RECIPROCAL INFLUENCES OF INTERPRETATION AND ATTENTIONAL BIASES TO HEALTH-RELATED INFORMATION

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We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ABSTRACT

RECIPROCAL INFLUENCES OF INTERPRETATION AND ATTENTIONAL BIASES TO HEALTH-RELATED INFORMATION

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Cognitive processing biases to health-related information have been endorsed to be present in patients who are suffering from medical diseases. Attentional bias is one of the cognitive processes which facilitates the detection of health-threatening information. Interpretation bias is the other cognitive mechanism that makes patients attribute catastrophic meanings to ambiguous bodily sensations. Despite the literature demonstrating that attentional and interpretation biases increase negative emotions and challenge patients for adaptation to their health condition, the link between these two biases has remained unclear. While some theories claim that attentional and interpretation biases are interrelated, some state that they might be orthogonal components of cognitive processing. Therefore, this thesis aimed to investigate the relationship between interpretation and attentional biases to health-related information by modifying interpretation bias and studying its effect on attentional bias.

One hundred undergraduate students who lacked any medical or psychological problems were randomly allocated to Main-Modification or Placebo-Modification groups. All participants were asked to complete a battery of questionnaire including health anxiety inventory, Beck depression inventory, and Beck anxiety inventory in order to control between-group differences regarding these constructs. As the pre-modification assessment, participants' interpretation and attentional biases to health-related information were respectively measured using the Modified Version of Online Interpretation Bias and Dot-probe tasks. Then, the Main-Modification group underwent Main On-line Negative Interpretation Bias Modification Task aimed to impose unsafe and threatening interpretations for ambiguous health-related scenarios. The Placebo-modification group completed Placebo On-line Negative Interpretation Bias Modification Task. The modification phase was followed by post-modification measurements.

Results revealed that the participants in the Main-Modification group experienced more post-test interpretation bias indexed by Unsafe valence of interpretations for ambiguous health-related situations compared to the Placebo group. The Post-test between-group difference, however, was not significant for interpretation bias indexed by reaction time. Main negative interpretation bias modification succeeded to amplify attentional bias toward Ambiguous images in the Main group but Placebo modification did not do so. Unlike Placebo modification, Main modification increased attentional bias to Health-Related images as well. However, this increase was not statistically significant.

These results can be considered as the pieces of evidence endorsing the idea that interpretation and attentional biases are interrelated aspects of cognitive processing. Repeated exposure to negative interpretations for health-related situations might increase patients' accessibility to negative meanings for interpreting further ambiguous health-related situations. In turn, the new negative meanings might facilitate detection of ambiguous bodily sensations or another health-related information known as attentional bias.

Keywords: Interpretation Bias, Attentional Bias, Cognitive Processing, Cognitive Processing Modification, Health .

ÖZET

SAĞLIKLA İLGILI BILGILER ÜZERINE YORUMLAMA VE DIKKAT YANLILIKLARININ KARŞILIKLI ETKILERI

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Sağlıkla alakalı bilgiler üzerine bilişsel süreç yanlılıklarının, tıbbi bir hastalık sahibi olan kişilerde bulunduğu onaylanmıştır. Dikkat yanlılığının da bu bilişsel süreçlerden biri olarak, sağlık tehdidi içeren bilgilerin tespitini kolaylaştırdığı görülmüştür. Yorumlama yanlılığı ise muğlak bedensel algılara felaket anlamları yüklemeye neden olan bir diğer bilişsel mekanizmadır. Literatürde, dikkat ve yorumlama yanlılıklarının olumsuz duyguları arttırdıkları ve hastaların sağlık durumlarına alışmalarını zorlaştırdıkları kanıtlanmış olmasına ragmen, bu iki yanlılık arasındaki bağ açık değildir. Bazı teoriler dikkat ve yorumlama yanlılıklarının birbirleriyle alakalı olduğunu savunurken, bazıları ise bu yanlılıkların bilişsel süreçlerin paralel bileşenleri olduklarını belirtmişlerdir. Bu nedenle, sözkonusu tez sağlıkla ilgili bilgilere karşı yorumlama ve dikkat yanlılıklarının arasındaki ilişkiyi, yorumlama yanlılığını değiştirip bu sürecin dikkat yanlılığına etkisini inceleyerek anlamayı hedeflemiştir.

Herhangi sağlık veya psikolojik problemi olmayan 100 lisans öğrencisi, Ana-değişiklik veya Placebo-değişiklik gruplarına rastgele paylaştırılmıştır. Gruplar arası farklılıkları kontrol etmek amacıyla bütün katılımcılardan, sağlık anksiyete duyarlılığı ölceği, Beck Depresyon Tarama Ölçeği ve Beck Anksiyete Duyarlılığı İndeksin içeren bir dizi anketi doldurmaları istenmiştir. Değişiklik öncesi ölçüm olarak, katılımcıların sağlıkla alakalı bilgilere karşı yorumlama ve dikkat yanlılıkları On-line Yorumlama Yanlılığı ve Görsel nokta izleme görevlerinin değiştirilmiş versiyonları kullanılarak ölçülmüştür. Daha sonra, Ana-değişiklik grubu sağlıkla alakalı muğlak senaryoların güvensiz ve tehtid edici anlaşılmasını amaçlayan Ana On-line Negatif Yorumlama Yanlılığı Değişimi görevini tamamlamışlardır. Placebo-değişim grubu ise Placebo On-line Negatif Yorumlama

Yanlılığı Değişimi görevini tamamlamışlardır. Değişiklik safhasını değişiklik sonrası ölçümler takip etmiştir.

Sonuçlar Ana-Değişim grubundaki katılımcıların Placebo grubundakilerle karşılaştırıldığında sağlıkla alakalı muğlak durumlarda güvensiz yorum değerlendi- rmelerinin gösterdiği üzere daha yüksek test sonrası yorumlama yanlılığı göstermişlerdir. Yorumlama yanlılığı için test sonrası grup farklılıkları tepki süresi dikkate alındığında ise istatistiksel olarak anlamlı bir sonuç çıkmamıştır. Ana olumsuz yorumlama yanlılığı yönetimi muğlak görsellere karşı dikkat yanlılığını arttırmakta başarılı olurken, Placebo grubu yönetimi başarılı olamamıştır. Placebo değişikliğinin tersine, Ana- değişilik uygulamasu sağlıkla alakalı görsellere karşı dikkat yanlılığını da arttırmıştır. Bu sonuçlar yorumlama ve dikkat yanlılıklarının bilişel süreçlerin birbirleriyle alakalı tarafları olduklarına dair kanıt olarak düşünülebilir.

Sağlıkla alakalı durumların yinelenen bir şekilde olumsuz yorumlanması, hastaların sağlıkla ilgili diğer muğlak durumları da olumsuz anlamlandırmalarına imkan sağlamaktadır. Böylece, yeni olumsuz anlamlandırmalar vücuttaki muğlak duyumarın ve sağlıkla alakalı bilgilerin farkedilmesini kolaylaştırarak dikkat yanlılığını ortaya çıkaracaktır.

Anahtar sözcükler: Yorumlama Yanlılığı, Dikkat Yanlılığı, Bilişsel Süreçler, Bilişsel Süreç Yönetimi, Sağlık .

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Chapter 1

Introduction

1.1 Overview

Health conditions can influence daily life negatively. Some of these diseases will last for a longer time and their unpredictable phases or consequences might add to their severity. Therefore diseases are considered as stressors that increase anxiety and challenge the patient for adaptation [1, 2, 3]. According to the cognitive-processing models of anxiety [4], two attentional and interpretation biases are suggested to be underlying cognitive mechanisms that attribute to the experience of negative emotions in reaction to the health-related problems. While attentional bias facilitates the detection of threat-related information in comparison to the neutral one, interpretation bias refers to the attribution of catastrophic meanings to both ambiguous and threatening information.

Several studies have endorsed the presence of attentional and interpretation biases to health-related information in patients suffering from medical diseases compared with healthy individuals who do not have any diagnose. Even among those who are suffering from a specific disease, those with more cognitive biases to health-related information have the higher levels of anxiety and problems in adaptation. Findings, also, have revealed that cognitive biases to threatening health-related information in the absence of any disease are associated with dysfunctional anxiety leading to illness anxiety disorder. Despite a growing body of studies evaluating attentional and interpretation biases to health-related information, the link between these two cognitive processing biases has remained unclear. Is there a relationship between attentional and interpretation biases or are they two orthogonal processes? The limited number of research in this area has claimed that attentional and interpretation biases share common neurocognitive factors. However, the insufficient evidence makes it difficult to speculate on the relationship between these two biases.

The identification of the relationship between attentional and interpretation processing might highlight the mechanisms that describe how these two processes result in more negative emotions after receiving a diagnosis. In addition, the evidence about the relationship between biases might be beneficial in developing more effective cognitive processing modification protocols or strategies that address reducing biases and their consequences through more implicit challenges about sensitive issues such as health (see [5]).

In this thesis, to investigate the relationship between attentional and interpretation biases specifically to health-related information, we applied a negative interpretation modification paradigm. Negative interpretation modification aimed to impose negative interpretation bias to the ambiguous health-related situations in healthy individuals who had no health problem. Then, using a dot-probe paradigm, we examined if the increase of negative interpretations for the ambiguous health-related situations can result in the attentional bias toward the threatening and ambiguous health-related images.

1.2 Background and Related Work

Traditional biomedical approaches to chronic disease explain patients' responses to their disease by solely focusing on the variation in symptoms and biological factors [6, 7]. The inadequacy of these unidimensional models in explanation of chronic disease and their related emotional problems have resulted in the introduction of integrative biopsychosocial models that consider more cognitive and social factors [6, 8, 9]. Parsons, Kruijt, and Fox's information-processing model of resilience, for example, is one of these multidimensional models that explains how a stressful situation such as receiving a diagnosis might lead to negative emotions or resilience in patients [10]. They claim that their model centers on applying cognitive processing biases including attentional and interpretation biases [10]. Cognitive biases have been considered as important components of another models that explain responses to disease (chronic pain: [11]; Cancer: [12]). Regarding that health-related situations are anxiety-provoking, the models have mostly relied on cognitive processing models of anxiety in order to explain variations in the response to health-related information (see [6, 11]).

1.2.1 Cognitive Processing Model of Anxiety

According to the cognitive processing model of anxiety (Fig. 1.1), the impact of adverse situations such as the death of a friend varies from one person to another [4]. In addition, some events are ambiguous as they might have both positive and negative aspects or their consequences are not clear. Therefore the processing style, or bias, that individuals apply to process the information determines if a situation will be perceived as negative or positive [13]. Attentional and interpretation biases are two of the main cognitive processing components that can contribute to differences in the way individuals process a specific ambiguous situation. While attentional bias facilitates the detection of threat-related information in comparison to neutral one [14, 15, 16], interpretation bias refers to the attribution of catastrophic appraisals to both ambiguous and threatening information[4]. In below, these two processes have been described in more details.

Attentional bias can be detected only in case two or more processing options with different emotional valences (safe or threatening for example) compete with each other simultaneously [4, 17]. Attention, as a mechanism that works based on the priority system, determines which information is prior and can dominate

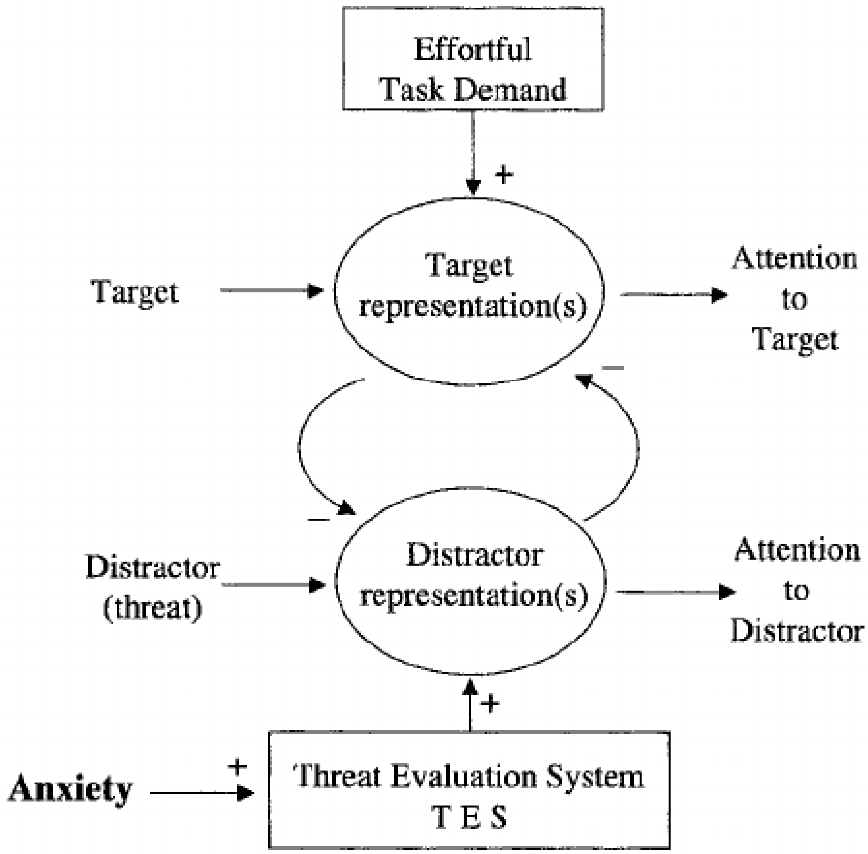

Figure 1.1: Mathews and Mackintosh's Cognitive processing model of anxiety

the competitions over other information. The activation of this prior representation accompanies by the inhibition of other option regularly until one of the options wins and captures attention resources in order to come into awareness. Based on the results about the faster identification of the threatening stimuli than the neutral ones (see [18, 19]), Mathews and Mackintosh hypothesized that an automatic threat evaluation system (TES) makes attention give priority to the threatening valences [4]. It has been suggested that TES is an evolutionary mechanism and helps survival by the rapid detection of danger-related cues. In addition to these biologically prepared cues, the information that has been arbitrarily learned through associations with threat is stored at TES and can be accessed rapidly through early and non-conscious processing. In anxious people or in stressful situations, the output threshold of TES decrease. Therefore cues that previously did not trigger TES will, now, be matched to the danger-related information in TES, capture attention, and cause anxiety. Accordingly, the ambiguous cues that were not already anxiety-provoking might be associated with threat representations in TES and lead to attentional bias as well. In addition to this unconscious evaluation system, there is a controlled effort that prevents the further process of threat cues. This conscious effort might succeed or fail to prevent the threat representation from dominating the competition.

Not only attentional bias to threat but also the selection of threatening or non-threatening interpretations for an information or a situation will undergo the same evaluation process. As it is mentioned above, some situations might have both positive and negative meanings or their valences are ambiguous. Therefore a competitive process will cause one interpretation to be activated and inhibit the other interpretations. This competition will continue until one of the interpretations dominates. Unlike non-anxious individuals who tempt to consider positive meanings [20], meanings will be matched to the negative representation of TES in anxious people leading to catastrophic interpretations. Similar to attentional bias, interpretation bias to the threatening interpretations can be controlled by a more conscious efforts as well. However, stressful situations or trait-anxiety might reduce the ability of controlled effort to oppose such interpretations.

1.2.2 Cognitive Processing Biases to Health-Related Information

Health is one of the important aspects of someone's feeling of safety and wellbeing. Therefore bodily sensations or changes can be considered as threats that trigger threatening representations of TES regarding the priori hypothesis. Supporting this claim, several studies about different medical situations have revealed that these problems are associated with both attention and interpretation biases to health-related information. Furthermore, studies on hypochondria and illness anxiety, which known as dysfunctional worries about health in the absence of any medical disease, have highlighted cognitive processing biases to health-related information.

1.2.2.1 Attention Bias To Health-Related Information

Attention bias toward health-related information has been studied using different cognitive paradigms including dot-probe and Stroop tasks. Studying patients with chronic pain using emotional Stroop task, Pearce and Morley reported that chronic pain patients had pain-related bias compared to control group [21]. However, the sample size (n=16) was small in this study. A visual-probe task in another study showed positive bias toward sensory pain words in patients with musculoskeletal pain [22]. In this study, there was no bias to other word categories i.e. affective pain, disability-related, and threat words [22]. The same result was reported in chronic and acute low back pain. Haggman *et al.* demonstrated that individuals with low back pain, compared with the control group, displayed bias to sensory pain words [23]. Some other studies have investigated attentional bias using pictorial stimuli. It is suggested that the threatening words, in comparison with the sensory and perceptual stimuli, cannot result in fear unless they evoke images, memories or bodily sensations that are associated with fear. It is because TES has been evolved before the development of language [13]. Roelofs *et al.* used both pictorial as well as linguistic versions of the dot-probe task in order to study the attentional bias in people with chronic low back pain [24]. Although both the patient and control groups demonstrated difficulty in disengagement from threatening images, the difficulty was greater in the patients. Between-group differences were not significant regarding linguistic task including sensory pain, affective pain, movement, injury, social threat and neutral words [24]. Schoth and Liossi applied dot-probe task with the headache-related images and reported that the headache group had a significant attentional bias to these images in both 500 ms and 1250 ms time courses in comparison to the healthy control group [25]. In their next study, Schoth and Liossi used more image categories including headache-related, pain-related, health-related, and general health-related images [26]. In comparison to the control group, participants with chronic headache displayed attentional bias to headache images at 1250 ms and to pain images at 500 ms time courses [26].

In addition to pain, studies on cancer have revealed attentional bias to cancer-related information. Glinder *et al.* reported that woman with early diagnose of breast cancer showed the attentional bias toward supraliminal cancer-related words and attentional bias away from subliminal cancer-related words but not any attentional bias to or away from threatening social words [27]. In another study on two groups of people with the cancer diagnosis who were suffering from post-cancer acute (0-3 month) or persistent (12-18) insomnia, it was revealed that both groups displayed attentional bias to cancer-related words in Stroop task [28]. However, only individuals with persistent insomnia had the bias to sleep-related words compared with ones with acute insomnia [28]. Research on female participants with a family history of cancer in their first-degree relatives using Stroop cancer-related words showed that this group demonstrated attentional bias indexing by the longer response latencies for the cancer-related words compared with women with no family history of cancer in their first-degree relatives [29].

Attention bias to the health-related words, assessed by dot-probe task, was also seen in patients with chronic fatigue syndrome in comparison to control group [30].

Furthermore, studies have revealed the role of attentional bias in health-related information in illness anxiety. Keogh *et al.*, using dot-probe task, reported that students with high levels of fear of pain demonstrated greater attentional bias to pain-related words in comparison to students with low fear of pain [31]. Two groups, however, had no difference in attentional bias to social-related information. Owens *et al.* reported that compared to people with low levels of illness anxiety, individuals with high illness anxiety exhibited the attentional bias to health-related information in Stroop task [32]. In another research, attentional bias was examined using administration of dot-probe task consisted of ideographically selected health-threat words on healthy students [33]. This study reported that behavioral and somatic aspects of illness anxiety were correlated with attentional bias [33]. Further analysis demonstrated that the bias was related to difficulty in disengagement from the threat than facilitated detection of threatening word [33]. Kim and Lee used eye-tracking in order to evaluate attentional bias to the health-related information in four groups of people with different levels of illness anxiety (high-low) and coping strategies (monitor-blunter) [34]. The results revealed that individuals with high levels of illness anxiety, regardless of their coping strategy, responded more to health-related images. However, the pattern of attention in high illness anxious people with monitor strategy was different from high illness anxious people with monitor strategy. While the first group attended to the health-related images, the latter showed attention away from the health-related images.

1.2.2.2 Interpretation Bias To Health-Related Information

Different studies have approved the presence of the interpretation bias to the health-related information in patients with medical diseases or people with the fear of specific disease. In one study using Interpretation of Bodily Threat Task, adolescents with higher levels of pain catastrophizing reported more negative interpretation bias for pain and body threat situations compared with individuals with lower levels of pain catastrophizing. However, the between-group differences were meaningful for social situations as well [35]. In addition, negative interpretation of ambiguous pain-related situations could mediate the relationship between pain experiences and pain catastrophizing [35]. Pincus *et al.* reported that pain patients, compared to control ones, interpreted ambiguous cues more pain-related and produced more pain-related associations for these cues [36]. In another study about interpretation bias to ambiguous facial expressions, healthy female subjects completed an incidental learning task in which painful and happy facial expressions were designed to predict a specific target location [37]. Participants, then, were tested through two test phases using painful, happy as well as morphed pain and happiness facial expressions. Results revealed that in comparison to the students with low pain catastrophizing, individuals who experienced high levels of pain catastrophizing had faster reaction time when targets were displayed at the locations where predicted by painful expressions than the location associated with happy faces. Although this difference was not significant [37].

Studies on women suffering from cancer with high and low distress levels demonstrated a borderline between-group difference in interpretation bias to cancer-related words measuring by ambiguous cues task [38]. Patients with high distress considered more negative interpretations compared to those with less distress [38]. Miles *et al.* reported that individuals with high levels of fear of cancer, interpreted cancer-related scenarios more catastrophically [39].

Investigating the role of interpretation bias toward illness-specific information in the patients with chronic fatigue syndrome, Hughes *et al.* reported that these patients interpreted ambiguous scenarios as somatic, compared with control group [40]. Somatic interpretations were correlated with catastrophizing [40]. The results were repeated in another study [41]. In this study, chronic fatigue syndrome patients made more somatic interpretations of the ambiguous words in the ambiguous cues task. Interpretation bias to the ambiguous heart-related bodily sensations, also, mediated the relation between daily activities and state anxiety in the patients with congenital heart disease relative to healthy group [42]. The patients with congenital heart disease who had higher levels of trait anxiety reported more negative interpretations than those with lower anxiety levels [42].

1.2.3 Reciprocal Influences of Attentional and interpretation Biases

As discussed, studies have approved the presence of attentional and interpretation biases toward health-related information in different medical or psychological conditions. Some studies have revealed that patients (regardless of their diagnosis) experience more attentional and interpretation biases to health-related information in comparison to the healthy control group. Therefore diseases as stressors can cause or increase cognitive biases toward the health-related situations. Some other studies have demonstrated the between-subject differences in the samples who are suffering from the same diagnosis. These studies evaluated cognitive biases as mechanisms that might have been related to different reactions (resilience vs negative emotion for example) to the same diagnoses. Another part of studies has examined the role of cognitive biases to health-related information in psychological problems in the absence of any disease. These findings showed that cognitive bias to the health-related stimuli could lead to psychopathologies such as illness anxiety disorder or fear of specific disease. Despite all these studies have endorsed that attentional and interpretation biases might cause between-group or within-group differences in health-related situations, the relationship between attentional and interpretation biases has not been considered. Therefore it is not clear if cognitive processing components i.e. attention and interpretation have interaction with each other or work independently. On the one hand, attentional and interpretation biases might be interrelated cognitive processing, and on the other hand, they might be two orthogonal components of information processing [43].

The theoretical models of cognitive processing endorse the combined cognitive biases hypothesis. Attentional and interpretation biases might stem from a common processing mechanism [4, 44, 15] or one cognitive bias might influence the other processing [45]. Furthermore, experimental modifications of attentional and interpretation processes have revealed that changes in each of these processing mechanisms can increase vulnerability to anxiety [46, 13, 45] or decrease anxiety symptoms [47, 48] concluding that both of them can interact in the development or the maintenance of anxiety. However, the influence of one cognitive processing on the other one has been studied rarely.

One of the paradigms to examine the relationship between attentional and interpretation biases is modifying one cognitive bias and evaluate its effect on the other bias. In one study using a small-sized sample of female young adults who scored on the normal range of Spielberg trait-anxiety inventory, a dot-probe task was applied in order to train individuals to attend to angry faces [43]. Then, they measured the effect of attention training on interpretation bias assessed by ambiguous sentence competition task. Results revealed that individuals who received attention training selected more threat-related words as their first answer in comparison to the individuals in the placebo group. Although there was no between-group difference regarding the total proportion of threat-related interpretations [43]. Bowler *et al.* evaluated the reciprocal influences of cognitive processing by modifying both attention and interpretation separately during eight sessions and measuring their effects on the other one [49]. They used dot-probe task to decrease attention toward threat words and positive interpretation bias modification task in order to increase positive resolutions for incomplete ambiguous scenarios (with homesickness, financial, academic, and social concerns) in anxious students. Results revealed that attention training not only decreased attentional bias toward threat words but also increased positive interpretations in attention training group compared with the control group [49]. However, interpretation modification task only increased positive interpretation in training group than control group while had no significant effect on attentional bias [49]. In a study by Lichtenthal *et al.* who evaluated the effect of cognitive bias modification on the reduction of fear of breast cancer recurrence, positive interpretation modification could not reduce attentional bias toward threat-words [50]. Post-modification attentional bias indices were the same for the main and placebo groups [50]. In contrast, the effect of interpretation modification on attentional bias was approved in individuals with social anxiety [51]. Amir *et al.* used incomplete sentences in order to increase positive interpretations for the ambiguous social situations. The results revealed that interpretation modification could make attention away social-threat words in the dot-probe task in individual allocated to modification group compared with control group [51].

In addition to these studies that evaluated interpretation bias as a cognitive processing, there is two research that changed interpretation using more conscious reinterpretation instructions in the context of emotion regulation and studied its effect on attentional bias to threat. Urry restricted attention to the specific part of emotional pictures and revealed that even in the condition of controlling attention, reinterpretation could not increase or decrease negative emotions [52]. Consistent to this finding, Bebco *et al.* guided subjects to look at both negative and neutral parts of emotional images and reported that subjects' emotions had not been changed after application of reinterpretation [53]. Regarding these results, they concluded that attention and interpretation are independent [52, 53].

Despite the fact that these studies have highlighted the link between attentional and interpretation biases, the number of such studies are remarkably rare and makes it difficult draw any firm conclusion about the relationship between this two cognitive processing. In addition, we have found only one research that has studied the relationship between attentional and interpretation biases to health-related information [50]. Previous studies have been mostly focused on social stimuli or more general threatening situations including financial and academic concerns. The small sample size is another factor that makes us consider the connection between attention and interpretation with more caution as small-sized samples decline the chance of achieving a true effect [54]. In addition, in almost all studies, attentional bias is evaluated only toward threatening stimuli but not ambiguous ones. Studies did not examine if modifying interpretations for ambiguous situations might make participants attend to or away from ambiguous and threatening stimuli in the same manner. Using word stimuli in the dot-probe task might be the other shortcoming of previous studies. As mentioned before, some researchers believe that threatening words, in comparison with pictorial stimuli, cannot result in strong fear (see [13]). Therefore inefficacy of interpretation modification tasks in changing attentional bias toward threat in Bowler *et al.* [49] and Lichtenthal *et al.* studies [50] might be concluded regarding these two notions: a) modifying interpretations for ambiguous situations might not have been effective in influencing attention to threatening situations but it might have been beneficial in affecting attention to ambiguous stimuli if it was assessed, b) words were not sufficiently sensitive for assessment of attentional bias. Furthermore, there were some shortcomings in the way that different studies manipulated interpretations in order to study its effect on attentional bias to or away from the threat. In some studies (see [52, 53]), application of reinterpretation was done based on experimenters' simple instructions for considering a negative situation from another perspective or supposing a good ending for them. This issue can increase the variance and reliability of applying interpretation by different subjects that consequently influence the relationship between variables and their effect size. Effect size refers to a quantitative measure of the strength of a phenomenon that can be influenced by different factors such as the reliability of dependent variables. The type of independent variable and the way we manipulate it can affect the dependent variable. However, there are studied that have increased the reliability of interpretation training using more standard tasks. For example, *Bowler et al.* used a list of same incomplete sentences asking participants to complete them [49]. These sentences were designed in a way to be completed only by a positive resolution in order to modify interpretation more equally. Although, the absence of any competing negative word might reduce the effect of training because as discussed earlier, cognitive bias is seen while two options are competing. In addition, the number of trials in interpretation modification task were limited in Bowler *et al.* study [49]. The small number of trials might not be enough to train subjects effectively [49]. While repeated exposures with more ambiguous situations and challenge to resolve them in a specific way (positive or negative) provide participants with more practice to consider a specific resolution (positive for example) and inhibit the other resolution (positive for example). As the result, participants will switch away from specific information in favor of another information [51]. These two limitations might have caused inefficacy of interpretation modification in changing attentional bias in Bowler *et al.* research [49]. Therefore designing an interpretation modification task that reinforces specific interpretations in participants through exposing them with more situations as well as more competing resolutions might be more efficient in implementing desired interpretation and studying its influence on other cognitive processing i.e. attention.

1.3 Scope and Motivation of the Present Study

In the present thesis, we aim to investigate the relationship between attentional and interpretation biases by modifying interpretation bias for ambiguous health-related situations and study its influence on attentional bias. Addressing the mentioned shortcomings of previous studies, we apply a computerized negative interpretation modification paradigm to impose negative interpretation bias for ambiguous health-related information and examine its effect on increasing attentional bias toward both threatening and ambiguous health-related stimuli in a large sample of healthy students who are not suffering from any health problem.

Through negative interpretation modification paradigm, we make healthy individuals in the Main-Modification group interpret the ambiguous scenarios as unsafe health-threatening situations by a feedback system. We present both unsafe and safe resolutions for each scenario in order to increase cognitive processing in participants by exposing them with two competing resolutions. Furthermore, we assess attentional bias not only to threatening health-related pictures but also to ambiguous ones. The internal or environmental stimuli that might attract attention are not always threatening for sure. Will the picture of a woman with hands on her stomach (in case her face and emotions are not observable) be as neutral as the picture of a woman with her hands on the arm of a chair or as threatening as the picture of a woman who squeezes her stomach firmly? Also, interpretation modification paradigm always trains participants using the ambiguous situations. Therefore we would like to examine if interpretation modification would have the same effects on attentional bias to threatening and ambiguous images. To control any possible confounding factors, we include a control group in which participants perform placebo interpretation modification.

We hypothesize that:

- Negative interpretation modification will significantly increase the selection of unsafe resolutions for the ambiguous scenarios than safe ones in the Main group while Placebo modification will not do so.

- Negative interpretation modification will significantly decrease reaction times to the ambiguous scenarios in the Main group compared to participants in the Placebo group.

- Negative interpretation modification will significantly decrease reaction times to unsafe resolutions of ambiguous scenarios than safe resolution in the Main group while Placebo modification will not make any differences in reaction times to unsafe and safe resolutions.

- Negative interpretation modification will significantly increase attentional bias toward threatening health-related images in the Main group while Placebo modification will not do so.

- Negative interpretation modification will significantly increase attentional bias toward ambiguous health-related images in the Main group while Placebo modification will not do so.

In case negative interpretation modification can increase both unsafe interpretations for ambiguous situations as well as the attentional bias toward threatening and ambiguous health-related images in healthy subjects, we will be able to speculate on the presence of cognitive processing biases in health-related problems that might lead to anxiety or other dysfunctions. Negative interpretation modification makes healthy participants consider unsafe anxiety-provoking interpretations for ambiguous situations that they face with. Repetition of such negative resolutions might increase the ease of accessibility to such negative meanings stored in TES and its dependent anxiety levels. The anxiety, in turn, will increase attentional bias to the threatening health-related stimuli as well as the ambiguous health-related stimuli that do not use to attract attention heretofore. The same process might happen in case of suffering from a disease. Exposing to a serious negative interpretation (receiving diagnose of breast cancer after mammography) for an ambiguous situation (pain sensation in the breast) might increase a patient's tendency to interpret any ambiguous bodily sensations as the sign of cancer progress or metastasis. These anxiety-provoking interpretations increase the patient's attentional bias to any health-related information such as bodily symptoms or news about cancer that in turn, lead to further negative interpretations of this perceived information.

The findings not only might provide more evidence supporting the cognitive processing model of health-related problems but also result in the development of more effective therapeutic strategies. If we can increase negative interpretation and attentional biases to health-related information in healthy subjects using negative interpretation modification task, we might be able to decline catastrophic interpretations and attentional bias to the anxiety-provoking health-related information that patients might experience due to their diagnosis through positive therapeutic interpretation modification tasks. For some patients with chronic medical diseases, it might be difficult to talk about the sensitive topics (such as disease) (see [49]). Therefore development of interpretation modification tasks that do not require more active thought challenges might be beneficial to these patients.

Chapter 2

Method

2.1 Participants

The sample was consisted of 100 undergraduate students at Bilkent University recruited through an announcement sent to all undergraduate students via Bilkent University Administrative Information Service (BAIS). In addition to the purpose of the study (studying cognitive processing), the inclusion and exclusion criteria were mentioned in the email. Inclusion criteria were being a Turkish speaker, over 18 years old, and an undergraduate student. Exclusion criteria were any history of serious or chronic medical and neurological disease, history of head trauma, history of surgery within recent 12 months, history of psychiatric diagnosis, using any psychiatric medication (prescribed or unprescribed), and addiction. They, also, should not have taken two Perception, Attention, and Action (PSYC310) as well as Cognitive Neuroscience (PSYC320) courses. Volunteer students were supposed to inform the experimenter via email. One hundred and five (105) students informed experimenter about their desire to attend the experiment. These volunteers were invited to the interview session in order to be evaluated more precisely regarding inclusion and exclusion criteria. One hundred (100) students who met inclusion criteria but did not meet exclusion ones were selected as sample.

Then, the sample were randomly allocated to Main Online Negative Interpretation Modification or Placebo Online Interpretation Modification groups (50 students in each group).

2.2 Measures

2.2.1 Questionnaires

2.2.1.1 Short Health Anxiety Inventory (SHAI; [55])

SHAI is an 18-item 4-Likert questionnaire that evaluates health anxiety independent from physical health status. These items measure different aspects of illness anxiety such as health worries, awareness of body sensations and changes, and negative consequents of illnesses. This inventory has been reported to have appropriate validity and reliability [55]. In the current study, we used the Turkish version of the questionnaire to control the levels of health anxiety between the two Main and Placebo groups. The Internal consistency of the Turkish version of this questionnaire, calculated by Alpha Cronbach, was 0.91 [56].

2.2.1.2 Beck Depression Inventory (BDI; [57])

BDI is a 21-item 4-Likert questionnaire that assesses depression symptoms. The validity and reliability of this questionnaire are reported to be appropriate [57]. In the current study, we used the Turkish version of the questionnaire to control the levels of depression between the two Main and Placebo groups. The Internal consistency of the Turkish version of this questionnaire, calculated by Alpha Cronbach, was 0.80 [58].

2.2.1.3 Beck Anxiety Inventory (BAI; [59])

BAI is a 21-item 4-Likert questionnaire that assesses the severity of anxiety. The validity and reliability of this questionnaire are reported to be appropriate [59]. In the current study, we used the Turkish version of the questionnaire to control the levels of anxiety between two Main and Placebo groups. The Internal consistency of the Turkish version of this questionnaire, calculated by Alpha Cronbach, was 0.93 [60].

2.2.2 Tasks and Materials

2.2.2.1 Modified Version of Online Interpretation Bias Task

Modified Version of Online Interpretation task measures interpretation bias toward ambiguous health-related situations that can be interpreted as both health-threatening or non-health-threatening (refer respectively to Unsafe and Safe Valence). The task consisted of 32 situational scenarios with the length of four lines while the final sentence of each description was incomplete and lacked a word. The task was incorporated 16 Ambiguous (AMB) scenarios that could lead to either an Unsafe (health-threatening) or a Safe (non-health-threatening) resolution. It, also, had 16 forced scenarios consisting of 8 Health-Related (HR) scenarios that only the Unsafe (correct) resolutions made sense for them (Safe resolutions are considered as error) and 8 Non-Health-related (NHR) scenarios that only the Safe (correct) resolutions matched to them (Unsafe resolutions are considered as error). Eight Ambiguous scenarios were matched to eight Health-Related scenarios and eight Ambiguous scenarios were matched to eight Non-Health-Related scenarios (matched according to their resolutions). The forced scenarios were used as the control ones.

A fixation point was shown on the screen for 500 ms. Then, the first line of the scenario appeared on the screen followed by the second to the fourth lines. The second line appeared 2000 ms after the first line, the third line appeared

1500 ms after the second line, and the fourth line appeared 1500 ms after the third line while lasting for more 1500 ms. Therefore, participants had 6500 ms to read each scenario overall. The fourth line contained a missing word. As soon as all lines were presented, at time 7000 ms, two Unsafe and Safe choices were presented on the screen for a total of 3000 ms while the scenarios were yet on the screen. The subject was supposed to start reading each scenario line by line as soon as it shown on the screen and to select the choice that complete the scenario by pressing the right or the left arrow keys corresponded the location of each choice. As soon as pressing the key, the next trial began with the presentation of the next fixation point (Fig. 2.1). If participants could not choose any of the choices within 3000 ms, the trial was finished and participants received NA (Not Answered). To prevent being biased to right or left answers, words with Safe and Unsafe Valences were presented on the right and left sides of the screen equally. The correct and error answers were, also, equally presented on the right and the left sides.

Before performing this main task, participants completed a training phase to adjust their reading speed and to ensure us that they had learned how to respond. The scenarios that were used in the training phase were non-health-related with two Safe choices that were different from the scenarios used in the main assessment phase.

Interpretation bias was indexed by two components: Valence and Reaction Time. The Valence component consisted of both fewer numbers of Safe resolutions as well as more numbers of Unsafe resolutions for Ambiguous health-related scenarios. Reaction time indexed by faster mean reaction time to Ambiguous scenarios than Health-Related and Non-Health-Related scenarios along with faster mean reaction time to Unsafe resolutions than safe ones for Ambiguous scenarios.

The current task was the modified and summarized version of the original Dutch version of On-line interpretation Task developed by Vancleef *et al.* [61]. The sentences were translated into English by the experimenter. Then, two undergrad students translated them into Turkish. All the sentences were evaluated by the experimenter in order to make sure that the translations are appropriate.

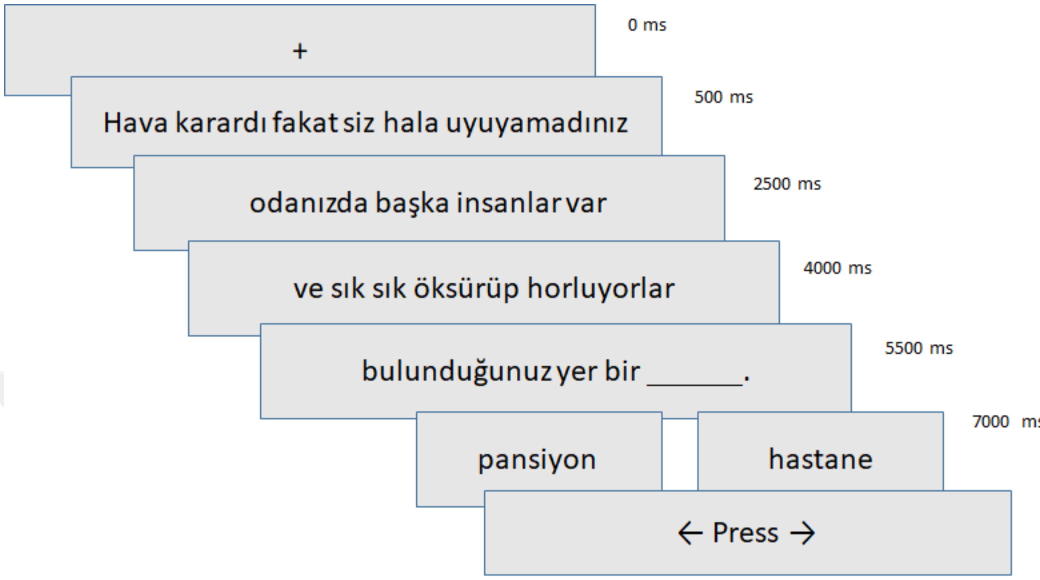

Figure 2.1: Illustration of trial events on Modified Version of Online Interpretation Bias Task

After finishing the translation, an expert who holds certified degree in Turkish Literature evaluated and edited all the sentences according to correct grammar. Then, 10 non-psychology students read and informed us if the scenarios were understandable. They, also, evaluated if sentences were correctly categorized in each of Ambiguous, Health-Related, and Non-Health-Related trials. In the next step, the task was developed using Affect 4.0 software package [62]. In a pilot study, the task was run for 4 students to see if they can read, perceive, and respond to the sentences within given time spans. The time span of 6500 ms for reading and 3000 ms for responding to each scenario were endorsed appropriate as it was enough to read the scenarios fast but not long to allow them to think a lot or change their answers. All the students that attended the pilot studies were recruited by an announcement on BAIS and compensated by receiving 10 GE points for the GE250/251 course.

2.2.2.2 Dot-probe task:

Dot-probe task measures attentional bias to specific stimuli. In the current study, the stimuli were 10 Health-Related and 10 Ambiguous-health-related (called ambiguous from now on) images paired with their neutral images that were presented in 80 trials.

To select 10 Health-Related and 10 Ambiguous-health-related images, experimenters selected 80 pictures that some of them were health-related for sure and some of them were ambiguous. Using Google Form, a picture rating form was developed. All 80 pictures were uploaded on the form while asking participants to look at the pictures one by one and, by selecting a number between 0 to 10, rate each picture according to three questions: a) Is this picture related to illness? While 0 meant the picture was not related to illness at all, 10 meant the picture was completely related to illness. They could choose any other number between 0 -10, b) Rate the picture according to its Valence. While 0 meant the picture was completely unpleasant, 10 meant the picture was completely pleasant. Participants could choose any other number between 0 -10, and c) Rate the picture according to its Arousal. While 0 meant the picture made them completely calm, 10 meant the picture made them completely aroused. In a pilot study, 50 students rated the pictures at the lab. Among 80 pictures, 10 pictures that were evaluated as related to illness (illness > 8) and their valence and arousal were rated average ($4 \leq$ arousal ≤ 6; $4 \leq$ valence ≤ 6), were selected as Health-Related images.

Ten pictures that were equally rated as both health-related (illness ≥ 7, by half of the sample) or non-health related (illness ≤ 3, by another half of the sample) and their valence and arousal were rated average ($4 \leq$ arousal ≤ 6; $4 \leq$ valence ≤ 6), were chosen as Ambiguous-health-related images. After selecting these 20 main images, experimenters looked for neutral paired images that were similar to the main images according to complexity, form, chromatic features, and luminance. For each main image, three matched images were selected. Then, using Google Form, a similarity rating form was developed. In each page, the main image and its paired image were presented while asking participants to rate the similarity between images according to each complexity, form, chromatic features, and luminance indexes by selecting a number between 0 (completely different) and 10 (completely similar). 20 students took part in this pilot study. Twenty pictures that received the most similarity rates in all similarity indexes (complexity/form/chromatic features/luminance ≥ 8) were selected as the neutral paired images. All the students who attended the pilot studies were recruited by an announcement on BAIS and compensated by receiving 10 GE points for the GE250/251 course.

The task was developed using Affect 4.0 software package [62]. A fixation point was presented on the screen for 500 milliseconds. Then, two Health-Related and neutral pictures or Ambiguous-health-related and neutral pictures were shown for 500 milliseconds and then disappeared. After that, one of the pictures was replaced with a dot. By pressing the up or down arrow keys on the keyboards, participants were supposed to determine the location of the observed dot (Fig. 2.2). Each pair of pictures were presented four times: two times at each location and two times with the dot behind each of them. The Congruent sub-trials were those in which the dot was presented in the location of Health-Related and Ambiguous-health-related pictures while Incongruent sub-trials were those in which the dot was presented in the location of the neutral images. Therefore, we had 20 trials in each four blocks of congruent/health-related/neutral, congruent/health-related/neutral, congruent/ambiguous/neutral, and incongruent/ambiguous/neutral. Attention bias to health-related images was calculated using mean reaction times (mRT) in formula: (incongruent/health-related/neutral mRT - congruent/health-related/neutral mRT) and Attention bias to ambiguous-health-related images was calculated through the formula: (incongruent/ambiguous/neutral mRT - congruent/ambiguous/neutral mRT). The higher scores showed more attentional bias because it means that participants tended to detect and react faster when the dot is behind the Health-Related or Ambiguous-Health-related images than the neutral ones. The task had also a training phase to teach the participants how to respond. The images used in the training phase were 4 neutral pictures different from those used in the main phase.

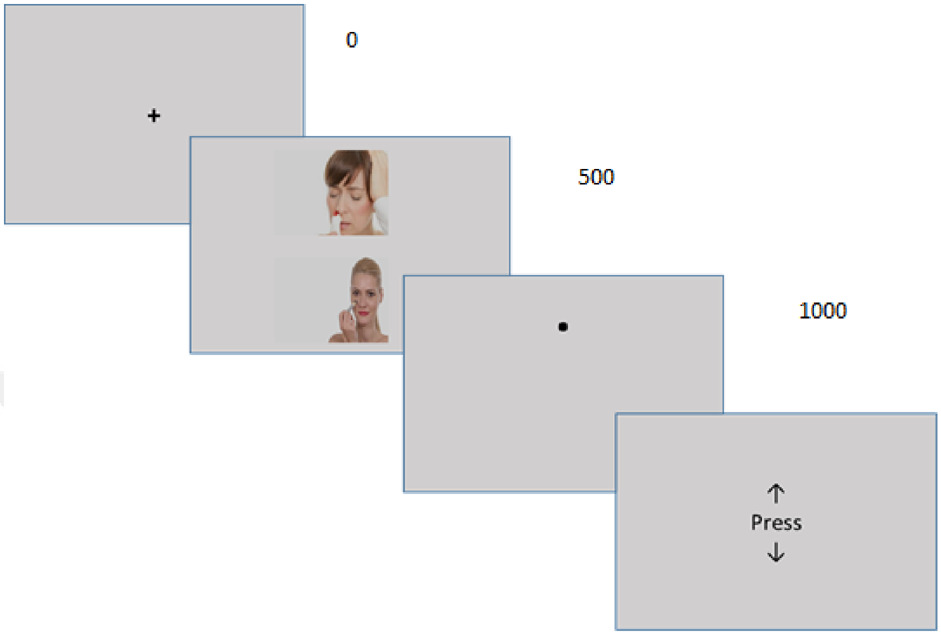

Figure 2.2: Illustration of trial events on dot-probe task

2.2.2.3 Main Online Negative Interpretation Bias Modification Task

This task was used to increase negative interpretation bias to ambiguous health-related situations through reinforcing catastrophic interpretations. This task was similar to Modified Version of Online Interpretation Task used in the assessment phase. However, it was consisted of 100 situational scenarios different from scenarios in On-line Interpretation Task in content. The scenarios were four lines length while the final sentence of each description was incomplete, lacking a word. The task incorporated 50 Ambiguous scenarios (AMB) that could be lead to either Unsafe or Safe resolution as well as 50 forced scenarios consisting of 25 Health-Related (HR) leading to Unsafe resolution and 25 Non-Health-Related (NHR) leading to Safe ones. The way that scenarios were presented on the screen, the duration of their presence on the screen, and the period of time that subjects should have chosen their answers were as the same as Modified Version of On-line Interpretation Task. After selecting the resolution, a positive (Green color) or negative (Red color) feedbacks was presented on the screen based on their responses. As we aimed to increase negative interpretations to ambiguous situations, selection of Safe words for Ambiguous scenarios was immediately led to negative feedback (Red color) while the selection of Unsafe words for Ambiguous scenarios immediately resulted in positive feedback (green color). In the forced trials, participants were required to select correct answers i.e. Unsafe and Safe words respectively for Health-Related and Non-Health-Related scenarios in order to receive positive feedbacks. Other resolutions (errors) resulted in negative feedbacks. To prevent being biased to right or left answers, words with Safe and Unsafe Valence were presented on the right and left sides of the screen equally. The correct and error resolutions were, also, equally presented on right and left sides. The task had also a training phase to teach participants how to respond.

these hundred sentences were selected among the sentences of the original Dutch version of On-line interpretation Task developed by Vancleef *et al.* [61]. The procedures for translating, finalizing, and running pilot studies were the same as procedures for developing On-line Interpretation Task. This task was, also, developed using Affect 4.0 software package [62] by the author.

2.2.2.4 Placebo Online Interpretation Bias Modification Task

This task was the same as the Main Online Negative Interpretation modification task regarding its material and procedure. The only difference was that the participants were not receiving any feedback for their responses.

2.3 Procedure

After receiving ethical approval, an email containing information about the project aim (studying cognitive processing), inclusion/exclusion criteria as well as a brief description of the procedure was sent to all undergraduate students at Bilkent University using Administrative Information Service (BAIS). Volunteer students were supposed to inform the experimented by email. Then, a time was set for each participant to come to the Social Psychology Lab for the experiment. At that session, participants' demographic information was received. In addition, the presence and absence of inclusion and exclusion criteria were examined more precisely by the experimenter. Those students who met inclusion but not the exclusion criteria received the consent form containing detailed information about the research aim, procedure, benefits, and risks of the experiment. They were asked to read and sign the consent form. After that, they were given a five-digit code. The codes were assigned to them not only to record all the data confidentially regarding ethical principles but also to determine their group allocation. Participants with odd codes were allocated to Main Online Negative Interpretation Modification group and the ones with even codes were allocated to Placebo Online Interpretation Modification group. None of the participants was informed about which group she/he is allocated in until the experiment was completed. After that, they were asked to fill a battery of questionnaire including health anxiety inventory, Beck depression inventory and Beck anxiety inventory. Then, they were taken individually to the experiment lab equipped with a computer in order to complete pre-modification, modification, and post-modification computerized task.

As pre-modification assessments, they first performed Modified Version of Online Interpretation Task. After reading the instruction, they did the training phase. As soon as finishing the training phase and responding to participants' possible questions or concerns, they started performing the main phase. The end of the task was announced to them by the word "The End" on the screen. After completing this task, the dot-probe task was run for them. They read the instruction and did the training phase. Then, they completed the main dot-probe task. Pre-modification assessment took 10 to 12 minutes.

As soon as finishing the pre-modification assessments, the Modification phase was performed for them according to the group that they belonged to. Individuals in the Main group performed Main Online Negative Interpretation Modification task. They were told that they would do a task that looked like the first task (i.e. Modified Version of Online Interpretation Task) but they would receive feedback on their responses. Individuals in Placebo group completed Placebo

Online Interpretation Modification task. Both groups did the training phase before starting the main ones. Modification took 16 to 19 minutes.

In the next step, they completed post-modification assessments that were the same as pre-modification ones.

After completing the experiment, all the participants were debriefed and the session was terminated. The students were compensated by receiving 23 GE points for their GE250/251 course.

Chapter 3

Results

3.1 Data Preparation

3.1.1 Modified Version of Online Interpretation Task

The needed indexes of valence (number of Safe and Unsafe resolutions) and mean Reaction Time were calculated using MATLAB R2017 a. For valence, the frequency of Safe and Unsafe responses to Ambiguous scenarios, Unsafe (correct) and Safe (error) responses to Health-Related scenarios as well as Safe (correct) and Unsafe (error) responses to Non-Health-Related scenarios (NHR) were calculated for each participant. Then, the mean reaction times to each scenario types (in millisecond scale (ms)) as well as mean reaction times to Safe and Unsafe resolutions of Ambiguous scenarios (in millisecond scale (ms)) were obtained.

3.1.2 Main and Placebo On-line Negative Interpretation Bias Modification Task

The needed indexes of valence (number of Safe and Unsafe resolutions) and mean Reaction Time were calculated using MATLAB R2017 a. The frequency of Safe and Unsafe responses to Ambiguous scenarios, Unsafe (correct) and Safe (error) responses to Health-Related scenarios as well as Safe (correct) and Unsafe (error) responses to Non-Health-Related scenarios (NHR) were calculated for each participant as the index of Valence. Then, the mean reaction times to each scenario types (in millisecond scale (ms)) were obtained.

3.1.3 Dot-Probe Task

The needed indexes were prepared using MATLAB R2017a. Incorrect responses were removed first. The overall mean reaction time and standard deviation (SD) were calculated for each person (in millisecond scale (ms)). After removing reaction times over and below 3 SD, the mean reaction times (ms) for congruent and incongruent sub-trials of each Health-related/neutral and Ambiguous/neutral trials were calculated. Then, Attention Bias to Health-Related stimuli was calculated by subtracting the mean reaction time (ms) to Health-Related-Congruent sub-trials from the mean reaction time (ms) to Health-Related- Incongruent subtrials. Higher scores demonstrated attentional bias to Health-Related pictures while negative scores referred to attentional bias away from Health-Related pictures. Attention Bias to Ambiguous stimuli was calculated by subtracting the mean reaction time (ms) to Ambiguous-Congruent sub-trials from the mean reaction time (ms) to Ambiguous-Incongruent sub-trials. While higher scores reflected the attentional bias to Ambiguous pictures, negative scores showed attentional bias away from Ambiguous pictures.

3.2 Data Analysis

Before analyzing, the data belong to two participants was removed as they had left the experiment before completing it. In addition, after examining pre and Post-modification data, four outliers were removed because of extremely poor task performance. The remained data (n = 94) was analyzed using IBM SPSS Statistics 23 software.

3.2.1 Pre-Modification Analysis

The data of the pre-modification phase was analyzed to ensure that both Man-modification and Placebo-Modification groups were not different according to any of the research variables before applying the modification.

3.2.1.1 Between-group differences in demographic characteristics and self-report indices

According to the descriptive statistics, gender ratio and age average did not differ between two Main and Placebo modification groups. In addition, Multivariate Analysis of Variance (MANOVA) demonstrated that there were no significant between-group differences in levels of health anxiety [$F(1, 92) = 0.06$, $p = 0.79$, $\eta_p^2 = 0.001$], depression [$F(1, 92) = 0.36$, $p = 0.54$, $\eta_p^2 = 0.004$] and anxiety [$F(1, 92) = 0.16$, $p = 0.69$, $\eta_p^2 = 0.002$] that were respectively measured by HAI, BDI, and BAI. Gender ratio, age average, and mean scores in HAI, BDI, and BAI are presented in Table 3.1.

Table 3.1: Descriptive statistics of Main-Modification and Placebo-Modification groups

Group	Female	Male	Age(M)	HAI(M)	BDI(M)	BAI(M)
Main-Modification	30	17	19.63	16.43	11.47	13.78
Placebo-Modification	31	16	19.55	16.13	12.64	13.10
M: Mean, HAI: Health anxiety Inventory, BDI: Beck Depression Inventory, BAI: Beck Anxiety						

3.2.1.2 Between-group differences in Pre-Modification Interpretation Bias to Ambiguous Scenarios (Valence)

Between-group differences in pre-modification Valence of the resolutions (Safe and Unsafe) were evaluated using Multivariate Analysis of Variance (MANOVA) while group was considered as fixed factor and dependent variables were: a) Safe resolution of Ambiguous scenario (AMB-Safe), b) Unsafe resolution of Ambiguous scenario (AMB-Unsafe), c) Unsafe resolution of Health-Related scenario (HR-Unsafe) as well as d) Safe resolution of Non-Health-Related scenario (NHR-Safe). According to the results, between-group differences were not significant for none of AMB-Safe [$F(1,\ 92) = 0.61$, $p = 0.43$, $\eta_p^2 = 0.007$], AMB-Unsafe [$F(1,\ 92) = 0.79$, $p = 0.37$, $\eta_p^2 = 0.009$], HR-Unsafe [$F(1,\ 92) = 2.72$, $p = 0.10$, $\eta_p^2 = 0.02$], and NHR-Safe [$F(1,\ 92) = 1.98$, $p = 0.16$, $\eta_p^2 = 0.02$]. The results have been presented in Table 3.2.

Between-group differences in errors including incorrect resolutions i.e. Safe resolution of Health-Related Scenario (HR- Safe) [$F(1,\ 92) = 3.55$, $p = 0.06$, $\eta_p^2 = 0.37$] and Unsafe resolution of Non-Health-Related scenario (NHR-Unsafe) [$F(1,\ 92) = 0.50$, $p = 0.50$, $\eta_p^2 = 0.02$] were not significant.

Table 3.2: Results of MANOVA for Pre-modification Valence of resolutions for Ambiguous, Health-related, and Non-Health-Related scenarios

	Group								
	Main-Modification (n=47)		Placebo-Modification (n=47)						
	M	SD	M	SD	SS	MS	F	sig	η_p^2
Pre-AMB-Safe	6.34	1.8	6.00	2.35	2.72	2.72	0.61	0.43	0.007
Pre-AMB-Unsafe	9.23	1.78	9.61	2.34	3.44	3.44	0.79	0.37	0.009
Pre-HR-Unsafe	7.21	0.72	7.44	0.65	1.28	1.28	2.72	0.10	0.029
Pre-NHR-Safe	7.78	0.41	7.98	0.31	0.26	0.26	1.98	0.16	0.021

M: Mean number of resolutions, SD: Standard deviation, SS: Sum of Squares, MS: Mean of Squares

Pre: Pre-modification, AMB: ambiguous, HR: Health-Related, NHR: Non-Health-Related

3.2.1.3 Between-group differences in Pre-Modification Interpretation Bias to Ambiguous Scenarios (Reaction Time)

Between-group differences in pre-modification mean Reaction Time to Ambiguous, Health-Related, and Non-Health-Related scenarios were evaluated by MANOVA. Group was considered as fixed factor and reaction times to each scenario types were supposed as dependent variables. Results showed that between-group differences were not significant for reaction time to Ambiguous [$F(1, 92)$ = 0.35, $p = 0.55$, $\eta_p^2 = 0.004$], Health-related [$F(1, 92) = 0.006$, $p = 0.94$, $\eta_p^2 = 0.000$], and Non-Health-Related [$F(1, 92) = 0.07$, $p = 0.78$, $\eta_p^2 = 0.001$] scenarios. The results have been demonstrated in Table 3.3.

We, also, aimed to examine the interaction between group and reaction time to each scenario types. Therefore, we did a 2 (Group) $\times$ 3 (Scenario-Types-RT) Mixed ANOVA while group was specified as between-subject factor and reaction time to scenario types (Ambiguous, Health-Related, and Non-Health-Related) as within-subject variables. The Mauchly's Test of Sphericity was not significant approving the equality of variance of differences. The results revealed the main

Table 3.3: Results of MANOVA for Pre-modification Reaction Time to Ambiguous, Health-related, and Non-Health-Related scenarios

	Group								
	Main-Modification (n=47)		Placebo-Modification (n=47)						
	M	SD	M	SD	SS	MS	F	sig	η_p^2
Pre-RT-AMB	1358.16	295.20	1324.20	260.58	27101.17	27101.17	0.35	0.55	0.004
Pre-RT-HR	1187.30	240.19	1190.92	225.26	308.28	308.28	0.006	0.94	0.000
Pre-RT-NHR	1060.07	227.48	1072.71	213.98	3751.99	3751.99	0.07	0.78	0.001

M: Mean reaction time (ms), SD: Standard deviation (ms), SS: Sum of Squares, MS: Mean of Squares

Pre: Pre-modification, RT: Reaction Time, AMB: ambiguous, HR: Health-Related, NHR: Non-Health-Related: ambiguous, HR: Health-Related, NHR: Non-Health-Related

effect of reaction time $[F(2, 184) = 121.87,\ p = 0.001, \eta_p^2 = 0.57]$ but not its interaction with group $[F(2, 184) = 0.98,\ p = 0.37,\ \eta_p^2 = 0.01]$. According to LSD post-hoc test, reaction time to all scenario types were significantly different (Table 3.4) in all participants (n = 94). All the participants, regardless of their group, responded to Non-Health-Related (NHR) scenarios faster than Health-Related (HR) ones. They, also, responded faster to Health-Related scenarios rather than ambiguous (AMB) one. Therefore, the processing speed of the scenarios was NHR > HR > AMB.

Table 3.4: Results of Pairwise Comparisons for Reaction Time to scenario types in all participants (n = 94)

(I)Scenario Type	(J)Scenario Type	Mean Difference (ms) (I-J)	Std. Error	sig
Pre-RT-AMB	Pre-RT-HR	152.06	18.14	0.001
	Pre-RT-NHR	274.78	18.25	0.001
Pre-RT-HR	Pre-RT-AMB	-152.06	18.14	0.001
	Pre-RT-NHR	122.71	16.43	0.001
Pre-RT-NHR	Pre-RT-AMB	-274.78	18.25	0.001
	Pre-RT-HR	-122.71	16.43	0.001

Pre: Pre-modification, RT: Reaction Time (ms), AMB: ambiguous, HR: Health-Related, NHR: Non-Health-Related

3.2.1.4 Between-group differences in Pre-Modification Attention Bias to Health-related and Ambiguous images

Between-group differences in pre-modification attentional biases to Health-Related and Ambiguous images were assessed using MANOVA. Group and attentional biases toward each trial were supposed as the fixed factor and dependent variables respectively. According to the results, there were no significant differences between two Main-Modification and Placebo-Modification groups in attentional bias to Health-Related images [$F(1, 92) = 0.01$, $p = 0.90$, $\eta_p^2 = 0.000$] and Ambiguous ones [$F(1, 92) = 0.07$, $p = 0.78$, $\eta_p^2 = 0.001$]. The results have been presented in Table 3.5.

Table 3.5: Results of MANOVA for Pre-modification Attention Bias to Health-Related and Ambiguous images

	Group								
	Main-Modification (n=47)		Placebo-Modification (n=47)						
	M	SD	M	SD	SS	MS	F	sig	η_p^2
Pre-HR-AB	-3.18	20.86	-3.97	38.43	14.58	14.58	0.01	0.90	0.000
Pre-AMB-AB	-0.05	19.97	-1.33	25.84	38.37	38.37	0.07	0.78	0.001
M: Mean, SD: Standard deviation, SS: Sum of Squares, MS: Mean of Squares									
Pre: Pre-modification, AB: Attention Bias, HR: Health-Related, AMB: ambiguous									

3.2.2 Modification Analysis

The data of the modification phase was analyzed to evaluate if two Main and Placebo groups act differently while they were performing Main Negative Interpretation Modification and Placebo Interpretation Modification tasks respectively.

3.2.2.1 Between-group differences in Interpretation Bias to Ambiguous Scenarios (Valence) during Modification phase

Between-group differences in modification-phase Valence of the resolutions (Safe and Unsafe) were evaluated using MANOVA. While group was considered as the fixed factor and dependent variables were resolutions of each scenario types. According to the results, between-group differences were significant only for Safe [$F(1,\ 92) = 63.24$, $p = 0.001$, $\eta_p^2 = 0.40$] and Unsafe [$F(1,\ 92) = 63.84$, $p = 0.001$, $\eta_p^2 = 0.41$] resolutions of Ambiguous scenarios. Groups were not different regarded to Unsafe resolution of Health-related [$F(1,\ 92) = 1.47$, $p = 0.22$, $\eta_p^2 = 0.01$] and Safe resolution of Non-Health-related [$F(1,\ 92) = 3.73$, $p = 0.056$, $\eta_p^2 = 0.03$] scenarios. Therefore, it seems that individuals in Main Modification learned to respond to ambiguous scenarios by selecting more Unsafe resolutions than Safe ones while Placebo group selected Safe and Unsafe resolutions for this type of scenarios equally. The results have been presented in Table 3.6.

Table 3.6: Results of MANOVA for Valence of resolutions for Ambiguous, Health-Related, and Non-Health-Related scenarios during Modification

	Group								
	Main-Modification (n=47)		Placebo-Modification (n=47)						
	M	SD	M	SD	SS	MS	F	sig	η_p^2
Modification-AMB-Safe	16.47	6.31	26.02	4.90	2022.29	2022.29	63.24	0.001	0.40
Modification-AMB-Unsafe	33.12	6.37	23.65	5.04	2106.64	2106.64	63.84	0.001	0.41
Modification-HR-Unsafe	24.57	0.92	24.36	0.76	1.06	1.06	1.47	0.22	0.01
Modification-NHR-Safe	23.76	1.41	24.23	0.86	5.14	5.14	3.73	0.056	0.03

M: Mean number of resolutions, SD: Standard deviation, SS: Sum of Squares, MS: Mean of Squares

Modification: Modification phase, AMB: ambiguous, HR: Health-Related, NHR: Non-Health-Related

3.2.2.2 Between-group differences in Interpretation Bias to Ambiguous Scenarios (Reaction Time) during Modification phase

Between-group differences in mean Reaction Time to each of Ambiguous, Health-Related, and Non-Health-Related scenarios during modification phase were evaluated by MANOVA. Group was considered as fixed factor and reaction times to scenario types were dependent variables. Results indicated that between-group differences were not significant for none of reaction time to Ambiguous [$F(1, 92)$ = 3.70, p = 0.057, η_p^2 = 0.03], Health-related [$F(1, 92)$ = 3.63, p = 0.06, η_p^2 = 0.03], and Non-Health-Related [F(1, 92) = 0.06, p = 0.80, η_p^2 = 0.001] scenarios. Although the difference in reaction time to Ambiguous scenario was near to significance range. Accordingly, it seems that Main Modification made participants react faster to Ambiguous scenarios compared with individuals in the Placebo group. The results have been demonstrated in Table 3.7.

Table 3.7: Results of MANOVA for Reaction Time to Ambiguous, Health-related, and Non-Health-Related scenarios during modification

	Group								
	Main-Modification (n=47)		Placebo-Modification (n=47)						
	M	SD	M	SD	SS	MS	F	sig	η_p^2
Modification-RT-AMB	1105.62	208.72	1202.12	273.07	218827.18	218827.18	3.70	0.057	0.03
Modification-RT-HR	918.40	175.56	994.62	210.31	136525.86	136525.86	3.63	0.06	0.03
Modification-RT-NHR	963.30	209.73	974.51	234.26	2950.51	2950.51	0.06	0.80	0.001
M: Mean reaction time (ms), SD: Standard deviation (ms), SS: Sum of Squares, MS: Mean of Squares,									
Modification: Modification Phase, RT: Reaction Time, AMB: ambiguous, HR: Health-Related, NHR: Non-Health-Related: ambiguous, HR: Health-Related, NHR: Non-Health-Related									

3.2.3 Post-Modification Analysis

Post-modification data were analyzed in order to study our thesis hypothesis pointing to the influence of Negative Interpretation Bias Modification on interpretation bias for Ambiguous health-related situations as well as the attentional bias toward Health-Related and Ambiguous images.

3.2.3.1 The Effect of Main Negative Interpretation Bias Modification on Interpretation Bias to Ambiguous Scenarios (Valence)

To evaluate our first hypothesis that is the influence of negative interpretation bias modification on increase of Unsafe and decrease of Safe interpretations for ambiguous situations, first, we applied Multivariate Analysis of Covariance (MANCOVA) in order to control the effect of pre-modification measurements. Group was the fixed factor and the dependent variables were the valences of resolutions for each scenario types. The results of MANCOVA demonstrated that between-group differences were significant for AMB-Safe [$F(1, 92) = 16.37$, $p = 0.001$, $\eta_p^2 = 0.15$], AMB-Unsafe [$F(1, 92) = 18.26$, $p = 0.001$, $\eta_p^2 = 0.17$], and HR-Unsafe [$F(1, 92)$ $= 6.02$, $p = 0.016$, $\eta_p^2 = 0.06$]. Individuals who underwent the Main Negative Interpretation Modification interpreted Ambiguous scenarios more catastrophically indexed by less Safe valence and more Unsafe valence of their resolutions in comparison to the participants in Placebo Interpretation Modification group. In addition, Main- Modification group selected more correct (Unsafe) words for completing Health-Related scenario compared with the the Placebo group. In other words, their error in responding to Health-Related scenarios was reduced. The results are demonstrated in Table 3.8.

Then, we examined the interaction of group, time, and valence of resolutions for each scenario type to see if modifications affected the resolution of each scenario types differently in groups from pre to post-modification phases. For this purpose, we applied a 2 (Group) $\times$ 2 (Time) $\times$ 3 (Scenario-types-Valence) Mixed ANOVA. Group was the between-subject factor while time and scenario-type-valence were within-subject variables. The Mauchly's Test of Sphericity was violated, so we reported the results according to Greenhouse-Geisser correction. The results revealed that the interaction between Group $\times$ Time $\times$ Scenario Type was significant [$F(2, 184) = 15.14$, $p = 0.001$, $\eta_p^2 = 0.14$]. The interaction of these three factors have been demonstrated in Fig. 3.1, Fig. 3.2, and Fig.

Table 3.8: Results of MANCOVA for Post-modification Valence of resolution for Ambiguous, Health-related, and Non-Health-Related scenarios

	Group								
	Main-Modification (n=47)		Placebo-Modification (n=47)						
	M	SD	M	SD	SS	MS	F	sig	η_p^2
Post-AMB-Safe	4.40	2.86	6.57	2.39	105.93	105.93	16.37	0.001	0.15
Post-AMB-Unsafe	11.55	2.85	9.27	2.42	119.54	119.54	18.26	0.001	0.17
Post-HR-Unsafe	7.78	0.46	7.53	0.65	1.94	1.94	6.02	0.016	0.06
Post-NHR-Safe	7.72	0.53	7.78	0.46	0.06	0.06	0.24	0.62	0.003

M: Mean number of resolutions, SD: Standard Devision, SS: Sum of Squares, MS: Mean of Squares

Post: Post-modification, AMB: ambiguous, HR: Health-Related, NHR: Non-Health-Related

3.3. As shown in the figures, after modification, individuals in Main Modification group interpreted Ambiguous scenarios notably more catastrophically while catastrophic interpretations in Placebo group had a minor decrease. Correct (Unsafe) resolutions for Health-Related scenarios in both groups increased from pre to post-modification. However, the Main group had more correct answers than the Placebo group. Correct (Unsafe) resolutions for Non-Health-Related scenarios had a minor decrease in both groups from pre to post-modification.

3.2.3.2 The Effect of Main Negative Interpretation Modification on Interpretation Bias to Ambiguous Scenarios (Reaction Time)

Studying our second hypothesis about the effect of Negative Interpretation Modification on the decrease of reaction time to Ambiguous scenarios, we used MANCOVA first. Group was specified as fixed factor and reaction time to each scenario as dependent variables. The results demonstrated that between-group difference was significant only for Non-Health-Related scenarios [$F(1, 92) = 6.23$, $p = 0.01$, $\eta_p^2 = 0.065$]. Participants in Main Modification group processed Non-Health-Related scenarios more than individuals in the Placebo group. The results are presented in Table 3.9.

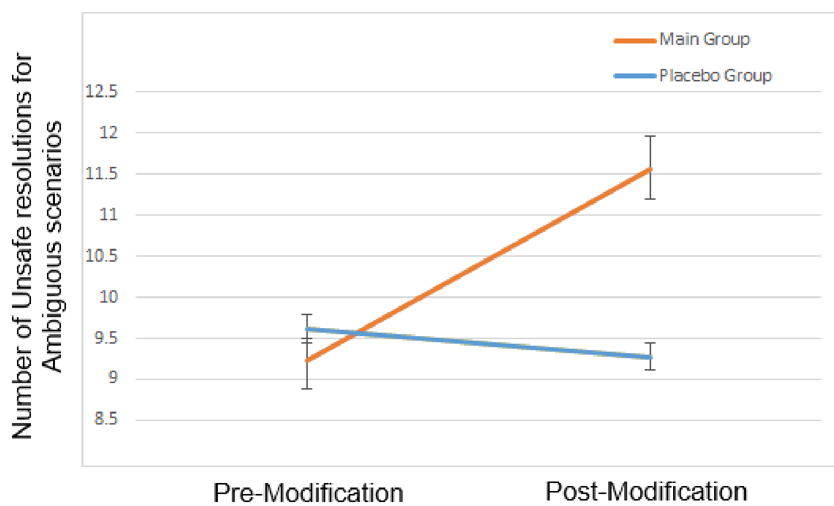

Figure 3.1: The effects of Main and Placebo Interpretation Modifications on Valence of resolutions for Ambiguous scenarios. The red plot indicates the mean numbers of Unsafe resolutions for Ambiguous scenarios in Main group (n = 47) from pre-modification session to post-modification session. The blue plot indicates the mean number of Unsafe resolutions for Ambiguous scenarios in Placebo group (n = 47) from pre-modification session to post-modification session.

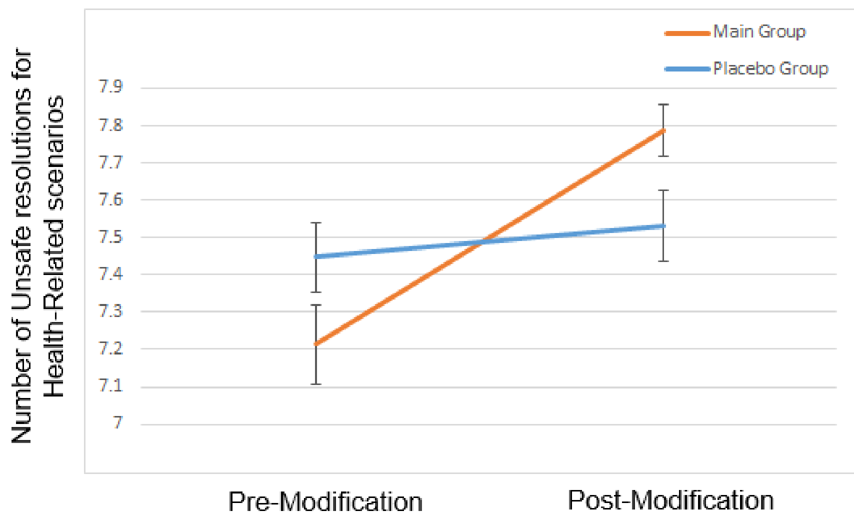

Figure 3.2: The effects of Main and Placebo Interpretation Modifications on Valence of resolutions for Health-Related scenarios. The red plot indicates the mean number of Unsafe resolutions for Health-Related scenarios in Main group (n = 47) from pre-modification session to post-modification session. The blue plot indicates the mean number of Unsafe resolutions for Health-Related scenarios in Placebo group (n = 47) from pre-modification session to post-modification session

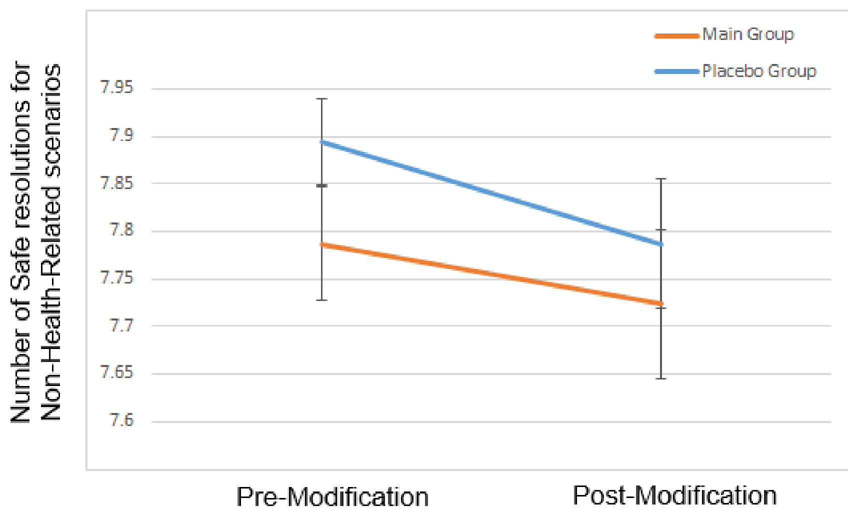

Figure 3.3: The effects of Main and Placebo Interpretation Modifications on Valence of resolutions for Non-Health-Related scenarios. The red plot indicates the mean number of Safe resolutions for Non-Health-Related scenarios in Main group (n = 47) from pre-modification session to post-modification session. The blue plot indicates the mean number of Safe resolutions for Non-Health-Related scenarios in Placebo group (n = 47) from pre-modification session to post-modification session

Table 3.9: Results of MANCOVA for Post-modification Reaction Time to Ambiguous, Health-related, and Non-Health-Related scenarios

	Group								
	Main-Modification (n=47)		Placebo-Modification (n=47)						
	M	SD	M	SD	SS	MS	F	sig	η_p^2
Post-RT-AMB	1116.72	267.61	1125.95	315.94	2872.26	2872.26	0.05	0.82	0.001
post-RT-HR	942.99	210.25	969.90	247.85	13902.95	13902.95	0.37	0.54	0.004
post-RT-NHR	961.86	259.42	867.83	211.45	234103.85	234103.85	6.23	0.01	0.065

M: Mean reaction time (ms), SD: Standard deviation (ms), SS: Sum of Squares, MS: Mean of Squares

Post: Post-modification, RT: Reaction Time, AMB: ambiguous, HR: Health-Related, NHR: Non-Health-Related

To study the interaction between group, time, and reaction time to scenario types, we used three-way i.e. 2 (Group) $\times$ 2 (Time) $\times$ 3 (Scenario-types-RT) Mixed ANOVA. Group was the between-subject factor while time and scenario-type-RT were within-subject variables. The Mauchly's Test of Sphericity was not significant and approved the equality of variance of differences. The results showed that the effect of scenario types [$F(2, 184) = 164.01$, $p = 0.001$, $\eta_p^2 = 0.64$] and its interaction with Group and Time were significant [$F(2, 184) = 5.82$, $p = 0.004$, $\eta_p^2 = 0.05$]. The interactions among these three factors have been demonstrated in Fig. 3.4 and Fig. 3.5. Although there was no between-group difference in pre-modification reaction time, reaction times to each of these scenario types were different (Table 3.4). In post-modification, reaction time to Non-Health-Related scenarios in the Main group was increased in comparison to the Placebo group's reaction time to Non-Health-Related scenarios. In addition, considering Time factor, the figures belong to placebo group look like each other in pre and post-modification phases. While in the Main group, figures are different regarding Non-Health-Related scenario. Reaction time to Non-Health-Related scenario exceeded the reaction time to the Health-Related scenario in post-test.

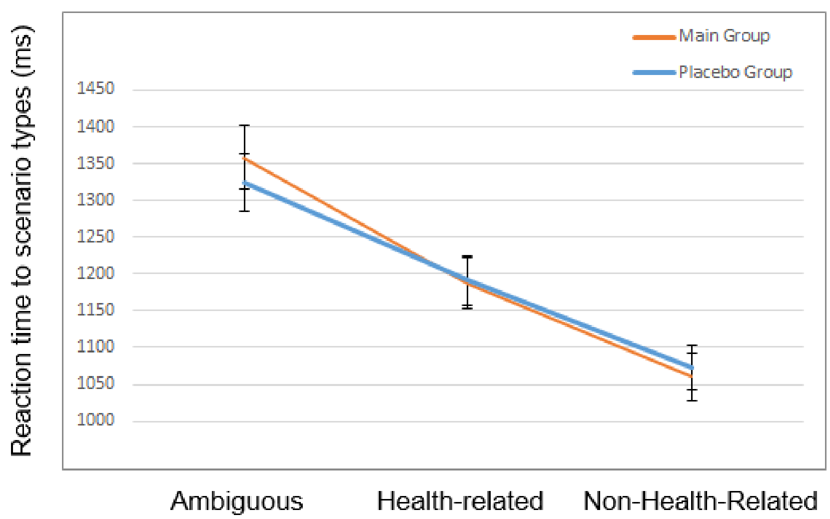

Figure 3.4: Between group differences in mean reaction time (ms) to each of Ambiguous, Health-Related, and Non-Health-Related scenarios in pre-modification session. The red plot indicates the Main group's (n = 47) mean reaction times (ms) to Ambiguous, Health-Related, and Non-Health-Related scenarios in pre-modification session. The blue plot indicates the Placebo group's (n = 47) mean reaction times (ms) to Ambiguous, Health-Related, and Non-Health-Related scenarios in pre-modification session.

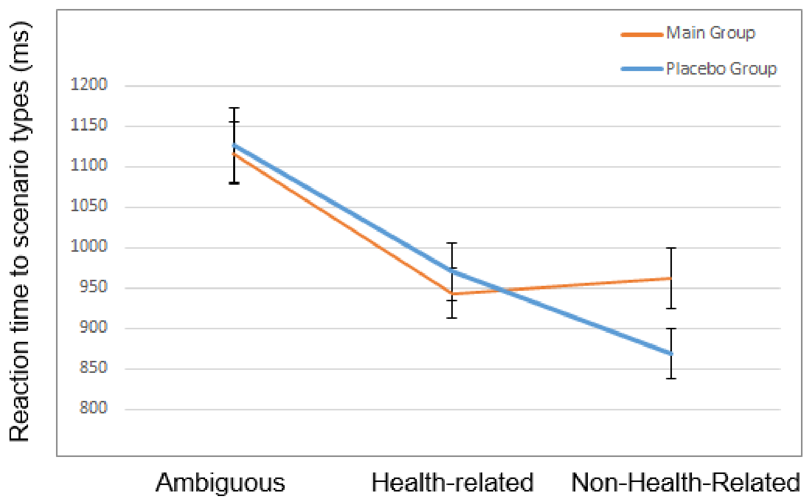

Figure 3.5: Between group differences in mean reaction times (ms) to each of Ambiguous, Health-Related, and Non-Health-Related scenarios in post-modification session. The red plot indicates the Main group's (n = 47) mean reaction times (ms) to Ambiguous, Health-Related, and Non-Health-Related scenarios in post-modification session. The blue plot indicates the Placebo group's (n = 47) mean reaction times (ms) to Ambiguous, Health-Related, and Non-Health-Related scenarios in post-modification session.

Although between-group difference in post-modification reaction time to Ambiguous scenarios was not significant, we aimed to evaluate if modification influenced the processing of Ambiguous scenarios when it resulted in different Valences (Safe or Unsafe). We hypothesized that Main Negative Interpretation modification would decrease reaction time to Unsafe resolutions that Safe ones in the Main group in comparison to the Placebo group. Accordingly, we did a 2 (Group) × 2 (Time) × 2 (Ambiguous-Valence) Mixed ANOVA. Group was the between-subject factor while time and valence of resolutions for Ambiguous scenarios were within-subject variables. Results showed the main effect of Valence [$F(1,92) = 5.02$, $p = 0.02$, $\eta_p^2 = 0.052$] and its interaction with Time [$F(1,92) = 5.25$, $p = 0.024$, $\eta_p^2 = 0.054$] but not with group [$F(1,92) = 0.002$, $p = 0.96$, $\eta_p^2 = 0.00$]. As it is presented in Fig. 3.6 and Fig. 3.7, in the pre-modification phase, participants in both groups reacted faster to Ambiguous scenarios when the valence of their resolutions was Unsafe than Safe. The reaction times to both valences reduced from pre to post-modification phase. However, this levels of reduction were not significantly different between groups. Detailed information on each group's reaction time to Safe and Unsafe valences in pre and post-modification phases have been presented in Table 3.10.

Table 3.10: Results for descriptive statistics of Pre and Post-modification Reaction time to Safe and Unsafe resolutions of Ambiguous scenarios

Group	Time	Resolution	Mean RT (ms)	SD (ms)
Main Modification	Pre	Safe	1403.945	45.802
		Unsafe	1319.989	41.633
	Post	Safe	1068.211	62.351
		Unsafe	1093.569	43.841
Placebo Modification	Pre	Safe	1390.804	45.802
		Unsafe	1269.777	41.633
	Post	Safe	1141.405	62.351
		Unsafe	1125.107	43.841
Pre: Pre-modification, Post: Post-modification, RT: Reaction Time,				

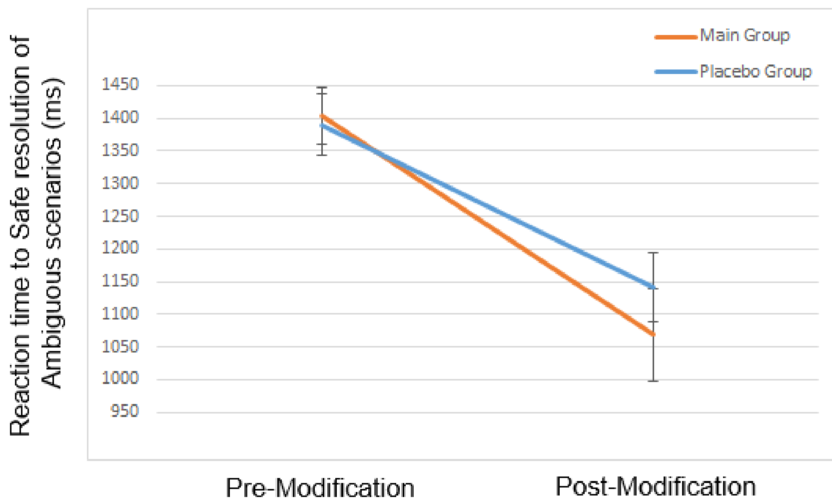

Figure 3.6: The effects of Main and Placebo Interpretation Modifications on reaction time (ms) to Safe resolutions of Ambiguous scenarios. The red plot indicates the Main group's (n = 47) mean reaction time (ms) to Safe resolutions of Ambiguous scenarios from pre-modification session to post-modification session. The blue plot indicates the Placebo group's (n = 47) mean reaction time (ms) to Safe resolutions of Ambiguous scenarios from pre-modification session to post-modification session.

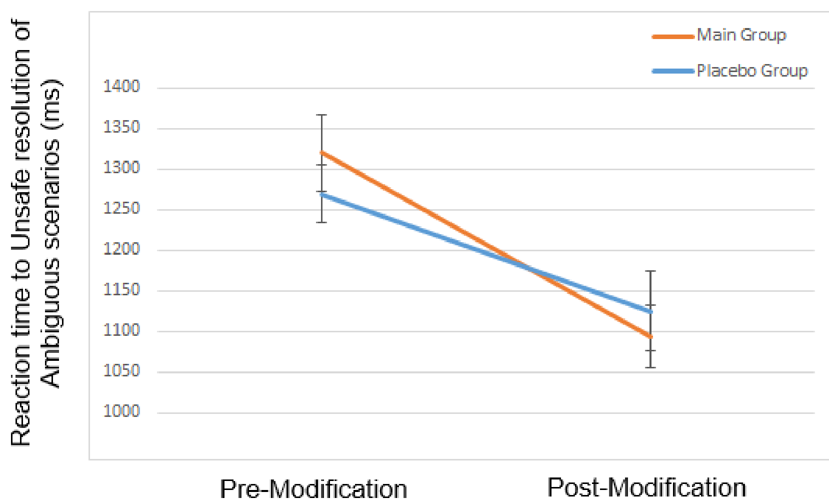

Figure 3.7: The effects of Main and Placebo Interpretation Modifications on reaction time (ms) to Unsafe resolutions of Ambiguous scenarios. The red plot indicates the Main group's (n = 47) mean reaction time (ms) to Unsafe resolutions of Ambiguous scenarios from pre-modification session to post-modification session. The blue plot indicates the Placebo group's (n = 47) mean reaction time (ms) to Unsafe resolutions of Ambiguous scenarios from pre-modification session to post-modification session.

3.2.3.3 The Effect of Main Negative Interpretation Bias Modification on Attentional Biases to Health-Related and Ambiguous images

In order to assess our next hypothesis regarding the effect of Negative Interpretation Bias Modification on increase of attentional biases to Health-Related and Ambiguous images, we used MANCOVA first. Group was specified as the fixed factor and attentional biases as the dependent variables. The results revealed that between-group difference was significant only for attentional bias to Ambiguous images [$F(1, 92) = 11.09$, $p = 0.001$, $\eta_p^2 = 0.11$] but not Health-Related ones [$F(1, 92) = 1.73$, $p = 0.19$, $\eta_p^2 = 0.19$]. According to Table 3.11, individuals who underwent the Main Negative Interpretation bias Modification experienced attentional bias to Ambiguous images in post-modification compared to individuals in the Placebo group whose score was negative reflecting no attentional bias. In addition, participants in the Main group showed attentional bias to Health-Related images as their mean in this trial was positive while the mean score in the Placebo group was negative reflecting their attentional bias away from Health-Related images. However, this difference was not statistically significant.

Table 3.11: Results of MANCOVA for Post-modification Attention Bias to Health-related and Ambiguous images

	Group								
	Main-Modification (n=47)		Placebo-Modification (n=47)						
	M	SD	M	SD	SS	MS	F	sig	η_p^2
Post-HR-AB	1.92	23.67	-4.90	26.83	1120.33	1120.33	1.73	0.19	0.01
Post-AMB-AB	10.33	17.99	-3.29	21.05	4333.28	4333.28	11.09	0.001	0.11

M: Mean, SD: Standard Deviation, SS: Sum of Squares, MS: Mean of Squares

Post: Post-modification, AB: Attention Bias, AMB: ambiguous, HR: Health-Related

To evaluate the effect of Main Negative interpretation Modification on each of attentional biases to Health-Related and Ambiguous images more specifically,

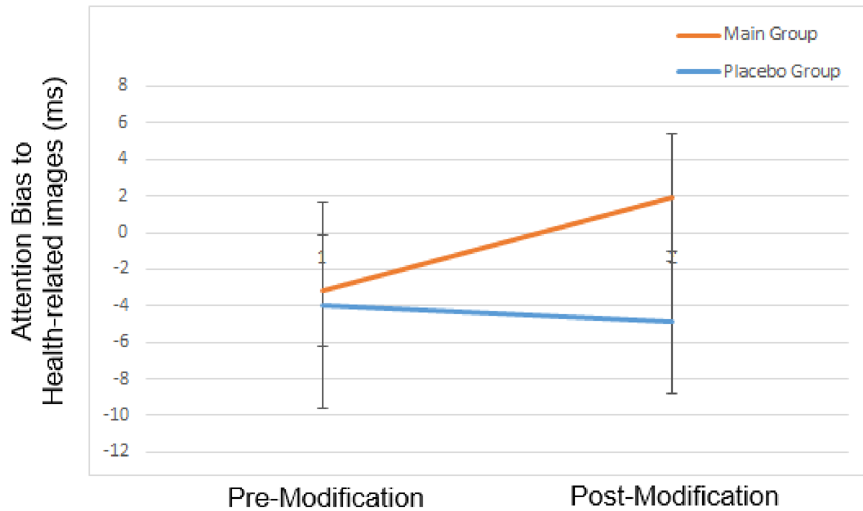

Figure 3.8: The effects of Main and Placebo Interpretation Modifications on attentional bias to Health-Related images. The red plot indicates the Main group's (n = 47) attentional bias to Health-Related images from pre-modification session to post-modification session. The blue plot indicates the Placebo group's (n = 47) attentional bias to Health-Related images from pre-modification session to post-modification session.

we performed a Mixed ANOVA for the interaction of group and time in attentional bias to each of Health-related and Ambiguous trials. Accordingly, we did a 2 (Group) × 2 (Time) ANOVA for attentional bias to Health-Related images while group and time were respectively between-subject factor and within-subject variable. Regarded to the results, the effect of Time [$F(1, 92) = 0.23$, $p = 0.63$, $\eta_p^2 = 0.003$] and the interaction of Group × Time [$F(1, 92) = 0.48$, $p = 0.48$, $\eta_p^2 = 0.005$] was not significant. According to Fig. 3.8, individuals in the Main group experienced increases in attentional bias to Health-Related images while Placebo group had declines in attentional bias to this stimuli. Therefore, between-group difference from pre to post-modification attentional bias was increased, although it was not reported significant.

Then we applied a 2 (Group) × 2 (Time) Mixed ANOVA for attentional bias to Ambiguous trial. Group and time were specified respectively as between-subject factor and within-subject variable. The results revealed that while the effect of

Time $[F(1,92) = 1.88,\ p = 0.17,\ \eta_p^2 = 0.02]$ was not significant, the interaction of Group × Time $[F(1,92) = 4.05,\ p = 0.04,\ \eta_p^2 = 0.04]$ was significant. As it is presented in Fig. 3.9, in the pre-test, both groups had no attentional bias to ambiguous images (the index of attentional bias is near to zero). In post-test, however, individuals in the Main group showed notable attentional bias to Ambiguous images. In contrast, the score of individuals in Placebo group was still negative in post-modification revealing no attentional bias to Ambiguous images.

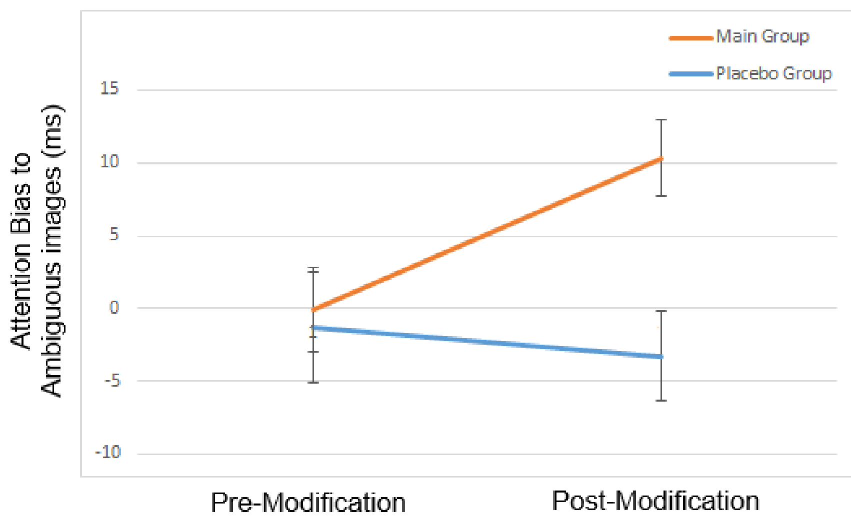

Figure 3.9: The effects of Main and Placebo Interpretation Modifications on attentional bias to Ambiguous images. The red plot indicates the Main group's (n = 47) attentional bias to Ambiguous images from pre-modification session to post-modification session. The blue plot indicates the Placebo group's (n = 47) attentional bias to Ambiguous images from pre-modification session to post-modification session.

To study the effect of interpretation bias modification on attentional bias regarding the congruent and incongruent sub-trials, we used a three-way Mixed ANOVA for each of attentional biases to Health-Related and Ambiguous images. First, we did a 2 (Group) × 2 (Time) × 2 (Sub-trial) ANOVA for attentional bias to Health-Related stimuli. Group was the between-subject factor while time and sub-trial were within-subject variables. Regarded to the results, the effect was only significant for Time $[F(1,92) = 20.27,\ p = 0.001,\ \eta_p^2 = 0.19]$ but not the interaction of Group × Time × Sub-trial $[F(1,92) = 0.48,\ p = 0.48,\ \eta_p^2 = 0.005]$.

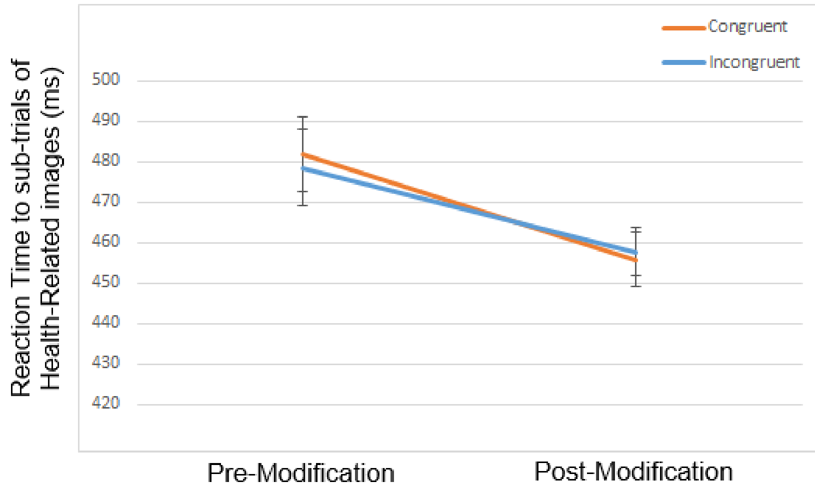

Figure 3.10: The effect of Main Interpretation Modifications on mean reaction time (ms) to Congruent and Incongruent sub-trials of attentional bias to Health-Related images in Main group (n = 47). The red plot indicates the Main group's mean reaction time (ms) to Congruent sub-trials from pre-modification session to post-modification session. The blue plot indicates the Main group's mean reaction time (ms) to Incongruent sub-trials from pre-modification session to post-modification session.

Based on Fig. 3.10 and Fig. 3.11, from pre to post, reaction time to both congruent and incongruent sub-trials of attentional bias to Health-Related images were reduced in both groups (n = 94). While this decrease was parallel in Placebo group, reaction time to congruent sub-trials in the Main group decreased more than incongruent one reflecting the attentional bias to Health-Related images. However, these differences between congruent and incongruent sub-trials in the Main group as well as the difference between Main and Placebo was not in a significant range. See Table 3.12 for mean reaction time for each sub-trials.

Then, we applied a 2 (Group) × 2 (Time) × 2 (Sub-Trial) Mixed ANOVA for attentional bias to Ambiguous stimuli. Group was between-subject factor while time and sub-trial were within-subject variables. According to the results, the effect of Time $[F(1,92) = 23.18,\ p = 0.001,\ \eta_p^2 = 0.20]$ as well as the interaction of Group × Time × Sub-trial $[F(1,92) = 4.05,\ p = 0.04,\ \eta_p^2 = 0.042]$ were

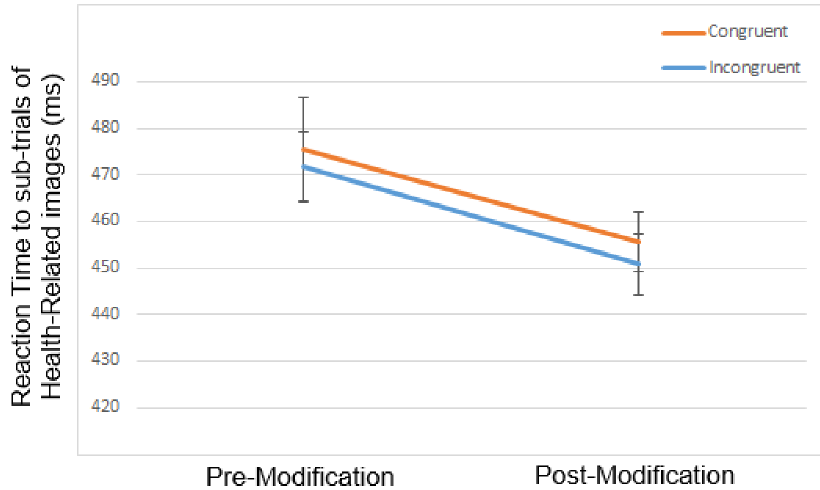

Figure 3.11: The effect of Placebo Interpretation Modifications on mean reaction time (ms) to Congruent and Incongruent sub-trials of attentional bias to Health-Related images in Placebo group (n = 47). The red plot indicates the Placebo group's mean reaction time (ms) to Congruent sub-trials from pre-modification session to post-modification session. The blue plot indicates the Placebo group's mean reaction time (ms) to Incongruent sub-trials from pre-modification session to post-modification session.

significant. As it is presented in Fig. 3.12 and Fig. 3.13, reaction time to congruent and incongruent sub-trials decreased from pre to post-modification phase in both groups. In addition, while the reaction time to both sub-trials was too close to each other in pre-modification phase in both groups, the difference between reaction time to congruent and incongruent increased in both groups in post-modification phase. However, in contrast to the Placebo group, the individuals in Main group had faster reaction time to congruent sub-trials than incongruent ones referring to attentional bias to ambiguous images. See Table 3.13 for mean reaction times for each sub-trials.

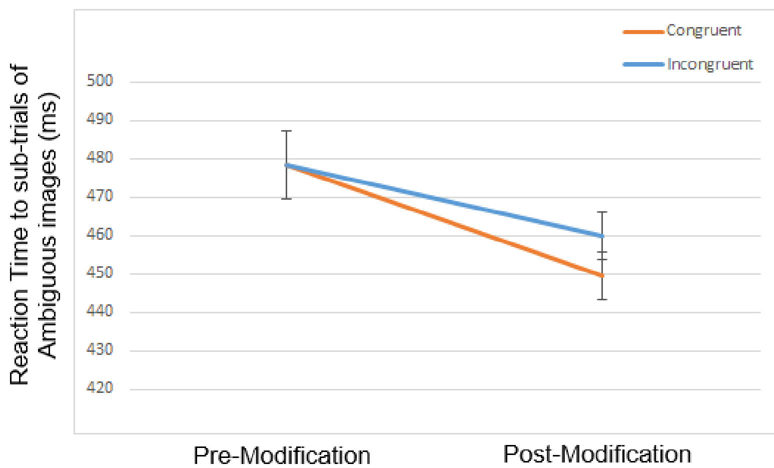

Figure 3.12: The effect of Main Interpretation Modifications on mean reaction time (ms) to Congruent and Incongruent sub-trials of attentional bias to Ambiguous images in Main group (n = 47). The red plot indicates the Main group's mean reaction time (ms) to Congruent sub-trials from pre-modification session to post-modification session. The blue plot indicates the Main group's mean reaction time (ms) to Incongruent sub-trials from pre-modification session to post-modification session

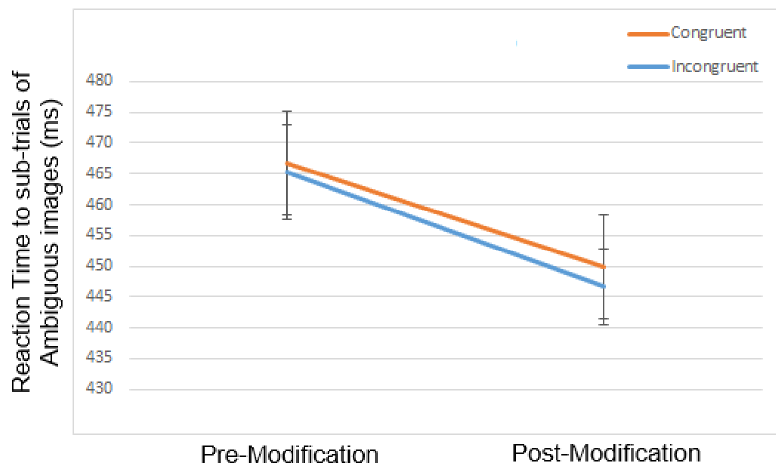

Figure 3.13: The effect of Placebo Interpretation Modifications on mean reaction time (ms) to Congruent and Incongruent sub-trials of attentional bias to Ambiguous images in Placebo group (n = 47). The red plot indicates the Placebo group's mean reaction time (ms) to Congruent sub-trials from pre-modification session to post-modification session. The blue plot indicates the Placebo group's mean reaction time (ms) to Incongruent sub-trials from pre-modification session to post-modification session.

Table 3.12: Results for descriptive statistics of Pre and Post-modification Reaction Time to Congruent and Incongruent sub-trials of Health-Related images

Group	Time	Health-related: Sub-Trial	Mean RT (ms)	Std. Error
Main Modification	Pre	Congruent	481.73	10.21
		Incongruent	478.55	8.60
	Post	Congruent	455.80	6.53
		Incongruent	457.72	6.32
Placebo Modification	Pre	Congruent	475.58	10.21
		Incongruent	471.61	8.60
	Post	Congruent	455.66	6.53
		Incongruent	450.75	6.32
Pre: Pre-modification, Post: Post-modification, RT: Reaction Time				

Table 3.13: Results for descriptive statistics of Pre and Post-modification Reaction Time to Congruent and Incongruent sub-trials of Ambiguous images

Group	Time	Ambiguous: Sub-Trial	Mean RT (ms)	Std. Error
Main Modification	Pre	Congruent	478.47	8.94
		Incongruent	478.42	8.38
	Post	Congruent	449.40	6.24
		Incongruent	459.73	6.18
Placebo Modification	Pre	Congruent	466.72	8.94
		Incongruent	465.39	8.38
	Post	Congruent	449.92	6.24
		Incongruent	446.63	6.18
Pre: Pre-modification, Post: Post-modification, RT: Reaction Time				

Chapter 4

Discussion

In this study, the influence of interpretation bias modification on attentional bias in health-related context have been examined. For this purpose, the negative interpretation biases for Ambiguous health-related scenarios were imposed on the normal sample using an interpretation modification task and studied its effect on the increase of attentional biases to Health-Related threatening and ambiguous images. The results primarily revealed that there were no between-group differences in pre-modification interpretation bias for Ambiguous scenarios as well as pre-modification attentional biases to Health-Related and Ambiguous images. Analysis of Modification-phase data revealed that during performing the Main modification, Unsafe resolutions for Ambiguous scenarios was increased in the Main-Modification group while the Placebo group were selecting Safe and Unsafe words equally. During modification, the Main group reacted faster to Ambiguous scenarios than Placebo one. However, the difference in the reaction time was near to significance. These results indicate that Main Negative Interpretation Bias Modification was successful in teaching the Main participants how to respond while Placebo modification was truly acting as a placebo modification. Post-modification results demonstrated that interpretation modification could influence cognitive processing by changing both interpretive and attentional biases to health-related information. Interpretation bias modification increased interpretation bias for Ambiguous scenarios index by the valence of resolutions (i.e. more

Unsafe resolutions and less Safe resolutions) in individuals who received Main Negative Interpretation Bias Modification while individuals in Placebo Interpretation Bias Modification group showed no difference from pre to post-modification phase. Furthermore, the results revealed no post-modification between-group differences in interpretation bias indexed by the reaction time to Ambiguous scenarios. In addition, there were no between-group differences regarding the reaction times to Safe and Unsafe resolutions for Ambiguous scenarios. Main Negative Interpretation Bias Modification, however, made individuals react faster to Non-Health-Related scenarios compared to Placebo Interpretation modification. Main Negative Interpretation Bias Modification boosted attentional bias toward ambiguous images in the Main group while attentional bias toward Ambiguous images did not change in participants of Placebo group. Although the individuals in Main group experienced attentional bias toward Health-Related images after receiving Main negative interpretation bias modification compared with the individuals in Placebo group, this difference was not statistically significant.

Individuals who underwent the Main negative interpretation bias modification used to interpreted Ambiguous scenarios more catastrophically indexed by less Safe valence and more Unsafe valence of their resolutions compared with participants in Placebo interpretation bias modification group. Therefore individuals in the Main group could generalize Unsafe interpretations to the new exemplars. Hence, the first hypothesis of the study has been approved. This result is congruent with Mathews and Grey's study in that training with threatening meanings caused participants to produce threatening meanings for the new homographs while non-threatening training did not have such effect [63]. In another study using incomplete ambiguous social situations, both positive and negative interpretation modifications could impose positive and negative interpretation biases respectively on normal participants [64]. Therefore, emotional interpretations are not permanent and can be modified. Accordingly, the interpretation bias in people with medical diseases might arise in the same manner. Repeated active exposures to competing negative and neutral resolutions for ambiguous bodily changes that are followed by negative interpretations of medical tests (such as the results of blood test, mammography, and brain scan) might increase a tendency in patients to generate unsafe interpretations than safe ones for any other ambiguous bodily sensations or health-related signs and symptoms. Although, Mathews and Mackintosh stated that active resolving of ambiguous situations is not necessary for generation of interpretation bias [64]. In their experiment, participants were asked to read ambiguous sentences while they were completed with positive or negative words. Even passive reading of complete negative sentences could make participants interpretations negative [64]. Therefore, passive exposure to negative information about health-related issues might also lead to the negative interpretation bias. It might explain interpretation bias in people with illness anxiety or fear of pain who do not have any diagnose of disease but interpret bodily sensations as threatening. These people search for health-related information as a safety behavior that can increase the possibility of exposing negative information. The results about the effect of interpretation bias modification on further interpretation bias can, in addition, be considered as consistent with studies that applied positive modifications on clinical samples [65, 66, 67]. In one study on the health issue, positive interpretation bias modification reduced the rate of negative interpretation bias [50]. Amir *et al.* reported that both standards and explicit interpretation modification increased positive interpretations of ambiguous social scenarios [48]. In Mobini *et al.* study, positive interpretation training could reduce threatening and increase benign interpretations of social performance scenarios [68].

Negative interpretation bias could reduce errors in Health-Related scenarios in the Main group rather than the Placebo group from pre to post-modification phase. That is participants in the Main group selected Unsafe resolutions for forced Health-Related scenarios as they were expected but individuals in the Placebo group did errors. Evaluating the mean for both groups shows that between-group difference in reaction time to Health-Related scenarios is really minor. Therefore, it can be explained that since the scenarios were forced ones with the certain answers, even minor errors made the differences significant. It, also, can be discussed as an evidence for the increase of concentration or more accurate process of health-related information as the result of negative interpretation bias modification that led to the more accurate resolution for these scenarios. However, more process of Health-Related scenarios has been not approved regarding the reaction time to Health-Related scenarios. Between-group differences in reaction time to Health-Related scenarios were not significant. Therefore, people in the Main group processed these forced scenarios as much as the placebo group but they ended up with more correct answers. No study that reported the same results could not be found.

Considering the results of the reaction time, individuals in the Main group had faster post-modification reaction time to Ambiguous scenarios than the Placebo group. However, the magnitude of this between-group difference was not statistically significant. We hypothesized that negative interpretation bias modification would reduce the ambiguity and make participants consider ambiguous situations as certain health-related ones that are processed faster and lead to less reaction time. Regarding less mean reaction time in the Main group compared to the Placebo one, it seems that negative interpretation bias modification could make the process of Ambiguous scenarios faster and reduce their ambiguity. However, the negative interpretation bias modification seemingly was not sufficient to boost between-group differences up to a significant level. It might be because of the fact that the sample consisted of normal participants with no medical disease and psychological problems (for example high trait-anxious individuals). Therefore, they might lack vulnerability to process Ambiguous scenarios as threatening ones and respond to them fast. Despite the fact that the participants completed many incomplete scenarios in order to be trained, they might have still considered the Ambiguous scenarios as uncertain situations that are needed to be processed further. However, participants resolved these Ambiguous situations with more Unsafe words than the Placebo group.

We, also, assumed that individuals in the Main group, compared to the Placebo group, would choose Unsafe words faster than Safe ones in ambiguous situations after modification (post-modification). It is because of the fact that Unsafe resolutions correspond to the valence of their modification in comparison to the Placebo group members. Results demonstrated that while both groups selected Unsafe resolutions faster than Safe ones in the pre-modification phase, this pattern repeated in the post-modification phase only for the Placebo group. The main group chose Unsafe resolutions slower (25 ms) than Safe ones in post-test. However, these within-group and between-group differences have not been significant. Consistent with this finding, Grey and Mathews did not find any between-group differences in the response time to valenced targets after training their participants by threatening and non-threatening meanings [69]. In contrast, Mathews and Mackintosh reported that participants were faster in resolving new ambiguous word fragments in case the fragments were matched to the valence of words in training phase (positive Vs. negative interpretation) [64]. Our finding on the same reaction time to Safe and Unsafe resolutions in the Main group can be considered as an evidence that endorses interpretation bias for Ambiguous scenarios (indexed by more Unsafe resolutions of Ambiguous scenarios) has been caused by processing of Ambiguous scenarios before resolving them but not by unwanted response bias. To explain more, it can be discussed that negative interpretation bias modification activated Unsafe resolutions in cognitive system of normal subjects of the Main group (compared to pre-modification phase) leading to increased competition between Safe and Unsafe resolutions according to the response competition theory [18]. This response competition, then, has made participants process the scenarios as well as all different competing resolution and react to them after their processing is finished instead of answering to them according to any specific biased responses. While response competition theory states that biases to threat happen when alternative options compete for cognitive resources, the response bias theory expresses that modifications might bias answers by triggering the training-congruent stimuli without influencing the process of information. In addition to increased competition, reinforcing negative-valenced resolutions in normal subjects might incline the challenges for inhibiting safe resolutions by unsafe ones leading to not reacting faster to unsafe resolutions than safe ones in the Main group. In other words, since non-patient and non-anxious individuals tempt to interpret information in a positive way (see [70, 43]), the current modification could just increase the competition between Safe and Unsafe resolutions in the Main group but it was not sufficient to override such positive biases by faster reaction time to unsafe resolutions than safe ones.

Interestingly, between-group differences in the reaction time were only different for post-modification Non-Health-Related scenarios. Individuals in the Main group significantly reacted slower to Non-Health-Related scenarios compared with the people in Placebo groups, although there were no between-group differences in the valence of resolutions. Therefore, the main group processed Non-Health-Related scenarios more than placebo one but both groups selected the same answers for completing these forced situations. This might have happened since negative interpretation bias modification has increased uncertainty in Main group individuals making them process scenarios more in order to reject incorrect answers (unsafe) more confidently. In addition, the modification might have primed anxiety in the participants and caused them to process even forced Non-Health-Related situations for finding any sign of threat. This finding might explain the sensitivity of patients to safe bodily sensations as they might believe that even safe situations might lead to negative consequences.

Our study has revealed that changing interpretation bias will lead to changes in attentional bias endorsing the interaction between these two cognitive processing components. Regarding our results, imposing negative interpretation bias could significantly increase attentional bias toward Ambiguous-health-related images from pre to post-modification phase in the Main group compared to the Placebo group. Negative interpretation bias modification for ambiguous situations might activate the unsafe interpretations that were already disregarded. Repeated exposures with such negative interpretations might gradually make cognitive resources be allocated to process of these unnoticed interpretations. Afterward, these changes in interpretations can influence attentional bias in different ways. First, negative interpretations of Ambiguous scenarios will be directly generated to Ambiguous health-related images leading to attentional bias to ambiguous stimuli that were not previously perceived as threat-related. Second, repetitive unsafe interpretations of Ambiguous health-related scenarios might cause allocation of attention to ambiguous images by increasing anxiety levels. As discussed in introduction section, anxiety and stress decrease the threshold for triggering threatening stimuli and meninges stored in TES. Therefore, images that were not already corresponded to threats in TES, will now be matched to stored threatening information and attract attention. Third, interpretation and attentional bias might be linked to a third common processing system. Interpretation modification might indirectly influence attentional bias by making changes in this common third factor. Although our study did not explored any of these three possible explanations, it endorses theories that state interpretation and attentional processing are intricately related but not orthogonal cognitive components [4, 71]. Repetitive inhibition of safe interpretations in favor of unsafe ones during negative interpretation bias modification probably facilitates attribution of unsafe meanings to ambiguous images compared to benign ones and consequently, lead to allocation of attention to these ambiguous images compared to neutral ones i.e. attentional bias in Main group rather than Placebo one. Our results on the efficacy of interpretation bias modification on increasing attentional bias to ambiguous images might be also considered as an indicator of more automatic and implicit interpretation bias. To explain more, capturing attentional resources to an encoding of ambiguous images might not be possible without attribution of threatening meanings to these images in a more unconscious and automatic way. Besides, the increase in attentional bias toward ambiguous images might reflect the activated competition of different meanings for being attributed to images without being affected by stress or anxiety.

Interpretation bias modification, in addition, boosted attentional bias to threatening Health-Related images in the main group compared with Placebo group from pre to post-assessment phase. Although this difference was obvious regarding the mean attentional bias, it was not statistically significant. We could not find any former studies about the effect of negative interpretation bias modification on attentional bias toward threat but there are contradictory findings of the influence of positive interpretation bias modification on attentional bias. Consistent with our finding, Lichtenthat *et al.* showed that positive interpretation modification for ambiguous health-related sentences could not change attentional bias toward threatening health-related words [50]. Some studies on other problems such as social anxiety, also, did not support the effect of interpretation modification on attentional bias [49]. While some findings reported that positive interpretation bias modification could reduce attentional bias to threat [51, 72]. Mobini *et al.* said that although the effect of positive interpretation bias modification for social situations on the reduction of attentional bias toward threatening social stimuli was significant in social anxious participants, the effect was not large and disappeared after one week [72]. Considering that individuals in the Main group have shown attentional bias in the post-modification dot-probe test, it seems that interpretation bias for Ambiguous scenarios might be able to incline attentional bias to threatening images along with ambiguous ones. However, its insignificance in resulting in significant changes might be explained in different manners. One reason of insignificance might be that negative interpretation modification designed to change safe interpretations of ambiguous situations into unsafe ones. Therefore, it might increase attention to and the process of ambiguous situations but not threatening or safe ones. The other explanation can be discussed regarding our sample. Since healthy subjects do not experience attentional bias toward threatening stimuli, the current interpretation modification was insufficient to develop the attentional bias to threatening Health-Related images. This might reinforce the explanation that attentional bias toward ambiguous images might be due to the competition of different interpretations for being attributed to images than aroused anxiety. Although, regarding the notable between-group differences in attentional bias to threatening Health-Related images, even if not significant, approving such discussions need further research.

Current findings need to be interpreted in the light of several limitations. Follow-up measurements were not performed in the current study. Therefore it is not clear if the effects of negative interpretation bias modification on the further interpretive bias and attentional biases are transient or consistent. The different sequence of cognitive bias modification i.e. the influence of attentional bias modification on interpretation bias was not evaluated. Thus, it cannot be claimed if modifying any cognitive processing would influence the other one. The other limitation of the study is that we did not measure levels of post-modification anxiety induced by modification. Therefore, interpreting the influence of interpretation bias modification on attentional bias by considering the mediating role of anxiety levels should be done with more caution. In this study, the levels of the participants' awareness of the indentation of the modification were not measured. As such, it might be claimed that the results of the Main group might be the effect of the intentional selection of target words known as the placebo effect. However, as discussed, same reaction time to safe and unsafe resolutions in the Main group can be considered as an indication that clarifies participants have processed scenarios and their resolutions rather than have being biased by any specific word. Especially that the time span for selecting responses was limited and requires the participants to select the word that came to mind as soon as possible. More importantly, the results of the dot-probe task as an implicit cognitive task showed that interpretation bias modification could increase attentional bias to threatening and Ambiguous health-related images. If the changes in interpretation bias seen in participants in the Main group has been caused due to a placebo effect than real ones, we expect not to see such modifications in attentional bias indexes. Furthermore, we believe that awareness and learning the mechanism of modification paradigms are not necessarily a negative point. Psychotherapy protocols, for example, are endorsed to modify cognitive processing and reduce symptoms while a person who is under psychotherapy is completely aware of cognitive challenges and the intention of the treatment sessions. The other issue that should be considered in the interpretation of attentional bias results is cue-target interval. Interstimuli interval (ISI) refers to the interval between presentation of the stimulus pair and the probe. According to Klumpp and Amir [73], longer ISI might change the direction or strength of attentional process as more than one shift of attention between images might happen. In other words, when the exposure time is short, the attentional orientation towards or away from a threat is probably unconscious [74]. While in longer exposure times (for example at a ISI of 500 ms that was used in our experiment), attentional orientation may be linked to a more controlled processing. Supporting this claim, it was reported that the intervals longer than 250 ms might be led to Inhibition Of Return (lOR) that means a slower response to the target that is presented at the cued location [75]. Therefore, the reported attentional bias in the current experiment might indicate the effect of interpretation bias on more controlled attentional processing.

Despite mentioned limitations, this thesis is one of the first studies that has evaluated the reciprocal influence of interpretation bias on attentional bias in the context of health-related information. The results have provided evidence supporting the idea that interpretation and attentional biases are interrelated processes than orthogonal ones. This research is one of the rare ones which has imitated the health-related negative cognitive processing biases in healthy subjects. Using the modification paradigm, our study has tried to create a negative interpretation bias for ambiguous health-related information that resembles the threatening interpretation biases in people with medical diseases. This modification probably leads to the generation of negative meanings that matched the representations in TES. In turn, the new negative meanings result in congruent changes in other cognitive bias i.e. attentional bias to ambiguous or threatening health-related stimuli. The study is, also, one of the rare works that evaluated the effect of interpretation bias modification on attentional bias to both ambiguous and threatening health-related information. Furthermore, the findings have demonstrated that changing the cognitive processes of a specific type of stimuli can be generalized to another type of information. We have modified the meanings of lexical information but the effects of modification have generalized to pictorial stimuli that have not been involved in modification paradigm.

The findings of the influence of negative interpretation modification on the increase of negative interpretation bias for Ambiguous scenarios as well as the attentional bias toward ambiguous Health-Related images can have theoretical and clinical implications. The results have provided experimental evidence for the theories that believe interpretation and attentional biases are interrelated. In addition, they can be considered as evidence that expresses suffering from a disease can bias cognitive processing. Theories about the role of cognitive bias in negative emotions such as anxiety as well as our findings of the influences of negative interpretation bias modification on the development of attentional bias to threat can be integrated in order to develop therapeutic modifications aiming to reduce cognitive processing biases and its consequences. Such modification programs can be used as independent treatments or adjunct therapies to maximize the efficacy of usual clinical practices such as cognitive-behavioral therapy (CBT)

[68] that are used to reduce anxiety and depression in people with medical diseases such as cancer and MS.

4.1 Implications For Future Studies

Future works need to think of designs that enable them to transfer the effects of interpretation bias modification from experiment labs to the real clinical settings. For this purpose, they can study the relationship between these interpretation and attentional biases by application of positive interpretation bias modification in patients who are suffering from medical diseases. They can evaluate if this modification paradigm influences attentional biases toward health-related information as well as the levels of anxiety and impairments experienced by these patients. Furthermore, it would be informative if they consider follow up studies. Such designs will clarify if experimental results are context-dependent or they will continue during the time [72]. They, also, can evaluate if modification-induced changes will influence deeper levels of cognitive processing including dysfunctional assumptions about illness and self-appraisal [68]. It will be beneficial if the effect of multi-session training can be studied in future projects in order to examine if longer modification procedures might cause different or more consistent changes in cognitive processing. What is more, future studies can use health-threatening stimuli along with other categories of threatening stimuli to examine if modification-dependent changes in interpretation and attentional biases are specific to health-related information or they are generated to other categories of threatening information. Besides, it is necessary to evaluate the alternative subsequence of cognitive processing using application of attentional bias modification and studying its influence on interpretation bias for health-related situations. More importantly, it seems that more experiments are needed to measure attentional bias using ambiguous stimuli and compare the results with the attentional bias to threatening stimuli in order to investigate if interpretation bias modification for ambiguous situations influences the allocation of attention to ambiguous and threatening information in different ways.

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