion creates memory traces in a network and when the particular node of the emotion is triggered it automatically activates all related representations in the memory network. This theory explains the free association effects of emotional material and mood-dependent and mood-congruence in memory (Bower, 1981; Bower & Forgas, 2001).

The free association effect refers to a situation where subjects make emotional associations to a neutral word such as ‘life,” which affects their mood state. Many studies confirmed a free association effect among depressed patients who make more negative
associations (Williams, Mathews & MacLeod 1997) and positively oriented subjects who choose more positive words in the free associations tasks (Bower 1981; Oatley & Jenkins, 1996). The mood dependent effect refers to the influence of mood state on recall. If the recall process occurs when one is in the same mood as he was during the learning process the recall effect will be greater (Bower 1981). It should be noted that further studies have not consistently replicated the mood-dependent memory effect in both typical subjects and patients with emotional dementia (Mathews & MacLeod, 1994; Oatley & Jenkins, 1996; Eich & Schooler, 2000; Chepenik, Cornen & Farah, 2007).

The mood-congruence effect suggests that we learn better, that is, faster, and we have quicker recall for things that are congruent with our emotional state, that is, mood. Studies presented by Bower (1981) show that we better attend to congruent material and we learn it faster. Moreover, Eich and Schooler (2000) presented a list of findings that describe the mood congruent effect generated in a task of autobiographical event generation. For example in a study performed by Eich (1994), undergraduate students with temporally induced sad and positive moods were asked to recall any events from their past that are related to a rose. The findings suggest that the type of mood is related to the emotional balance of the information given by each participant. In other words, the subjects who were in a sad mood gave more examples of sad events related to a rose, while participants who were in a positive mood recalled more positive events associated with a rose. There is also an interesting side of this effect, which is known as a mood-congruence bias. Here attention and/or memory are disturbed in word recognition when distractors with meaning related to the emotional state of participants are also presented. Thus, subjects recognize the target more slowly because of emotionally concurrent distractors (Bower 1981; Chepenik et al. 2007). It is also interesting to note that in the case of mood congruent memory; there is an observed interrelationship between memory and emotions.
Oatley and Johnson-Laird (1995) proposed a modification of the emotional network memory theory. In their view, emotion and behavior have always existed together throughout the evolution of our species. Basic emotions such as fear, anxiety, and love became stereotyped in cognition, protecting us from danger and fostering involvement in more pleasant behavior. In this light, the mode of fear activates a specific representation in order to find a solution as quickly as possible. Oatley and Johnson-Laird (1995) also pointed out that individual development and the culture of society affect the specific character of each mode. Therefore, each emotive mode has a subjective meaning for a person. One of the most important advantages of this approach is the fact that it highlights individual differences between subjects who are in experiments. As Chepenik et al. (2007) and Mathews and Macleod (1994) suggest, personality, history of depression, other mental issues, and the ability to experience one specific mood more than others may affect a subject’s results in cognitive tasks. As Mathews and MacLeod (1994) and Oatley and Jenkins (1996) suggest, Bower’s theory cannot explain why people recall better things with personal meaning for them. Moreover as the studies of Mathews and MacLeod (1994) on anxious patients suggest, attentional effects are more significant when emotional stimuli match the domain of greatest concern to those subjects.

The influence of emotions on attention

Attention acts as a filter, allowing an individual to focus on the most important stimuli in the environment so that they can be processed, analyzed and remembered. However, Desimone and Duncan (1995) point out that not only task-relevant information is processed, but also important, salient and vivid features of other task irrelevant objects in the visual field are.
A common notion in the current scientific literature is that attention prioritizes emotional information, which is therefore able to reach awareness faster than neutral information (Vuilleumier, Armony, Driver & Dolan 2001, 2005; Pessoa 2010; Bishop, 2008). Whether performance is improved or hurt by attention can be predicted by the task and target relevance. For example, if the target content possesses some emotional value it can improve performance. However, if distractors have emotional values, they will attract more attention than a neutral target, and as a result performance will be weaker (Vuilleumier, 2005).

This idea of attention as a mechanism for processing two sources of information that compete with one another was further developed by a load theory proposed by Lavie (1995, 2005). According to Lavie, attention can be differentially influenced by irrelevant distractors depending on the level of effort the viewer must employ in order to process target-related information. In other words, more cognitive resources are needed to process difficult tasks, resulting in a high-load condition, defined by a depletion of available resources that are necessary for processing task-irrelevant information. The author goes on to define two mechanisms of focal attention: a perceptual mechanism, and an attentional control mechanism. The former plays a rather passive role while the latter participates actively in attentional processing. More importantly, both of these mechanisms can be affected by the level of load of information either at the same time or separately. With increased load in the attentional control mechanism, the level of influence exerted by irrelevant distractors increases, but this influence abates when the perceptual load is high.

As was mentioned above, several studies report that emotional distractors overpower neutral distractors due to automatic processes that are involved in the perception of emotions (Vuilleumier et al., 2001). Vuilleumier et al. (2001) state that the influence of emotional distractors on attention is mostly studied in the case of fearful stimuli, which produce the
strongest cognitive and behavioral response. According to researchers such as Bishop (2008), this unusually strong response is due in large part to the processing of the threatening object by the amygdala. The signal from the amygdala is transferred to frontal brain regions via the Anterior Cingulate (ACC), which monitors conflict produced by distracting information. Vuilleumier et al. (2001) show that threatening information is processed automatically and that the signal from the amygdala is too strong to be ignored by conscious attentional mechanisms. As Bishop (2007, 2008) and Luo, Holroyd, Majestic, Cheng, Schechter, & Blair (2010) show, however, load theory provides important insight into this process. Emotional distractors have the advantage in low attentional load processing, but not in high when task difficulty is greater.

Moreover, it is not difficult to agree with Pessoa (2009) who believes that the emotional influence on attention has many causes, an important one of which is task: “an emotion-laden item that is task relevant will often improve behavioral performance because additional processing resources will typically be devoted to it (relative to neutral). At the same time, a task irrelevant emotional item will usually impair performance because resources will be taken away from the main task” (Pessoa, 2009, p.162). Another important factor is the level of threat. When the item is low in threat and is task relevant, behavioral performance usually is better than for neutral items. As Pessoa (2009) explains, the resources needed to interpret the emotional proprieties of the object are integrated with resources that are used in the processing of the target. Therefore, a subject has more resources and needs less time to respond. On the other hand, the item that is high in threat requires more resources in order to be processed, and as a result there are fewer resources available to process the actual (attended) stimulus. Pessoa (2009) draws an interesting conclusion by stating that both stimuli low in threat and positively valenced targets such as those associated with some reward can improve attention. In contrast, highly emotional targets or distractors, whether positive or negative, impair attention.
In the literature there are examples of experimental studies that support this theory. For example, Kanske and Kotz (2010) conducted an ERP and behavioral study among clinically healthy young subjects. The researchers used the flanker paradigm with threatening words in one condition and neutral words in another. In a flanker task subjects are asked to discriminate the centrally presented target that is flanked with incongruent or congruent distractors on both sides. In the current task, subjects on each trial were presented with three words vertically on the screen. Subjects were instructed to respond to the color of ink of the middle word, which could be either red or green. There were two conditions: threatening, in which all words were fearful such as: “blood”. and neutral in valence such as “table.” In congruent trials, all three were words of the same color and in incongruent trials the middle word (the target) was a different color than the two distractors. The flanker effect, observed in various experiments, is that participants are slower in incongruent trials than in congruent trials (Rowe et al, 2007). Additionally, a conflict effect can be calculated by subtracting the overall RT for incongruent trials from the RT for congruent trials. In the study of Kanske and Kotz (2010), the conflict effect was significantly smaller for the threatening conditions than for neutral ones. Therefore, these findings confirm if the target is not very threatening then emotional information coded into the target can improve attention performance. The ERP results revealed that emotional words evoke higher N2 amplitude 150 ms of stimulus onset. The authors argue that these findings support the predictions of Pessoa (2009), that emotional information becomes integrated with information about the attended target very early on in the information processing.

Similar conclusions were presented by Eastwood, Smilek, and Merikle (2001). They conducted visual search tasks among 11 undergraduate students. Subjects saw many faces on the screen on each trial, with the number of the faces varying across trials. Faces were neutral, angry, or happy. They found that subjects were significantly faster when the target was the happy or
angry face among neutral faces than when they needed to find the neutral face among emotional (angry or positive) ones.

In light of the above, it is possible to conclude that stimuli that possess some, but not a large amount of, arousal power can enhance attention processing in visual tasks. The theoretical assumption of Pessoa (2009) fits the Yerkes-Dodson Law, which describes a ‘U’ shaped relationship between arousal and performance. The optimal level of arousal can increase performance of a subject, but if the mood or stimulus is too weak or too intense it can have no effect or impair the subject’s performance (Yerkes & Dodson, 1908).

**The Broaden and Build theory of positive resources: an influence of positive affect and anxiety on attention and creativity**

**Positive affect**

As was mentioned above, positive affect is positively valenced. In other words, it is a type of mood that is generated by a blend of positive emotions. Furthermore, positive emotions such as happiness, joy, or coolness etc. are commonly accepted by many psychologists as vital ingredients of psychological well-being (Seligman, 2000). Interestingly, much research reveals that positive emotions can make problem-solving and decision-making easier because they increase participants’ creative thinking (Isen, Johnson, Mertz, & Robinson 1985; Isen 1999, and 2000).

One of the three studies that Isen et al. (1985) conducted employed different methods of mood induction. In the pilot study they used a gift in order to induce a positive mood. In the first study they provoked positive mood among participants by asking them to write associations to positively valenced words. In the second study they asked participants to watch a comedy or sad short movie to induce mood. In each of the studies participants were selected from a pool of
undergraduate students and in the largest study, the second one, 190 participants were involved. The tasks in each of these tasks were similar: Subjects were asked to write associations to given words. In study number one, the given word was only positive. In the second study the given words were positive, neutral or negative. The results reveal that only those subjects in a positive mood and associating to positive words produced significantly more unusual word associations; there were no differences between the neutral and negative conditions. The majority of these unusual associations were positive in valence as expected. However, what was interesting was the number of relatively rare associations triggered by a positive mood (Isen et al., 1985). The authors concluded that positive affect changes the structure of working memory such that more associations can be under consideration. As Isen et al. (1985) pointed out, positive affect can enhance creative thinking, but it can also enhance the probability of being distracted by allowing more aspects environmental distractors to be considered as well.

Fredrickson (2001) suggests that the Broaden and Build Theory of Positive Emotions can explain the results of Isen’s studies. According to this theory, the basic function of positive emotions is to inform a person that the action can be continued. Also, people are usually more willing to keep positive memories rather than negative ones. Positive emotions that remain in memory create or build positive resources, which allow people to broaden their thinking and to think in more creative ways (Fredrickson, 2001). The theory explains that positive resources have two main functions: broadening people's momentary thought action repertoires and widening the array of the thoughts and actions that come to mind. Finally, the theory suggests that the more positive events and feelings that are experienced during our life span the more positive resources we have. Below, are presented some studies that verified these assumptions.
along with others that investigated the effect of positive and negative emotion on cognition and brain functioning in general.

Rowe, Hirsch, & Anderson (2007) wanted to determine whether positive mood broadens the scope of attentional filters. Researchers used specific types of jazz or classical music in order to induce a happy or a sad mood in 24 participants. Subjects were given a semantic search task (Remote Associates Task – RAT) with a visual selective attention task that is, the Eriksen flanker task. These two tasks are employed in the present study and thus their description will be quite specific.

The flanker task used by Rowe et al. (2007) was based on the classic flanker task proposed by Eriksen and Eriksen (1974). The main purpose of this task is to verify the power of inhibitory control of selective attention and the capacity of attention (Eriksen & Eriksen, 1974). In this task, subjects are focused on the center of the screen and have to report as quickly as possible when a target appears. The target is always in the same place and it is flanked by the distractors that represent the same category as the target; for example, if the target is a letter the distractors are also letters. Distractors are presented on both flanks of the target and they are located in the same horizontal line as the target, thus creating a row with the target. However, their distance from the target can vary. Eriksen and Eriksen (1974) found that distractors that were more than 0.5 cm diagonal from the target had less or no interference effect on response time of subjects.

Rowe et al. (2007) used two types of distractors, compatible and incompatible ones, and three spacing conditions (near, medium, and far). The compatible response is a letter from the target set (e.g. the target was letter N and the distractors were the letter N also). The incompatible response is a different letter from the target (target N distractors H). Subjects in each condition
reported greater interference for incompatible flankers than compatible ones. However, the biggest difference was noted in the medium and far spacing conditions in which high positive mood was associated with a greater interference effect. Rowe et al. interpreted this result as an impact of positive mood on attention scope. It seems that positive emotions widen attention scope and thus the distractors located far from the target affected the response time of participants in the positive mood condition.

The Remote Associates Task (RAT) requires subjects to use their semantic knowledge to make word associations (Mednick & Mednick, 1964). The task consists of many word problems with each consisting of a word triad (e.g. BLACK, MAIN, KEY) in which a subject is asked to find the common association (in this case, BOARD). Rowe et al. (2007) showed that subjects in the positive mood condition made more semantic associations, that is, they reported more correct answers than in the sad and neutral conditions. There was no difference in performance between subjects in the sad group and those in the neutral group. Rowe et al. (2007) suggest that positive mood increases creative thinking abilities, and thereby more connections in the semantic network are established.

Smallwood et al. (2009) explored whether the positive mood effect of widening selective attentional manifested in the wandering mind effect. The wandering mind effect is a situation when a person thinks about something else while paying attention to a particular thing or task. Basically there are two types of this effect: thoughts related to the task (TRT) and thoughts unrelated to the task (TUT). In this study 59 undergraduate students were tested. Smallwood et al. (2009) used different types of Video clips in order to induce positive, neutral or sad moods. In order to measure if mood affects the ability to inhibit attention, the Sustained Attention to Response Task (SART) was used. This is a task similar to the Go/NoGo task (Smallwood et al. 2009). In SART subjects are asked to click a button as quickly as possible in response to a target
on the screen; however, they have to sustain their response when a particular stimuli is presented before the target. The target appears infrequently within a series of identical distractors. The task usually bores participants, which affects the number of errors committed by them, and each error in turn affects the response time for other trials (they become more cautious after an error, and thus slower). Smallwood et al. (2009) asked subjects after the task to report if they were wondering about something during the task, and if those thoughts were unrelated or related to the task. The results show that positive mood was correlated with higher scores on SART (they made fewer errors and were faster) and that these participants reported less mind wandering of any type. Negative mood increased the level of mind wandering, but subjects in the sad mood condition made as many errors as participants in the neutral mood condition, confirming the results achieved by subjects in the Go/No-Go task in a study by Chepenik et al. (2007). Smallwood et al. (2009) also observed that subjects in negative mood were both more likely to suffer lapses of attention and less likely to recover from them in comparison to positive mood conditions. This finding may seem contrary to the predictions of the Broaden and Build theory and this will be developed further below.

Subramaniam, Kounios, Parrish, & Jung-Beeman (2008) investigated two problems. The first one was the relationship between different moods and insight vs. non-insight (analytic) strategies in problem-solving tasks. The second one was the localization and level of brain activation under positive mood and during insight thinking. In their studies, 79 neurologically healthy, right-handed participants were involved. They did not use mood induction; instead they used standardized personality tests (PANAS – Positive Affect and Negative Affect Scale, and STAI - the State-Trait Anxiety Inventory). Participants had to solve a set of compound remote associate (CRA) tasks (similar to the Remote Association Task described above). According to Subramaniam et al. (2008) there are two ways to face a word triad, analytically or with insight.
The analytic strategy means that people try to find a word associated with each of the words in a triad; thus they must analyze each word separately. Subramaniam et al. (2008) believe that insight typically “occurs when people initially focus on an incorrect but dominant association in a word triad and need to overcome this impasse and switch to the correct solving strategy to be able to reach a sudden (Aha!) understanding of the solution” (p.418). Therefore, the insight strategy relies on the semantics association created after making an incorrect guess. Subramaniam et al. asked participants after each problem which strategy they used to solve it. The results showed that positive mood was related to insight strategies; that is, people who achieved a higher score on the PA scale chose insight strategies more often than subjects with lower PA scores, and more often than highly anxious participants. The highly anxious subjects showed the opposite effect: that is, they often used non-insight strategies in order to solve the puzzle than others. It should be noted that those participants who were positively oriented (and those who were low anxious) did not use only one strategy to solve the puzzle, but were more flexible in shifting strategies; therefore their overall result of solved problems was higher than low positive and high anxious subjects.

Thus research suggests strongly that positive emotions have positive effects on cognition. Rowe et al. (2007) and Subramaniam et al. (2008) believe that positive emotions release resources that allow people to make more semantic connections in their semantic networks. Additionally, Smallwood et al. (2009) state that resources released by positive affect increase one’s ability to inhibit attention. Therefore, people are not only more focused on task but they are less distracted by thoughts unrelated to the task. On the other hand, Rowe et al. (2007) report that highly positive participants in flanker tasks show a wide scope of attention, making them more vulnerable to distractors. These two last results seem to conflict with one another. It seems that positive emotions affect attention differently and type of task and mood are important factors at
the attention stage of information processing. In other words, positive moods do not always affect the scope of attention by making it wide. The nature of the task and mood itself determine the application and availability of attentional resources.

Attention can also be affected by negative emotions. Fredrickson (2001) suggests that they should limit our performance by narrowing our attention scope. As studies presented below show, from a neurological point of view there is overlap among activation patterns in the brain in sad and depressed moods; however, the results from behavioral experiments show a different effect of anxiety and sadness on attention.

Mayberg Liotti, Brannan, McGinnis, Mahurin, & Jerabek (1999) conducted two experiments, one with healthy subjects and another with depressed patients in order to observe the relationship between shifts in overall mood state and activity in the brain. Healthy participants in the sad and neutral conditions rehearsed mood-congruent autobiographical scripts. The analysis of neuroimages from both experiments shows that sad mood affected the activity of a common set of prefrontal and limbic brain regions. The activity in the prefrontal cortex was noticed for both normal subjects in the sad condition and depressed patients. As Mayberg et al (1999) suggest, the prefrontal cortex is crucial to the mediation of mood-attention interactions necessary for maintenance of emotional homeostasis in healthy subjects and depressed patients.

Chepenik et al. (2007) studied the influence of sad mood on the cognition of 33 healthy subjects. Participants in a sad mood condition listened to mood-congruent music and focused on the imagery suggested by the mood induction instruction. Subjects in the neutral condition listened to neutral music. The researchers used two working memory tasks (object 2-back and digit span), two cognitive control tasks (Stroop color-word interference and Go/No-Go), and three tasks that measured attention, perception and memory for emotional material (attentional probe, free recall and recognition memory, and facial emotion recognition). Chepenik et al.
(2007) found a significant relationship between sad mood and cognition only in the recognition memory task with negatively valenced words and in recognition of facial emotion. In the first case, subjects in the sad mood condition showed a bias in recognition and in the second, they were less accurate than subjects in the neutral condition.

This study questions the suggestion that a sad mood in healthy subject limits human attention and memory, although several studies confirm the negative effect of a depressed mood on cognition among depressive patients (Watts, Macleod, & Mathews, 1997; Bower & Forgas, 2001). It seems that clinical depression has its own nature and a negative impact on cognitive processing. As Rowe et al. (2007) and Chepenik et al. (2008) suggest, it is also possible that the mood induction methods used in their studies and others may be insufficient for creating the type of sad mood which would affect cognition as effectively as happens in depressed patients.

**Anxiety**

Another type of negative mood that seems to have a greater impact on cognitive processing is anxiety. As was pointed out by Macleod and Mathews (1994), and Broadbent and Broadbent (1988), there is a significant effect of anxiety on selective attention, but only in cases of high anxiety. Macleod and Mathews (1988) found that only healthy subjects with the trait of high anxiety showed attention bias toward threatening stimuli in a dot-probe task. In other words they attended more to target stimuli that replaced a threatening word than they did to those that replaced a neutral word.

Fox and Knight (2005) explored the impact of anxiety on selective attention to threats among older adults. They tested 68 highly educated adults (M=73.6 years of age). Participants completed the Spielberger Trait Anxiety Inventory (STAI-Y2) on the basis of which they were assigned to either a high or low anxiety group. Subjects performed an emotional Stroop and dot-
probe task. In the emotional version of the Stroop task, a subject has to read the ink color of a threat word in one condition and a neutral word in the second one. In the dot probe task, participants read two words (threat words in one condition and neutral words in the other) appearing on the top of the screen and must press the spacebar when they see a dot. The results show that highly anxious participants were significantly more vulnerable to mood concurrent distractors and their overall performance was lower in relation to low level anxiety subjects. These results also confirmed the results of studies conducted on samples of younger adults (MacLeod & Mathews, 1988, 1994). Therefore, the negative impact of on anxious mood on attentional process is suggested to be permanent during the life span.

The other type of evidence comes from studies of math anxiety, which show that stress has a significant impact on performance in mathematical tasks. Ashcraft (2002) and Ashcraft & Kirk (2001) presents results that suggest that high math anxiety limits the capacity of working memory and thereby limits the overall performance in problem solving tasks in relation to low anxiety. Ashcraft & Kirk (2001) believe that the high level of stress is responsible for the minimization of available cognitive resources; thus the executive (working memory) has less potential for solving quantitative cognitive tasks.

**Conclusion**

The results of these studies suggest that positive mood and anxiety have an impact on one’s scope of attention and probably on the capacity of working memory. The role of sad moods is still questionable; however there is a significant advantage in performance when one is in a positive mood as opposed to when one is experiencing sadness and anxiety. It should be highlighted that a negative impact of anxiety on attention seems to be more significant than
sadness. Lastly, it is important to note that the patterns of brain activation also suggest that there is overlap between type of mood and level and localization of activation in the brain.

The purpose of the research

It is commonly believed that there is a connection among different human emotions and cognitive abilities (Oatley & Jenkins, 1996; Smallwood et al. 2009). As was presented above, much research shows that different emotions affect information processing differently. Furthermore, many findings reveal that positive emotions such as happiness and joy positively affect cognitive performance. According to the Broaden and Build theory and the results of Rowe et al.’s (2007) study, positive resources impair subjects’ inhibitory skills in the flanker task; however, the opposite was observed by Smallwood et al., (2009) in the case of the Sustained Attention to Response Task. However, there is agreement among most researchers that positive affect increases the probability of problem solving and high scores on creativity tasks (Isen at al., 1985; Isen, 1999; Frederickson, 2001; Subramaniam et al., 2008). On the other hand, there are many studies that show the negative impact of anxiety on cognitive performance, especially attention (Broadbent & Broadbent 1988; Macleod, & Mathews, 1994). However, there are only a few studies with a longitudinal design that investigate emotions and their influence on cognition in the natural environment and under natural stressors (Fox, 2008). Many researchers try to investigate the influence of induced moods rather than stable mood traits on information processing (Rowe et al., 2007; Fox, 2008; Smallwood et al., 2009; Oatley & Jenkins, 1996).

The present study examines naturally occurring effects of positive affect and anxiety (exam stress at different points in the semester) on attentional performance and creative abilities of undergraduate students. The main purpose of two experiments that will be presented in this paper is to answer the following questions:
1. Will subjects characterized as highly positive using a self-report questionnaire show a wider scope of attention than those characterized as highly anxious?

2. Will subjects characterized as highly positive outperform highly anxious subjects on the Remote Associates Task?

3. Do semester pressures reflected in the date of measurement affect cognitive performance of highly positive and highly anxious subjects?

**Hypothesis**

The three aforementioned research questions can be explored in three main hypotheses:

**H1:** According to the Broaden and Build theory participants with High Positive Affect (PA) and/or Low Anxiety State (AS) should have limited number of positive resources and therefore they would be more distracted and therefore the influence of incongruent distractors on their selective attention would be greater in Medium and Far spacing conditions than for subjects in the low PA (and/or High AS) and neutral PA (and/or Neutral AS) groups.

**H2:** According to the Broaden and Build theory Participants with higher PA would solve more semantic problems in in two creative tasks than participants with high level of AS. On the other hand, a negative correlation should be observed between AS and participants’ results on the creative tasks.

**H2a:** If hypotheses one and two are true, the higher conflict effect score measured as a difference in reaction times between incongruent distractors and congruent distractors in Medium and Far spacing conditions should be positively correlated with a greater number of correct responses in the creative tasks.
**H3:** Participants will notice higher PA scores in the non-stress period of the Fall semester than at the end of the Fall term. Therefore, their AS score should be higher at the second testing session than in the middle of the semester (the first testing session).
Methods

Subjects

Fifty (38 females) undergraduate students from the City University of New York between 18 and 25 years old participated in the first session of the experiment, during October 2010. Thirty-five (28 females) of them returned for the second testing session in December 2010.

Materials

The Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule (PANAS) is a questionnaire that measures the level of positive and negative emotions experienced (Watson et al., 1988). The measurement consists of two ten-item self-report mood scales: one refers to negative feelings (Negative Affect or NA) such as anger or anxiety and the other measures positive moods (Positive Affect or PA) such as joy and enthusiasm. Before the test, participants are instructed to think about each emotion in the context of the past few weeks; then they rate each of the feelings based on a scale from one (very slightly or not at all) to five (extremely). The maximum possible score in either Positive Affect (PA) or Negative Affect (NA) sub-scales is 40. According to Watson and Tellegen (1988) for the Positive Affect Scale Cronbach alpha coefficient was 0.86 to 0.90; for the Negative Affect Scale, 0.84 to 0.87. The full instrument is attached in Appendix A.

The State-Trait Anxiety Inventory

The State-Trait Anxiety Inventory (STAI) is a popular tool for trait anxiety measurement. It consists of two sub-scales: one measures Anxiety State (AS) and the second measures Anxiety Trait (AT). Each sub-scale consists of 20 statements and each refers to a specific symptom of anxiety. Subjects rate their responses on a four point frequency scale from one (almost never) to
four (almost always); the total scores range from 20 to 80 points on both AS and AT scales (Spielberger, Gorsuch, & Lushene., 1970). According to Barnes and colleagues (2002), the STAI is also highly reliable and valid, with coefficient alphas ranging from 0.72 to 0.96. The test-retest correlations range from 0.82 to 0.94. Due to the copyright agreement that was signed by this author only four sample items are attached (please see Appendix A).

**Eriksen Flanker Task**

The flanker task is based on the method proposed by Eriksen and Eriksen (1964) and is similar to the method used by Rowe (2007). The subjects are presented with five letters string at the center of the computer screen and their target is always a letter in the middle of the string. A group of two letters on each flank (side) serves as distractors. Distractors can be congruent, that is, they can be the same as the target or incongruent, that is, different letters than the target. Similarly to Eriksen and Eriksen (1964), there were two targets in this task: H (first set) or K (second set). Subjects were asked to press an assigned key when they saw one of the two letters (for example ‘left mouse key’ for ‘H’ or ‘right mouse key’ for ‘K’). The types of letters in each response set are not accidental. Erikson and Erikson (1974) used the letters proposed by Gibson (1969). The letters H and K share five features (types of lines that are essential for those two letters). Therefore, these two letters are similar and discrimination between them is more difficult than in the case of letters such as ‘D’ and ‘N’ that do not share so many features.

As was mentioned above, there were two types of distractors: congruent and incongruent. Congruent distractors are letters that match the target (e.g., for the target H, the compatible distractors will be H’s). Incongruent distractors match the other target (e.g., letter K for the target H). As was done in Rowe et al (2007), the distance between distractors and the target was manipulated. There were three distances: 0 (Near), 1 (Medium), or 2 (Far) letter widths for each
of the compatible and incompatible target/distractors combinations. Stimuli matched those of Rowe et al. (2007): letters in uppercase in Times New Roman 12-point font, measuring 0.2” high on the screen. The distance between each subject and the stimuli was 23.5”. The Visual Angle of the target in degrees was 0.47 cm degrees. Examples of stimuli for each distance are presented below:

**Target H** with incongruent distractors **K** in ‘Near’ condition:

KHKHKK

**Target H** with congruent distractors **H** in ‘Medium’ condition:

HHHHH

**Target H** with incongruent distractors **K** in ‘Far’ condition:

KKHKK

**Remote Associates Task (RAT) and Compound Word Problems (CWP)**

RAT - in this task participants are given three words and are asked to say one common word/theme from the word triad that they see. This task requires the ability to create semantic associations (Mednick, 1964). The examples of word triads were taken from Mednick and Mednick (1967). Similarly to Rowe et al. (2007)’s method, subjects faced a list of ten moderately difficult word triads. There was one word solution for each of these problems. An example of the question is presented below:

What single word associates these three words together?

**Cottage; Blue; Mouse**

The answer is **Cheese**

CWP – is a subset of the RAT. The difference between the two sets is that in the CWP a word that is a solution is always a word that allows creating compound words or two-word
phrases with three words presented in a word triad (Bowden & Jung-Beeman, 2003). For example:

**French; Car; Shoe**

The answer is: **Horn**

**Procedure**

Subjects were tested twice during the fall semester in a repeated measure design. The first testing session was conducted at the beginning of October 2010 over the month. The second testing session was conducted over the two last weeks of the Fall semester in December 2010, when stress levels were presumed to be higher due to the advent of final exams and term paper due dates. Subjects were tested for one hour in each of the two sessions. At the beginning of both test sessions, the subjects filled out the PANAS and STAI questionnaires. Then each participant was seated 23.5" from the 19" CRT computer screen and performed the computer tasks. The first task was always the flanker task and the last ones were CWP and RAT. The computer tasks were programmed and presented by the NBS Presentation software.

**Procedure for the flanker task**

Before each block, participants were informed that they would have to press one mouse key when they saw at the center of the screen ‘H’ and another mouse key when they saw ‘K’. Participants performed three blocks of 100 trials each. Subjects were presented with the Near, Medium or Far conditions randomly with one block per condition. Each of the experimental blocks was preceded by a 30 trial corresponding practice session. In the practice session after each response, the subjects were given feedback on the screen as to both accuracy (‘correct’ or ‘incorrect’) and speed (after 1000 ms they would see ‘too slow’ and if they responded in the first 100 ms from stimulus onset, ‘too fast’). When subjects attained accuracy higher than 80%, they
were ready for the real task without feedback information. The order of the blocks and the mouse responding buttons were counterbalanced across subjects throughout the study. In the flanker task subject response time is measured in each spacing condition.

**Procedure RAT and CWP**

In practice and testing sessions each participant saw a word triad on the computer screen for a maximum of 30 seconds. Beforehand, subjects were instructed to type their answer using the computer keyboard. The word problems were divided into two groups of ten triads per group: RAT and CWP. Before a subject responded to either type of word triad he or she performed one practice word problem of that type. In the practice session the experimenter confirmed the correct answer. Therefore, it was two practice and 20 experimental word triads for each subject. The maximum number of points that a subject could achieve in this task was 20. Each point equals a correctly solved word triad.

**Data analysis**

The data from the two sessions were analyzed using Excel 2007 (Microsoft Office) and SPSS for Windows, 17th edition. Data analysis included descriptive statistics, within and between subject t-tests and ANOVAs, and correlation analyses. In case of reaction time data in each condition distribution was approximately normal, this allowed using parametric tests to measure participant’s performance in the two tasks.
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Results

The effect of academic pressure during a semester: PANAS and STAI results

Results of the PANAS (PA and NA) and STAI (AS and AT) administered to 50 subjects for the first session and 35 subjects for the second session are presented in Table 1.

Table 1 Descriptive statistics for questionnaires measuring emotions, in the second column are results for all subjects that participated in the first session, columns three and fourth present difference in result obtained by 35 subjects in both sessions.

<table>
<thead>
<tr>
<th>Mood measurements</th>
<th>Mean and std. deviation for session 1 (n=50)</th>
<th>Mean and std. deviation for session 1 (n=35)</th>
<th>Mean and std. deviation for session 2 (n=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Positive Affect</td>
<td>33.40 (7.23)</td>
<td>32.66 (6.55)</td>
<td>29.94 (7.76)</td>
</tr>
<tr>
<td>1st Negative Affect</td>
<td>24.34 (7.67)</td>
<td>24.00 (8.05)</td>
<td>25.06 (8.91)</td>
</tr>
<tr>
<td>1st Anxiety State</td>
<td>40.46 (11.76)</td>
<td>40.69 (12.09)</td>
<td>45.49 (12.55)</td>
</tr>
<tr>
<td>1st Anxiety Trait</td>
<td>46.70 (10.60)</td>
<td>47.69 (10.83)</td>
<td>46.29 (11.85)</td>
</tr>
</tbody>
</table>

The third and fourth column of Table 1 present results for 35 subjects that participated in both sessions are presented. They show that Positive Affect and Anxiety state were affected by time of test, in the predicted direction. Likewise, there was a small increase in the expected direction in Negative Affect. Within-subject two-tailed t-tests showed significance with medium effect size on positive affect $t(34) = 2.39, p < 0.05, r^2 = 0.14$, and power = 0.65, and anxiety state $t(34) = -2.47, p < 0.05, r^2 = 0.15$, power = 0.70, with negative affect and anxiety trait failing to reach significance $t(34) = -.98$ and .99 respectively.

Affect and Anxiety State groups in the first and in the second testing session

Positive Affect (PA) and Anxiety State (AS) were the only two variables measured that significantly fluctuated during the semester. In order to measure the effects of mood on the subject’s performance in attention and creativity tasks, participants were assigned to High, Neutral or Low Positive Affect or Anxiety State groups based on the responses on the Positive
Affect Scale and Anxiety State Inventory, respectively. It should be noted, that Anxiety Trait as a most stable variable across two sessions was also used in order to created two groups and measured the influence of time of testing on subjects’ performance (please see pages 51-53).

The first session

The analysis of skew and kurtosis of the distribution of PA in the first session showed that it is approximately normal. The observed skew was 0.27 (standard error of skewness = 0.34), and kurtosis was -0.51 (std. error of kurtosis = 0.66). A similar analysis was conducted for the AS distribution, which revealed also that this distribution was also approximately normal. The skew for AS was 0.62 (standard error of skew = 0.34) and kurtosis was -0.03 (std. error of kurtosis = 0.66).

Three group types (Low, Neutral, and High) were created on the basis of quartiles that were obtained from both frequency distributions described above. Subjects were assigned to three different groups created for each scale (PA and AS). More specifically, subjects were assigned to the Low (lowest through 25th percentile), Neutral (highest through 25th to 75th percentile) and High (highest through 75th percentile) categories for the Positive Affect and Anxiety State scales.

Both types of mood groups created in the first testing session are presented in Table 2. A between-subject ANOVA and a Tukey HSD post-hoc test revealed that the differences in the scores in PANAS (Positive Affect) and STAI (Anxiety State) questionnaires among members of the Positive Affect groups and Anxiety State groups respectively are statistically significant for p < 0.01.
Table 2 Positive Affect and Anxiety State groups in the first session

<table>
<thead>
<tr>
<th>1st session PA groups</th>
<th>n</th>
<th>Mean and std. deviation of PA</th>
<th>1st session AS groups</th>
<th>n</th>
<th>Mean and std. deviation of AS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low PA</td>
<td>13</td>
<td>24.46 (2.14)</td>
<td>Low AS</td>
<td>12</td>
<td>26.27 (3.25)</td>
</tr>
<tr>
<td>Neutral PA</td>
<td>25</td>
<td>33.24 (2.4)</td>
<td>Neutral AS</td>
<td>26</td>
<td>39.23 (4.38)</td>
</tr>
<tr>
<td>High PA</td>
<td>12</td>
<td>43.42 (3.37)</td>
<td>High AS</td>
<td>12</td>
<td>56.92 (7.53)</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>33.40 (7.23)</td>
<td>Total</td>
<td>50</td>
<td>40.46 (11.76)</td>
</tr>
</tbody>
</table>

It was impossible to create one type of emotional group because Anxiety and Affect, although significantly correlated (negatively: rho = -0.57, p < 0.001) also measure different things and as a result the same people did not wind up in the high positive affect and low anxiety groups as can be observed in Figure 1. Furthermore, as is shown in Appendix A, the Positive Affect questionnaire asks participants about their feelings in the last few weeks, while the anxiety state survey focuses on actual emotions of the participants at the moment of completing the questionnaire. It is important to note that the affect grouping therefore focuses on long-lasting mood rather than the actual state at the time of the session.

Figure 1 Representation of members of Low, Neutral and High Anxiety State (AS) groups in each Positive Affect (PA) group, at the first session. It should be noted that there is no the Low Anxiety State group (blue bar) members in the Low Positive Affect group.
Thus, because the two measures characterized subjects differently, results on the tasks of interest were analyzed for group effects in both Positive Affect groups and Anxiety State groups.

The second session

In the second testing session the procedure was repeated and both variables were again approximately normally distributed. For PA the observed skew was 0.39 (standard error of skewness = 0.40), and kurtosis was -0.75 (std. error of kurtosis = 0.78). In the case of the AS distribution skew was 0.36 (standard error of skewness = 0.40) and kurtosis was -0.92 (Std. Error of Kurtosis = 0.79).

The Positive Affect Groups and Anxiety State Groups created in the second session are presented in Table 3. As in the first session, the between-subject ANOVA and Tukey HSD post-hoc test revealed significant differences (p < 0.01) in the scores in PANAS (Positive Affect) and STAI (Anxiety State) questionnaires among members of Positive Affect groups and Anxiety State groups.

Table 3 Positive Affect and Anxiety State groups in the second session

<table>
<thead>
<tr>
<th>2nd session PA groups</th>
<th>n</th>
<th>Mean and std. deviation of PA</th>
<th>2nd session AS groups</th>
<th>n</th>
<th>Mean and std. deviation of AS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low PA</td>
<td>9</td>
<td>20.78 (1.85)</td>
<td>Low AS</td>
<td>9</td>
<td>30.77 (2.44)</td>
</tr>
<tr>
<td>Neutral PA</td>
<td>17</td>
<td>29.23 (3.25)</td>
<td>Neutral AS</td>
<td>16</td>
<td>43.68 (5.46)</td>
</tr>
<tr>
<td>High PA</td>
<td>9</td>
<td>40.44 (3.50)</td>
<td>High AS</td>
<td>10</td>
<td>61.60 (5.46)</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>29.94 (7.76)</td>
<td>Total</td>
<td>35</td>
<td>45.48 (12.55)</td>
</tr>
</tbody>
</table>

In the second testing session members of the two types of group better overlapped (please see Figure 2) and the Spearman rank correlation again revealed significant negative correlation between membership in the Positive Affect group and the Anxiety State group: \( \rho = -0.65 \), \( p < 0.01 \).
Figure 2 Representation of members of Low, Neutral and High Anxiety State groups in each Positive Affect group, session 2. It should be noted that there is no the Low Anxiety State group (blue bar) members in the Low Positive Affect group.

The results presented in Figure 2 lead to the same conclusion as in the first testing session; thus analyses for the flanker task and both semantic tasks were conducted separately for Positive Affect groups and Anxiety State groups.

It should be noted that the group of 35 subjects who came back for the second session showed relatively stable membership status in two sessions. As shown in Figure 3 most people who were in the low positive, medium and high PA groups in the first session remained in the same groups in the second session (ρ = 0.57, p < .001). A similar observation was noted for Anxiety State (ρ = 0.503, p = 0.002); this finding is presented in Figure 4.
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**Figure 3** Representation of members of Low, Neutral and High Positive Affect groups from session 1 in each Positive Affect group in session 2.

**Figure 4** Representation of members of Low, Neutral and High Anxiety State groups from session 1 in each Anxiety State group in session 2.

**Flanker task descriptive results**

Participants performed the flanker task in three spacing conditions (Near, Medium and Far). As can be seen in Table 4, subjects suffered most in the Near spacing condition where letters are close to one another, responding slower for incongruent (different letters as distractors) trials (labeled as INCON in Table 4) than congruent (distractors are the same letters as the target) trials (labeled as CON) in both testing sessions. Both Table 4 and Figure 5 show that differences between the congruent and incongruent flanker conditions replicate at the Medium and Far distances in both sessions. It should be pointed out, that only reaction time
results are presented because accuracy exceeded 90% in all conditions, rendering no statistically significant differences because of a ceiling effect.

Table 4 Mean (M) and standard deviation (SD) of reaction times (RT) for each condition in the flanker task in the first and second session.

<table>
<thead>
<tr>
<th>Flanker task trial type:</th>
<th>M and SD for 1st session (n=50)</th>
<th>M and SD for 2nd session (n=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Near RT</td>
<td>600.78 (97.44)</td>
<td>557.16 (77.50)</td>
</tr>
<tr>
<td>CON RT for Near</td>
<td>581.24 (100.03)</td>
<td>539.63 (81.31)</td>
</tr>
<tr>
<td>INCON RT for Near</td>
<td>620.31 (97.22)</td>
<td>575.29 (75.00)</td>
</tr>
<tr>
<td>Overall Medium RT</td>
<td>561.80 (77.61)</td>
<td>527.18 (75.27)</td>
</tr>
<tr>
<td>CON RT for Medium</td>
<td>548.56 (76.80)</td>
<td>514.16 (74.58)</td>
</tr>
<tr>
<td>INCON RT for Medium</td>
<td>574.47 (81.66)</td>
<td>540.43 (80.04)</td>
</tr>
<tr>
<td>Overall Far RT</td>
<td>551.20 (77.68)</td>
<td>525.29 (69.95)</td>
</tr>
<tr>
<td>CON RT for Far</td>
<td>544.50 (75.59)</td>
<td>514.35 (71.59)</td>
</tr>
<tr>
<td>INCON RT for Far</td>
<td>557.78 (83.90)</td>
<td>535.44 (70.11)</td>
</tr>
</tbody>
</table>

Figure 5 The difference between Congruent (CON) and Incongruent (INCON) trials type in (from the left): Near, Medium, and Far conditions of the Eriksen flanker task observed in the first testing session.

In the first testing session paired-sample t-tests revealed significant differences between congruent and incongruent reaction times at all distances. It should be noted that the observed difference in response time for incongruent and congruent type of trials suggest that the congruency phenomena (participants are slower on incongruent trials in comparison to congruent
trials) diminishes with greater distance between distractors and target. This observation will be probed further below.

**The reaction times and congruency in two testing sessions for the 35 subjects who came back for the second session**

As can be seen in Figure 6, participants who returned for the second testing session responded much faster on both congruent and incongruent trials in the second testing session than in the first one. It is important to note that participants who came back for the second session were faster in almost all spacing conditions compared to their performance in the first session, as shown in Table 5. The faster RTs in the second session could be a result of practice even though there was a 30 day separation between sessions. However, as we have seen, anxiety also increased for the second session, and there is a possibility that it affected the scores.

<table>
<thead>
<tr>
<th>Type of pair</th>
<th>Mean difference</th>
<th>t (34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st CON RT for Near – 2nd CON RT for Near</td>
<td>26.98</td>
<td>2.56**</td>
</tr>
<tr>
<td>1st INCON RT for Near - 2nd INCON RT for Near</td>
<td>29.98</td>
<td>3.44**</td>
</tr>
<tr>
<td>1st CON RT for Medium - 2nd CON RT for Medium</td>
<td>19.90</td>
<td>2.38*</td>
</tr>
<tr>
<td>1st INCON RT for Medium - 2nd INCON RT for Medium</td>
<td>23.81</td>
<td>2.45*</td>
</tr>
<tr>
<td>1st CON RT for Far - 2nd CON RT for Far</td>
<td>19.79</td>
<td>2.43*</td>
</tr>
<tr>
<td>1st INCON RT for Far - 2nd INCON RT for Far</td>
<td>12.42</td>
<td>1.39</td>
</tr>
</tbody>
</table>

**. – Difference significant for p < .001; *. – p < .05

A three way repeated-measure ANOVA (session time [first vs second] X spacing [near-medium-far] X congruency [congruent-incongruent]) was used in order to verify the relationship among testing time, spacing effect and congruency. Assumptions of independence of observations, normality, and sphericity were met. All three main effects were significant: congruency F (1, 34) = 121.80, p < 0.001, \( \eta^2 = 0.78 \); spacing F (2, 68) = 44.78, p < 0.001, \( \eta^2 = 0.57 \); and session time F (1, 34) = 9.99, p = 0.003, \( \eta^2 = 0.23 \). There was also a significant
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interaction between congruency and spacing $F(2, 68) = 7.6$, $p = 0.001$, $\eta^2 = 0.18$. However, neither the interaction between session time and congruency $F(1, 34) < 1^1$, nor the interaction between session time and spacing $F(2, 68) = 1.20$, $p = 0.31$ reached significance. The three-way interaction also failed to reach significance $F(2, 68) < 1$.

Figure 6 Interaction between the spacing effect and the congruency effect in the first (figure on the left) and the second session (figure on the right) for 35 subjects

In conclusion we note that for the 35 subjects who performed in both sessions, there was an improvement in speed from the first session to the second one in the Near and Medium conditions, but not robustly in the Far condition. The interaction between spacing and congruency shows that congruency effects were reduced with greater flanker distance. In other words, the reduced distance between incongruent distractors (green line) and congruent distractors (blue line) presented in Figure 6 show better inhibitory skills of the subjects. This observation is clearest in the case of the Far spacing conditions among participants at the first session rather than in the second session.

The analysis of the spacing effect and mood on the congruency effects in two testing sessions

1 TF tests that resulted below 1 point are not fully described.
The main goal of the current study was to determine the effects of positive mood (Positive Affect and Anxiety State) on congruency at different spacing conditions. It was predicted that people with High Positive Affect (PS) and/or Low Anxiety State (AS) due to increased number of positive resources would be more distracted and therefore the influence of incongruent distractors on their selective attention would be greater in Medium and Far spacing conditions than for subjects in low PA (and/or High AS) and neutral PA (and/or Neutral AS) groups. As presented below, this hypothesis was not confirmed in either session. Furthermore, the results from the first session show something quite opposite.

**The first session**

A mixed-design model ANOVA with two within – subject variables: spacing (three levels: Near, Medium and Far), congruency (two levels: congruent and incongruent) and one between subject variable Positive Affect (PA) groups was conducted on the reaction time scores obtained in incongruent and congruent trials for the first session. For two within-subject effects: congruency and the interaction between spacing and congruency, the assumptions of independence of observations, normality, and sphericity had been met. However, Mauchly’s test indicated that the assumption of sphericity was violated in the case of the third within-subject effect, that is, spacing ($\chi^2(2) = 12.04$, $p < .001$); therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.90$).

The ANOVA showed significant main effects of congruency $F (1, 34) = 104.57$, $p < .001$, $\eta^2 = 0.69$, and spacing $F (2, 76.41) = 20.71$, $p < .001$, $\eta^2 = 0.3$, but were qualified by a significant interaction between spacing and congruency $F (2, 94) = 7.28$, $p < 0.001$, $\eta^2 = 0.13$. There was no significant interaction between PA groups and spacing $F (4, 47) = 1.32$, $p = 0.27$, $\eta^2 = 0.05$. Also the interaction among PA groups, congruency and spacing was not strong.
enough to reach significance at the .05 level $F(4, 47) = 2.04, p = 0.09, \eta^2_p = 0.08$. However, the influence of PA groups on congruency was significant, especially taking into consideration medium effect size noted for this interaction $F(2, 47) = 2.67, p = 0.08, \eta^2_p = 0.10$.

![Three figures present interaction between congruency effects (green line - incongruent distractors, blue line – congruent distractors) and Positive Affect (PA) groups of the first testing conditions in three spacing conditions, from left: Near, Medium, and Far.](image)

As can be seen in the right hand graph in Figure 7, Low positive affect participants were relatively immune to the possible advantage offered by increased spacing in conflict conditions, unlike the Neutral or High PA participants. In order to verify the influence of Positive Affect group membership on processing of incongruent versus congruent distractors, a conflict effect was calculated: the absolute difference of congruent distractors subtracted from incongruent ones. Between-subjects one way ANOVA calculated on conflict revealed that the neutral and the High PA group were more inhibited with increased distance of distractors from the target in the Far spacing condition $F(2, 47) = 4.28, p = 0.03, \text{partial } \eta^2 = 0.15$. Due to a validation of equality of variance assumption, a Games-Howell Post-Hoc analyses was used. It indicated that members of the High PA group could inhibit distractors significantly faster than people in the Low PA group ($p < 0.05$).
Another mixed-design ANOVA with the same within-subject variables was conducted to verify if the pattern of results of the Anxiety State groups as a between subject factor paralleled that of the Positive Affect groups (please see Figure 8). Similarly to the last mixed-design, all tested assumptions were met in two within-subject effects (congruency, and spacing X congruency) but Mauchly’s test indicated that the assumption of sphericity had been violated in the case of spacing \( \chi^2(2) = 9.2, p = .010 \). Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity \( (\varepsilon = 0.85) \). Results again indicated significant main effects of congruency \( F(1, 47) = 88.91, p < .001, \eta_p^2 = 0.65 \), and spacing \( F(2, 79.53) = 18.68, p < 0.001, \eta_p^2 = 0.28 \), and a significant interaction between these two factors \( F(2, 94) = 8.03, p = 0.001, \eta_p^2 = 0.15 \). The relationship between AS groups and congruency was not as strong as that for the PA groups \( F(2, 47) = 0.49, p = .65, \eta_p^2 = 0.02 \) for the main effect and \( F(4, 47) = 0.37, p = .79, \eta_p^2 = 0.02 \) for the interaction with spacing. However, the main interaction among spacing, congruency and AS groups almost reached significance and it is characterized by medium effect size \( F(4, 47) = 2.39, p = 0.056, \eta_p^2 = 0.09 \).
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Figure 8 Three figures present interaction between congruency effects (green line - incongruent distractors, blue line – congruent distractors) and Anxiety State (AS) groups of the first testing session in three spacing conditions, from left: Near, Medium, and Far.

The interaction among congruency, spacing and a membership in AS groups shows that the effect of incongruent distractors on selective attention is alleviated by greater space between the target and distractors only for specific Anxiety State groups. As Figure 8 shows, people in the Low AS group perform better on incongruent trials when the distance between targets and distractors increased in the Medium and especially in the Far spacing condition. These observations confirm the results of the High PA group noted above.

In conclusion for this part of the study, in both mood conditions subjects who were either in a highly anxious state or a low positive mood did not benefit from greater space between the targets and distractors in the Medium and the Far spacing conditions. Therefore, it seems that the session of the study conducted during the lesser stress period of the academic calendar favored students with higher Positive Affect and lower Anxiety State. We will see if that replicates for groups in the second session, and further if there is a decrement in spacing advantage in the higher stress session.
The second session

Similar analyses used for the first session were applied to the results for the 35 subjects that came back for the second phase of the study. The mixed ANOVA with the same within-subject factors as above and with Positive Affect groups as a between subject variable met all testing assumptions (independence of observation, normality and sphericity). As in the first session, there were significant main effects of congruency $F(1, 32) = 59.65, p < 0.001, \eta^2 = 0.65$, and spacing $F(2, 64) = 22.55, p < 0.001, \eta^2 = 0.41$. However, the interactions for within-subjects variables did not reach significance $F(2, 64) = 2.86, p = 0.064, \eta^2 = 0.08$. Furthermore, the between subject factor (Positive Affect groups) neither influenced congruency $F(2, 32) = 0.40, p = 0.67, \eta^2 = 0.03$ nor spacing $F(4, 32) = 1.07, p = 0.38, \eta^2 = 0.06$ significantly. Finally, the three-way interaction also failed to reach significance $F(4, 32) = 1.08, p = 0.37, \eta^2 = 0.06$. Figure 9 presents the observed relationships among those variables. The lack of significant relationship in this stage of the study may support hypothesis that change in anxiety level influence the performance of subject from the first to the second session. However it should be noted that practice and order effect may also pay role in this process which will be discussed further below.
The mixed designed ANOVA conducted for Anxiety State groups of the second testing session showed the same pattern of results as did Positive Affect. All tested assumptions were met. There were significant main effects of congruency $F(1, 32) = 60.29, p < 0.001, \eta^2_p = 0.65,$ and spacing $F(2, 64) = 21.91, p < 0.001, \eta^2_p = 0.41.$ The interaction between congruency and spacing $F(2, 64) = 3.00, p = 0.06, \eta^2_p = 0.09$ failed to reach significant. Anxiety State groups neither influenced congruency $F(2, 32) = 0.45, p = 0.64, \eta^2_p = 0.03$ nor spacing $F(4, 32) = 0.81, p = 0.52, \eta^2_p = 0.05$ significantly. The three-way interaction variables was also not significant $F(4, 32) = .83, p = 0.51, \eta^2_p = 0.05.$
In conclusion, in the second session the interesting effect of spacing as a consequence of Positive Affect or Low Anxiety State did not replicate. It should be noted that during the second session the groups that truly benefited from the change in space between the targets and distractors were Low PA and High AS (please see figures 9 and 10). Therefore, it seems that academic stressors influence the relationship between current mood and performance in the attention task especially in the far spacing condition.

A relationship between anxiety trait and time of measurements for 35 subjects

In order to verify the influence of testing time (academic stressor) on participant’s performance across two sessions it is worthwhile to divide participants into two groups based on their trait observed in the first session rather than actual state. Anxiety trait was a very stable characteristic across two sessions (please see page 37). In order to increase power of the comparison a median of Anxiety Trait of the first session (Median = 46) was used instead of
percentiles we did for PA and AS, this procedure allowed to created two relatively big groups Low Anxiety Trait (n=20) and High Anxiety Trait (n=15). As it is shown in Figure 11 all of 15 participants who belonged to the High AT group in session 1 remained in the same group in session 2 and only one subject classified as a member of Low AT group in session 1 (n=20) moved to High AT group in session 2 (rho = 0.94, p < 0.001).

![Figure 11](image)

**Figure 11** Representation of members of Low (n=20), and High (n=15) Anxiety Trait groups from session 1 in each Anxiety Trait group in session 2.

It should be pointed out that these two groups were significantly different in Anxiety State in session 1 [F (1, 33) = 7.47, p = 0.01, ηp2 = 0.19] and this difference was even higher in session 2 [F (1, 33) = 16.90, p < 0.001, ηp2 = 0.34]. Also, there was a difference for Positive Affect between Low AT and High AT in the first session [F (1, 33) = 4.29, p = 0.047, ηp2 = 0.12] and this difference increased in the second session [F (1, 33) = 8.54, p = 0.006, ηp2 = 0.21].

A mixed-design model ANOVA with three within – subject variables: time (two levels: session 1 and session 2), spacing (three levels: Near, Medium and Far), congruency (two levels: congruent and incongruent) and one between subject variable Anxiety Trait (AT) groups was
conducted on the reaction time scores obtained in incongruent and congruent trials for the two sessions. All testing assumptions (independence of observation, normality and sphericity) were met.

Results indicated significant main effects of time: $F(1, 33) = 10.61, p = 0.003, \eta^2_p = 0.24$, congruency: $F(1, 33) = 127.29, p < .001, \eta^2_p = 0.79$, and spacing: $F(2, 79.53) = 18.68, p < 0.001, \eta^2_p = 0.28$, and a significant interaction between congruency and spacing $F(2, 32) = 49.10, p < .001, \eta^2_p = 0.51$. The main effects of spacing and congruency were qualified by significant interaction between these two factors $F(2, 66) = 7.07, p = 0.022, \eta^2_p = 0.17$. The interactions between time and congruency ($F < 1$), and time and spacing $F(2, 66) = 1.86, p = 0.17, \eta^2_p = 0.052$ did not reach significance. Nor were the interactions between anxiety trait groups and time ($F < 1$) and congruence and anxiety trait groups $F(1, 33) = 1.99, p = 0.17, \eta^2_p = 0.06$. However, there was a significant interaction between AT groups and spacing $F(2, 66) = 3.07, p = 0.053, \eta^2_p = 0.09$. Furthermore, there was a significant interaction among AT groups and spacing and time $F(2, 66) = 3.23, p = 0.046, \eta^2_p = 0.09$. The last effect shows that time of testing influenced the quality of spacing in two anxiety trait groups as it is presented in the Figure 12. There were no more significant interactions for this model.

Figure 12 Three figures present interaction between time of two sessions (1 and 2) and Anxiety Trait (AT) groups in three spacing conditions, from left: Near, Medium, and Far.
The presented analysis confirms the observations noted before for PA and AS groups in the first session. However, now the effects of emotional trait is clear in case of the most difficult spacing condition (Near) rather than Far Spacing condition as it was shown above. People with lower levels of anxiety trait perform the flanker task in Near spacing condition faster in the first session than people with higher level of anxiety trait. This effect disappears in the second session. Numerical differences observed in the medium spacing effect are not statistically significant (F < 1). Interestingly, this analysis shows that more stress which appears in the second session favors people in the high AT group in comparison to their performance in the first session in the Near spacing condition. However, it could also reflect the existence of practice or other order effects; this issue will be discussed further in the discussion section.

**Remote Associates Task (RAT) and Compound Word Problems (CWP)**

Participants in both testing sessions performed two linguistic tasks, which measured their creative thinking through association of three word trials. As can be seen in Table 6, subjects in both sessions performed better on the CWP than on the RAT task. It should be noted that repeated measure t-tests revealed that the difference between RAT and CWP was significant in the second session t (34) = -2.49, p < 0.02. However, the same analysis revealed that there were no significant differences in performance on both tasks between the first and second session (please see table 7). In both phases of the study the RAT and CWP were significantly correlated (in the first session Pearson r = 0.54, p < 0.01, and in the second session Pearson r = 0.55, p < 0.01).
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Table 6 Means (M) and standard deviations (SD) of subjects’ accuracy in RAT, CWP and RAT_CWP in both sessions

<table>
<thead>
<tr>
<th>Task type</th>
<th>M and SD for session 1 (N=50)</th>
<th>M and SD for session 2 (N=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT session</td>
<td>2.54 (1.50)</td>
<td>2.20 (1.66)</td>
</tr>
<tr>
<td>CWP session</td>
<td>2.92 (1.68)</td>
<td>2.97 (2.12)</td>
</tr>
<tr>
<td>RAT&amp;CWP session</td>
<td>5.46 (2.79)</td>
<td>5.17 (3.34)</td>
</tr>
</tbody>
</table>

Table 7 Pair-sample t-test and mean difference of correct trials for RAT, CWP tasks and RAT_CWP (a sum of both of them) in first testing session (1) and the second one (2).

<table>
<thead>
<tr>
<th>Type of pair</th>
<th>Mean difference</th>
<th>t (34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAT session 1 - RAT session 2</td>
<td>0.17</td>
<td>0.66</td>
</tr>
<tr>
<td>CWP session 1 - CWP session 2</td>
<td>-0.29</td>
<td>0.89</td>
</tr>
<tr>
<td>RAT&amp;CAT session 1 – RAT&amp;CAT session 2</td>
<td>0.11</td>
<td>-0.25</td>
</tr>
</tbody>
</table>

The relationship between mood and RAT and CWP

It was predicted that higher positive affect would be related to a greater number of corrected responses in CWP or RAT or their sum. According to the Broaden and Build theory of positive affect more positive experiences increase the number of positive resources, allowing to people to perform better in a creative task. However, in neither session was this prediction confirmed by a significant correlation. Furthermore, as is shown in Table 8, the correct responses obtained by subjects in CWP, RAT and a sum of both (RAT&CWP) in each session were not significantly correlated with the results of any type of mood questionnaires (PA, NA, AS, AT).
The relationship between RAT and CWP and the conflict effect in the Near, Medium and Far spacing conditions.

According to one of the hypotheses, the higher conflict effect measured as a difference in reaction times between incongruent distractors and congruent distractors in Medium and Far spacing conditions should be positively correlated with a greater number of correct responses in the creative tasks. According to Rowe et al. (2007) when people are more distracted by greater distance of the distractors from the target they have a greater scope of attention and as a result more attention resources. More attention resources should increase probability of solving more word triads. However, this hypothesis was not supported in the current results (please see Table 9).
Table 9 Correlations table between RAT, CWP and RAT&CWP and two spacing conditions in the first testing session (top part) and the second session

<table>
<thead>
<tr>
<th>The first session n=50</th>
<th>RAT</th>
<th>CWP</th>
<th>RAT&amp;CWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium spacing</td>
<td>-0.19</td>
<td>-0.14</td>
<td>-0.19</td>
</tr>
<tr>
<td>Far Spacing</td>
<td>-0.03</td>
<td>-0.07</td>
<td>-0.06</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The second session n=35</th>
<th>RAT</th>
<th>CWP</th>
<th>RAT&amp;CWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium spacing</td>
<td>0.09</td>
<td>0.04</td>
<td>0.07</td>
</tr>
<tr>
<td>Far Spacing</td>
<td>0.00</td>
<td>0.03</td>
<td>0.02</td>
</tr>
</tbody>
</table>

The relationship between RAT and CWP and anxiety trait for 35 subjects

Although, there is no correlation between semantic tasks and mood questionnaires it is necessary to observe change in performance of 35 subjects from session 1 to session 2 to verify influence of academic stressor that emerged in the second session. In order to accomplish this goal, the Anxiety Trait groups (the Low and High AT) were used (please see description of these groups on pages 51-52). The descriptive statistics (M and SD) presented in Table 10 signals differences in performance for members of those two AT groups across two sessions. Therefore, a 2x2 mixed ANOVA was conducted to verify the importance of this observation.

Table 10 Means (M) and Standard deviations (SD) of correct responses for RAT, CWP and sum of both semantic tasks for members of Low and High Anxiety Trait groups in session 1 and 2

<table>
<thead>
<tr>
<th>Anxiety Trait Groups</th>
<th>RAT+CWP session 1</th>
<th>RAT session 1</th>
<th>CWP session 1</th>
<th>RAT+CWP session 2</th>
<th>RAT session 2</th>
<th>CWP session 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low AT</td>
<td>5.40</td>
<td>2.65</td>
<td>2.75</td>
<td>6.50</td>
<td>2.85</td>
<td>3.65</td>
</tr>
<tr>
<td>M</td>
<td>5.40</td>
<td>2.65</td>
<td>2.75</td>
<td>6.50</td>
<td>2.85</td>
<td>3.65</td>
</tr>
<tr>
<td>SD</td>
<td>2.78</td>
<td>1.60</td>
<td>1.65</td>
<td>2.74</td>
<td>1.23</td>
<td>2.08</td>
</tr>
<tr>
<td>High AT</td>
<td>4.60</td>
<td>2.00</td>
<td>2.60</td>
<td>3.40</td>
<td>1.33</td>
<td>2.07</td>
</tr>
<tr>
<td>M</td>
<td>4.60</td>
<td>2.00</td>
<td>2.60</td>
<td>3.40</td>
<td>1.33</td>
<td>2.07</td>
</tr>
<tr>
<td>SD</td>
<td>2.56</td>
<td>1.36</td>
<td>1.59</td>
<td>3.31</td>
<td>1.80</td>
<td>1.87</td>
</tr>
</tbody>
</table>
The 2x2 mixed ANOVA had one within dependent variable called, Time of Solving Word Problems, which is a sum of RAT & CWP problems (two levels: session1 and session 2) and one independent factor called AT groups (two levels: High AT and Low AT). For this model all assumptions were met.

The results reveal no significant main effect of Time of Solving Word Problems (F < 1). However, there was a significant interaction between Time of Solving Word Problems and AT groups F (1, 33) = 7.55, p = 0.01, ηp² = 0.19. The direction of this interaction is presented in Figure 12.

![Figure 12](image)

*Figure 12: Means of correctly solved word problems in session 1 and 2 by Low and High Anxiety Trait groups.*

Interestingly, people who were experiencing less trait anxiety did better in session 2 than 1 (less academic stressor). This finding could be again explained by an order effect; however, because it is in the opposite direction of interaction observed for high anxiety trait people it is an unlikely explanation. Students with more trait anxiety have some anxiety based issues with problem solving when academic stressors increased in the second session. More importantly a between subject ANOVA reveals that the difference between the two AT groups are significant
only in session 2 for the RAT [F (1, 33) = 8.81, p = 0.006, ηp2 = 0.21], CWP [F (1, 33) = 5.39, p = 0.027, ηp2 = 0.14] and sum of RAT and CWP [F (1, 33) = 9.16, p = 0.005, ηp2 = 0.22].
The study examined naturally occurring effects of positive affect and anxiety (exam stress at different points in the semester) on attentional performance and creative abilities of undergraduate students. One of the main goals of this study was to verify the prediction based on the Broaden and Build theory of positive resources by Fredrickson (2001). The theory claims that people who frequently experience positive emotions accumulate positive resources which help them in problem solving by widening their attention. A second goal was to possibly reproduce findings from the study conducted by Rowe et al. (2007). Although the mood manipulation used in this study, that is, placing testing sessions in non-stressful and stressful periods of the Fall term was successful the actual findings are far from the prediction based on the theory.

In the first testing session subjects in both High PA and Low AS group did benefit from greater space between the targets and distractors in the Medium and the Far spacing conditions. Their performance in these two spacing conditions was numerically better than the performance of subjects in other mood groups. In particular, the interaction between congruency and spacing was more robust for subjects with a low Anxiety State score. Furthermore participants with high scores on the PA scale performed significantly better in the Far spacing condition than subjects with low scores on the PA scale. The last finding contradicts the Broaden and Build theory and the results of Rowe et al. (2007), but confirms the findings of Smallwood et al. (2009) who noted better inhibitory skills for subjects with high level of PA.

Interestingly, the results of the second session, although not significant, could be partially predicted by the Broaden and Build theory, which assumes that participants with higher PA will
be more distracted, as they were here in the Medium and Far Spacing. However, the relationship between PA groups and spacing is not linear and subjects with high level of PA performed better in Medium spacing than in Near spacing and Far spacing conditions. Moreover, a linear relationship between spacing and mood was observed in the first session for Low AS and High PA. This observation is not consistent with the Broaden and Build theory of positive resources. We suspect that the high level of positive affect observed among subjects in the first session supported their information processing. According to the load theory of attention, better performance can be predicted by smaller cognitive load (Lavie, 1995, 2005). The cognitive load is an active inhibitory mechanism which is linked with working memory and other conscious cognitive processes therefore is prone to be overloaded and in a results prone to distraction. It seems that PA does not impair cognitive functions when the general mood of a subject is positive. On the other hand, much research reports that a higher level of anxiety is related to more tasks irrelevant thoughts (please see, Eysenck, 1983 and Smallwood et al., 2009, for review) which may disturb cognitive load by increasing the number of resources needed to process information and as a result decreases subject performance. However, positive affect is not a supportive factor when the general mood of a subject is not particularly any more positive as is the case for the participants in the second testing session.

The lack of a significant relationship between positive affect and results on the RAT and CWP does not mean that this relationship does not exist; much research has shown that positive affect supports creative thinking and problem solving (Fox, 2008; Oatley & Jenkins, 1996). Furthermore, there is relationship between anxiety and subject’s performance in these two tasks across two sessions. The lack of the significant result in this part of the study may be explained by the high difficulty of the semantic task used in this study. However, it should be pointed out
that there may be better instruments to measure creativity. Creativity is a complex cognitive function and as a result difficult to measure by looking on one aspect of creative thinking, that is, solving word triads (Oatley & Jenkins, 1996). Furthermore, the lack of relationship between positive affect and participant’s performance in RAT and CWP can question the idea that positive mood is a strong predictor of creative thinking. On the other hand anxiety and arousal which is a crucial component of emotion can influence participant’s performance especially when subjects are high in anxiety trait. This can be an important finding and requires further investigation.

There are few limitations in design and interpretation of the projects. First of all an observed change in performance of 35 subject who came back for the second session cannot be explained only by a change in their anxiety state from the first session to the second one. It is possible that an order effect influenced the results. In order to reject this possibility the study should be conducted in a different order for example the first session at the end of the Fall semester (high stress period) and the second one at the Spring semester (low stress period). Secondly the study was conducted in a university setting and all of participants were young adults (age 18-25). It is not clear if environmental stressors would have the same effect on attention for older adults. Thus it would be reasonable to validate these results in a sample of older adults by manipulating their job stressors.

Also, self-reported questionnaires are not the most valid instruments measuring emotional state of participants. It would be necessary to include some biological instruments such as Galvanic Skin Response in the future research in order to control level of arousal which always influences a subject’s performance (Fox, 2008). Having this tool would allow the grouping of subjects into two dimension of arousal (high and low). However, as it was
demonstrated in this project Anxiety Trait may be also a reliable method to measure influence of environmental factors on performance.

Finally, the lack of relationship between participant’s performance in flanker task and the semantic tasks may suggest difficulty of linking these two processes. In the attention paradigm the goal is to measure inhibitory skills of participants and their ability to ignore distractors, whereas in the creative paradigm we are interested in their ability to use environmental cues to solve the tasks. Therefore it was hypothesized that greater distractibility of subjects in Medium and Far spacing conditions would be related to better scores in the creative tasks. This was not observed. It has to be noted that whereas creative tasks require internal memory processing, the visual attention task is focused on the control of objects in a subject’s visual field. Therefore, different brain process may be involved in these two actions, explaining a lack of relationship between two tasks. However, it is possible to think about creativity and attention as processes that use the same control mechanism in order to manage the problem solving (creative task) and discriminatory decisions (attention tasks). Thus, in further research it would be necessary to focus on the mutual mechanism that governs creativity and attention rather than looking on the outcomes of actions in two different paradigms. This could be achieved by looking on the brain processes per se by using EEG and fMRI technologies.

In summary the project analyzed the influence of anxiety and positive and negative affect on attention and creativity. Level of anxiety was manipulated by testing subjects (undergraduate students) at the beginning and at the end of the Fall semester. This manipulation was successful: Subjects were measurably more anxious with less positive affect at semester end. The anxiety and positive affect influenced subject’s performance in the first session (less stress) by supporting inhibitory control mechanism of participants with low state and trait anxiety and high
positive affect. These effects of mood on attention disappeared in the second session (more stress). Furthermore, subjects defined as high in anxiety trait solved significantly fewer word problems in the second session than participants with low level of anxiety trait. It seems that emotions influence attention and creativity; however, the presented results do not allow for defining a relationship among emotions, attention and creativity. The study results though failed to show support for the Broaden and Build Theory (Fredrickson, 2001), but are consistent with Lavie's Load Theory of Attention (Lavie, 1995, 2005).
References


James, W., (1884). What is an emotion? Mind, 9, 188-205


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APPENDIX A

In this appendix there are a full copy of the PANAS questionnaire and instruction and direction and four items from the STAI survey (form Y1).

Positive and Negative Affect Scale (PANAS)

Please write your number ........

Instructions: Below are some words that may describe how you have felt during the past few weeks. Read each one and circle a number (from 1 to 5) to show if you have felt this way.

1 = Not at all true
2 = A little true
3 = Somewhat true
4 = Pretty true
5 = Very true

During the past few weeks I have felt:

1. interested 1 2 3 4 5
2. distressed 1 2 3 4 5
3. excited 1 2 3 4 5
4. upset 1 2 3 4 5
5. strong 1 2 3 4 5
6. guilty 1 2 3 4 5
7. scared 1 2 3 4 5
8. active 1 2 3 4 5
9. proud 1 2 3 4 5
10. irritable 1 2 3 4 5
11. enthusiastic 1 2 3 4 5
12. ashamed 1 2 3 4 5
13. alert 1 2 3 4 5
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14. nervous

15. inspired

1 = Not at all true
2 = A little true
3 = Somewhat true
4 = Pretty true
5 = Very true

16. jittery

17. determined

18. afraid

19. attentive

20. hostile

SELF-EVALUATION QUESTIONNAIRE STAI Form Y-1

Please provide the following information:

Your Number...........

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

1. I feel calm ................................................................. 1 2 3 4
2. I feel secure ............................................................... 1 2 3 4
3. I am tense .................................................................. 1 2 3 4
4. I feel strained ............................................................. 1 2 3 4

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