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**Lost in Thoughts -
A Quantitative Study About Repetitive Thinking, Gaze
Behavior and Experiences of Distress**

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Abstract

The purpose of the present study was to investigate if and how repetitive negative thinking (RNT) influences the level of experienced distress during recall of images of neutral and negative content, and how such effects might be modulated by gaze behavior. Another aim was to study whether RNT and image content influences participants' gaze behavior. The data that was analyzed in this thesis was previously collected by students at Lund University under supervision of Sabine Schönfeld and Roger Johansson. Eye-tracking was used to monitor 68 participants' gaze behavior during recall. Ratings were used to capture experienced distress and a questionnaire was used to classify RNT. Results of the present study showed a main effect of RNT on two distress ratings. The results did not support the prediction that gaze behavior would have an influence on the interplay between RNT and experienced distress. However, an exploratory analysis of gaze behavior, RNT and image type revealed that participants with high versus low RNT experience distress differently depending on how much they look back towards the position where the recalled content was originally encoded.

Keywords: Repetitive negative thinking, rumination, worry, eye-tracking, gaze behavior, looking at nothing, recall

Sammanfattning

Syftet med denna studie var att undersöka om och hur repetitivt negativt tänkande (RNT) påverkar nivån av upplevt obehag under återkallning av neutralt och negativt laddade bilder, samt hur blickbeteenden modulerar sådana effekter. Ett annat syfte var att studera huruvida RNT och bildinnehåll påverkar deltagarnas blickbeteende. Datan som analyserades i denna studie hade sedan tidigare blivit insamlad av studenter på Lunds universitet under handledning av Sabine Schönfeld och Roger Johansson. Ögonrörelser användes för att mäta 68 deltagares blickbeteenden under återkallning. Skattningsfrågor användes för att mäta upplevelser av obehag och självskattningsformulär användes för att ge ett mått på RNT. Resultaten av denna studie visade att RNT hade en huvudeffekt på två skattningar av obehag under återkallning. Vidare fanns det inget stöd för hypotesen om att blickbeteende skulle påverka samspelet mellan RNT och upplevt obehag. Dock visade en explorativ analys av blickbeteende, RNT och bildtyp att deltagare med högt respektive lågt RNT upplevde obehag på olika sätt beroende på hur mycket de tittade tillbaka i området där bilden som skulle återkallas tidigare hade kodats in.

Nyckelord: repetitivt negativt tänkande, ruminering, oro, ögonspårning, blickbeteende, looking at nothing, återkallning

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Lost in Thoughts -

A Quantitative Study about Repetitive Thinking, Gaze Behavior and Experiences of Distress

Picture yourself lying in bed the night before an important presentation. You have tossed and turned for hours, going through notes in your head over and over again. What happens if you forget what to say? If you get a coughing fit in the middle of the presentation? What happens if it turns out that you misunderstood the whole task? What will the consequences be? Or picture yourself in bed the night after the presentation. It seems that you cannot stop thinking about that one time someone in the audience yawned and looked away as you spoke, or the fact that your hands quivered for a minute.

This example is probably in some aspect relatable to many people and is an illustration of what is called *repetitive negative thinking*. Repetitive negative thinking (RNT) encompasses several cognitive processes that are characterized by extensive cognitive focus on the self, emotions and events in the past or future (Segerstrom et al., 2003). Although not all kinds of RNT are thought to be harmful (e.g. emotional processing and reflection), there are also aspects such as *worry* and *ruminatio*n that are often more disruptive in nature (Segerstrom et al., 2003). Studies have also shown that tendencies to ruminate and/or worry influences our way of experiencing or interpreting events (Eysenck et al., 2007; Hertel, 2004; Koster et al., 2011; Watkins, 2008).

Something that also influences our experiences is how we interact with the world through our eye movements. What we look at critically determines what we can encode into memory and what will be available during subsequent remembering. There is a general agreement that there is a strong link between eye movements and episodic remembering (Wynn, Shen & Ryan, 2019), which can be illustrated through the therapy form eye movement desensitization and reprocessing therapy (EMDR) where induced eye movements are used to desensitize the distress caused by traumatic memories in order to then reconsolidate them (Perlini et al., 2020).

The aim of this study is to further extend the knowledge about repetitive negative thinking. Whereas several studies have shown that repetitive negative thinking affects the direction of our attention and interpretation of events, there seems to be a lack in the literature regarding repetitive negative thinking and the process of *recall*. We aim to investigate this and more specifically examine how different levels of repetitive negative thinking may influence the

level of experienced distress during the process of recall of both neutral and negative stimuli, and how such potential effects interact with different gaze behavior.

Background

There are currently many different accounts of worry and rumination. Therefore, we start this thesis by introducing some of these accounts that have played and continue to play an important role in research and treatment of the many conditions that in some way contain aspects of RNT. This is followed by an overview of literature on gaze behavior, memory processes and eye tracking in literature.

Worry

The cognitive phenomena rumination and worry are similar yet different to one another. According to Gladstone and Parker (2003) worry is a kind of repetitive negative thinking that consists of imagining about feared future outcomes and events. Worry can be placed on a spectrum from functional to dysfunctional, and it is often difficult to self-regulate. It is mostly verbal in nature and involves a narrative process (meaning it is like having an inner monologue with oneself rather than a series of concrete internal images). Gladstone and Parker (2003) states that some research on “normal” worry shows that subjects find it to be a normal and acceptable part of their routine. Worry has been found to have beneficial effects, such as acting as a stimulus for action, which motivates subjects to solve their real-life problems. This makes subjects perceive their worry as a problem-solving activity. However, while worry may mimic problem solving, it does not actually help people achieve a satisfactory end or solution to their issues (Mathews, 1990). Worry might even lead to poorer performance on problem solving tasks as earlier research has suggested this negative correlation (Dugas & Letarte, 1995). In the same study, it is indicated that worry is related to problem orientation (meaning immediate cognitive-behavioral reactions to the problem) rather than problem solving skills, such as generating solutions and making decisions.

The Role of Worrying in Generalized Anxiety Disorder

According to DSM-5 (American Psychiatric Association, 2013), the following criteria should be met for a diagnosis of *Generalized Anxiety Disorder* (GAD);

- A. Excessive anxiety and worry (apprehensive expectation), occurring more days than not for at least 6 months, about a number of events or activities (such as work or school performance).
- B. The person finds it difficult to control the worry.
- C. The anxiety and

worry are associated with three or more of the following six symptoms (with at least some symptoms present for more days than not for the past 6 months): 1. Restlessness or feeling keyed up or on edge 2. Being easily fatigued, 3. Difficulty concentrating or mind going blank, 4. Irritability, 5. Muscle tension, 6. Sleep disturbance (difficulty falling or staying asleep, or restless unsatisfying sleep). D. The anxiety, worry, or physical symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning. E. The disturbance is not attributable to the physiological effects of a substance (e.g., a drug of abuse, a medication) or another medical condition (e.g., hyperthyroidism). F. The disturbance is not better explained by another mental disorder. (p. 222)

In Borkovec's model of GAD, worry functions as a cognitive avoidance response to perceived future threats. Worry has many functions and two of these functions are central in this model. By worrying, one is trying to generate ways to either prevent bad things from happening or prepare oneself for their occurrence. Worry has a verbal quality, which mutes emotional and somatic responses to images that are meant to induce fear. Both functions lead to the same outcome - worry being negatively reinforced and maintained. This cognitive avoidance response hinders one from emotionally processing the fear-related stimuli, which is needed for extinction of anxiety responses. This process maintains the worry (Borkovec, 1994).

In a study by Borkovec et al. (1993), speech-fearful participants were asked to imagine a phobic image while getting their heart rates and subjective reports of fear measured. The main assumption of this experiment was that the degree of cardiovascular response to phobic exposures indicates degree of emotional processing. According to Borkovec's model of GAD, worry should prevent processing of phobic material. Therefore, it was predicted that worry would inhibit cardiovascular response to such material in this experiment. The five subject groups differed regarding what mental activity they were instructed to engage in before imagining the phobic images. One group was asked to think of a relaxing situation and another one to engage in worrisome thinking. Three other groups were instructed to worry and focus on either thoughts, images or affects during the worrying. Results showed that participants in the four worry groups reported greater fear and vividness in response to the phobic images than the relaxation group. It also showed that participants who were asked to engage in worrisome thinking and focus on thoughts produced decreased heart rate responses than those who were

asked to relax in response to the first image. Borkovec et al. found that greater relaxed thinking in subjects who were asked to relax was associated with an increase in cardiovascular response. These results support Borkovec's model of GAD. However, the authors did not find the same pattern in cardiovascular response after the first image presentation, which is a limitation in the study.

Mennin et al. (2002) have proposed an *emotion regulation perspective* on GAD. This perspective suggests that people with GAD might have difficulties understanding their own emotional experiences. In addition to that, they might also possess few skills to modulate their emotions. Because of these difficulties with understanding and managing emotional experiences, people with GAD come to find emotions as overwhelming and dangerous and use worry to control or suppress these kinds of experiences. This can affect their interpersonal lives by making them develop relationships aimed at obtaining security and avoiding negative interpersonal outcomes (Mennin et al., 2002). The results from a series of studies by Mennin et al. (2005) provide some support for the emotion dysregulation model of GAD. Amongst other things, these studies show that individuals who met criteria for GAD reported higher intensity of emotional experiences, a greater tendency to express negative emotions, more difficulties in their ability to identify, describe and clarify emotional experiences and more catastrophic beliefs concerning consequences of emotions such as anxiety, sadness, anger and positive emotions (Mennin et al., 2005).

In a neurophysiological experiment by Denefrio et al. (2019), scalp-recorded measures of event-related potential in the brain were studied in participants with GAD and healthy controls while they viewed angry and neutral faces. Neural responses indicated reduced discrimination between angry and neutral faces in the GAD-group compared to the controls. The conditions (angry and neutral faces) were not counterbalanced however, so there was a risk of order effect.

In contrast to the studies that like Borkovec (1994) have speculated that worrying is used to lessen the emotional impact of fear inducing images, Newman and Llera (2011) have presented the *contrast avoidance model* which proposes that worrying does not in fact subdue negative emotions, but rather enhances and increases them. The purpose of engaging in extensive worrying is thought to be an attempt to avoid very sudden increases in negative affect that people with generalized anxiety disorder (GAD) are especially sensitive towards. The constant worrying maintains a negative state as a protective emotional defense against negative events that could

occur in the future. It also facilitates positive emotional contrast, meaning that one feels relief if the negative event that was expected does not actually occur, or does occur but has positive outcomes. These processes contribute to negatively reinforcing the behavior of worrying in those with GAD who are sensitive towards sudden increases in negative affect that accompany negative events (Newman & Llera, 2011).

Llera and Newman (2014) have tested the main tenets of their own model of GAD: whether worry leads to heightened negative emotionality and if individuals with GAD find worry to be more helpful in managing stressors than non-anxious controls. The results support the contrast avoidance model by indicating that participants in the induced worry condition were in a more negative emotional state than others, which helped them avoid or reduce the sharp increase in negative emotion experienced in the other conditions in response to the fearful stimuli. Low levels of negative emotion and arousal during relaxation and neutral inductions facilitated an increase in negative emotion in response to the fearful film clip. The authors also found that the GAD group reported prior worry more helpful in coping with negative exposures, while non-anxious controls reported that worry made them feel less able to cope with negative emotions. Findings show that the GAD group preferred to avoid sudden negative emotional contrasts even if it meant spending more time in a negative emotional state, but the opposite applied for controls. This could have clinical implications, such as that the treatment of GAD should focus on underlying avoidance patterns before taking on the worry behavior. The experiment by Llera and Newman (2014) assigned subjects to GAD and control groups based on self-report measures as opposed to a diagnostic interview, which could be seen as a limitation. They report that the GAD group's means were well above the cut-scores. On one hand, this ensured them that the subjects in the GAD group did indeed meet criteria for GAD. At the same time, this and the fact that the study was based on a non-treatment-seeking GAD sample makes it more difficult to generalize the results on GAD patients.

A study by Skodzik et al. (2016) was designed to test the contrast avoidance model and examine the role of verbal vs. imagery-based thinking during worrying. The results show that worrisome thinking led to a larger increase in negative affect, self-reported somatic anxiety symptoms and skin conductance level than distraction. Prior worry also reduced a further increase in negative affect and somatic arousal in response to the stressor, while distraction led to a greater emotional contrast. This was found for both styles of worrying, meaning both verbal

and imagery worrying, and it did not support the authors' hypothesis that the contrast avoidance effects of worry are explained by their verbal nature. These findings also support the contrast avoidance model by showing that worrying does not lead to an avoidance of the negative affect, but rather an avoidance of a sharp increase in negative affect and arousal. The authors point out a limitation in their study in that the sample was non-clinical, so it is unclear whether these findings about contrast avoidance can be connected to GAD as it was intended by Newman and Llera (2011).

Rumination

In contrast to worry that entails repetitive thoughts about the future, the other type of RNT called rumination consists of perseverative thinking about past or current problems. Ruminations are persistent, repetitive and passive cognitions that focus the subject's attention on their symptoms and the causes and consequences of them, and they are highly associated with negative affects (Watkins & Baracaia, 2001). Ruminative thinking is characterized by questions such as "why do I keep getting things wrong?" (Watkins & Baracaia, 2001, p. 723). In an experiment by Watkins & Baracaia (2001), a majority of the participants reported one or more perceived benefits of rumination, like increased self-awareness and understanding of depression and better problem solving and prevention of future mistakes. They also reported at least one perceived disadvantage, the most common ones being increases in depressed and negative feelings and reductions in constructive and pleasurable activities. This shows ambivalent feelings towards rumination amongst people who ruminate. It is noted however that perceived benefits could be factors that maintain the worrying, but that they could also be post-hoc rationalizations of the behavior and that no causal relationship can be established because of the correlational design of the study.

Cognitive Impairments and Rumination

Some theories posit cognitive impairments as causal contributors to ruminative thinking. Mor and Daches (2015) reviewed these theories and other relevant findings within the paradigm of cognitive bias modification. The perseverative nature of rumination has led researchers to believe that cognitive deficits and biases may be the cause of ruminative thinking. Linville (1996) proposed that rumination could be caused by deficient attentional inhibition, which makes it harder for the individual to guard themselves against ruminative thoughts that once were relevant but now are irrelevant because of a change in goals. Linville also suggested that this

effect may be strengthened by stress and depression since stress and depression might weaken the individual's ability to inhibit goal-irrelevant information and thoughts.

Withmer and Banich (2007) aimed to investigate whether attentional inflexibility in ruminators might occur because of switching deficits, inhibitory deficits or a combination of both. They used a task-switching paradigm in two experiments. The results of these experiments showed that depressive rumination is associated with a deficit in inhibition, while angry and intellectual rumination is related to difficulties in switching to a new task. According to Withmer and Banich (2007), this could mean that different forms of rumination are associated with different cognitive mechanisms. This study provides some support to the relationship between attentional inflexibility and rumination, but the authors were unable to determine causality due to the correlational nature of the experiments.

Other theories have focused on an inability to disengage from negative thoughts and an impaired ability to exert control when confronted with negative stimuli as the cause of the cycle of ruminative thinking and negative mood. Rumination can be viewed as a habit of attending, interpreting and remembering negative stimuli in depression according to Hertel (2004). This habit develops when cognitive self-control is impaired. When faced with situations with no external control, people who tend to ruminate find it harder to focus and to keep or switch attention, making it easier for them to fall into ruminative patterns of thinking (Hertel, 2004). Koster et al. (2011) proposed the *impaired disengagement hypothesis* and similarly attribute rumination to reduced attention control and conflict signaling in a review article. This means that ruminators become trapped in ruminative cycles because of negative thinking that is congruent with their goals and beliefs and an inability to disengage from self-referring negative thoughts. This is speculated to be the consequences of an attentional bias in favor of negative material. These two cognitive factors then supposedly lead to ruminative thinking, negative affect, difficulties with problem solving and task performance. If people become trapped in the ruminative cycle, it becomes their habitual way of thinking. However, directionality regarding attentional control and rumination has yet to be established according to the authors (Koster et al., 2011).

Impaired disengagement hypothesis has been tested in an experiment by Southworth et al. (2017), where participants with high or low levels of RNT were presented with word pairs of one neutral word and one negative word. An anchor probe was presented before the word pair

and participants were supposed to indicate whether a target probe following the words had the same incline as the anchor. To test disengagement, response time was measured for the trials where the anchor probe appeared in the same locus as the negative words, where longer response time indicated a difficulty to disengage from the negative material compared to when the anchor appeared in the same locus as a neutral word. It was found that participants with high levels of brooding rumination but not reflective rumination (as assessed by a questionnaire and an in-vivo task) showed slower disengagement from negative material, thus providing support for the hypothesis of Koster et al. (2011). The authors note however that it is not possible to discern whether the results show a reduced ability to switch attention to a probe that is distal to the negative word or whether they show a general reluctance to switch attention from negative material prior to the probe being shown (Southworth et al., 2017).

Impaired disengagement theory was also tested by Kornacka et al. (2019). Rumination was initially induced by asking the participants about unresolved concern in their present lives that made them stressed. Questions were also asked about their unfulfilled goal and at the end participants were instructed to provide keywords describing their concern. These words were used in a probe task where probes appeared along pairs of words (negative, neutral or the RNT-related words provided by the participants) and response times for when the probe appeared were measured. Participants had also been induced to a concrete rumination condition, an abstract rumination condition and a distraction condition before doing the probe task. Among the significant results was the finding that word type affected disengagement among the participants in general, where RNT-related words yielded slower disengagement compared to neutral words and negative words led to faster disengagement compared to neutral words.

The *attentional scope model of rumination*, that Whitmer and Gotlib (2013) has presented, posits that a narrowed scope of attention is the cause of ruminative thinking. Negative mood is hypothesized to increase the likelihood for rumination to occur by narrowing the scope of attention. This limits the availability of thoughts, promotes perseverative thinking, impairs flexibility and inhibition of irrelevant information as well as the ability to switch to other information, which leads to rumination. The attention scope model also suggests that differences in individuals' attentional scope is due to trait rumination, meaning that those who have a narrow attention scope are also more ready and likely to engage in rumination as a response to negative mood.

Fang et al. (2017) constructed an experiment to test the attentional scope model. In this experiment, participants with a high or low level of rumination were instructed to read sentences where their view of the text was obstructed by a different sized moving window in each trial. An eye tracking-device was used during the experiment to measure gaze fixations. The authors found that people with high rumination had a faster reading time (as indicated by a smaller number of fixations and fixation times) in the small window condition than the low rumination group. This points to a smaller scope of attention in the ruminative group. Having the view obstructed by the window in the peripheral vision disrupts the reading. However, this would not be the case if the attentional scope is smaller or as big as the window, thus leading to the conclusion that the rumination group has a narrower scope of attention. This could not be explained by the participants current mood, nor depressive levels.

Concrete and Abstract Rumination

Abstract and overgeneral thinking is another cognitive factor that may be responsible for rumination and its negative consequences. As described by Watkins (2008), ruminators adopt an abstract, evaluative and verbal-analytic mode of thinking. This makes them reflect about the causes, meanings and consequences of negative stimuli, rather than focus their attention on the experience or trying to find an appropriate solution. The abstract, evaluative and verbal-analytic mode of thinking is also related to overgeneral memory, which is often seen amongst depressed patients (Watkins & Teasdale, 2001). This was tested by Watkins and Moulds (2005) in a study where depressed and non-depressed participants were induced with either concrete or abstract self-focused rumination. The concrete self-focused rumination seemingly led to better social problem solving among depressed participants (when rated on their suggested solutions to social problems by others) compared to abstract-self focus, which gives support to the idea that abstractness exacerbates the negative consequences of rumination. One limitation is noted in the study; the authors cannot say whether concrete thinking increases problem solving or if abstract thinking decreases problem solving, but a significant difference can be seen between the two conditions.

In summary, RNT encompasses worry and rumination which are both perseverative thought processes that often can be disruptive. In the current literature there is a variety of explanations and presumed factors contributing to these modes of thinking, ranging from attentional biases to a preferred avoidance of certain affects or sudden increases in affect.

Eye Movements, Attention and Memory

While our thought patterns and emotions can be influenced by RNT, another important factor in this interplay is eye movements. This link between eye movements, thoughts and emotions have been utilized in the Post-Traumatic Stress Disorder (PTSD) treatment EMDR (Perlini et al., 2020). In order to change dysfunctional memory associations, they need to be re-experienced and reconsolidated in a way that results in updated memory representations and better predictions about the world. Eye movements appear to play an important role in this interplay and although we do not know the exact mechanisms behind EMDR, research indicates that gaze behavior is involved when people access and alter their memories and emphasize a strong link between eye movements, emotions and memories (Chamberlin, 2019). In the following paragraphs, we will explain the basic principles of how gaze behavior is connected to memory processes.

What we see and remember depends on where we look, and where we look depends on two attentional processes - *bottom-up* processes and *top-down* processes. Bottom-up factors refer to how external features of stimuli, such as contrast, light, edges and luminance, catch and pull our attention towards them (Itti & Koch, 2000). For example, if we are searching for people with blond hair in a picture, we are using bottom-up processing since we are focusing on and responding to the physical property of color, instead of the possible meanings of the picture that we are looking at (Goldstein, 2014). However, bottom-up processing is not the only mechanism that steers our attention. Our attention allocation is also strongly affected by top-down processes such as prior knowledge, tasks and goals (Eysenck et al., 2007). Our knowledge to a large degree influences where we look and the stimuli we focus on are typically relevant for our current goals (Goldstein, 2014).

Certain clinical states can affect our top-down and bottom-up processes. For example, *attentional control theory* focuses on bottom-up and top-down attentional processes in the context of anxiety. It seems that anxiety disrupts the balance between these two attentional systems. It increases the influence of the bottom-up attentional process and decreases the influence of the top-down attentional process. This imbalance leads to a hypervigilance for threat and biased cognitive processes (Eysenck et al., 2007).

When something catches our attention through top-down or bottom-up factors, our eyes fixate on it. They do so for only fractions of a second before jumping onto the next thing that

catches our attention. These quick jumps from one fixation to another are called *saccades* (Kappas & Olk, 2008). It is during the fixations that we have the capacity to process visual information whereas we are virtually blind during the saccades.

The things we pay attention to and look at enter our sensory memory, which only holds information for a very short period of time. If we focus our attention on it, it passes into short-term memory. Goal-relevant information in short-term memory is then transferred to our long-term memory that holds information for long periods of time (Baddeley, 2000). Our long-term memory can be subdivided into different types of memory systems, such as procedural memory, semantic memory and episodic memory. While procedural memory is used for physical actions, like riding a bike and playing the guitar, semantic memory is memory for facts and episodic memory is memory for events in one's life (Goldstein, 2014). In our study, we focus on *episodic remembering*, i.e. the ability to mentally reconstruct and relive previously experienced events.

Eye-movements are closely related to our memories. Recent research using eye tracking has shown that people frequently “look at nothing” when engaged in episodic remembering, meaning that they will fixate on locations where a sought-after memory was originally encoded, even when this location is emptied of visual information. This phenomenon suggests that associated eye-movements are part of the episodic memory trace. *Looking at nothing* seems to then facilitate retrieval of said representations (Ferreira et al., 2008) and it has been observed in different contexts. For example, Richardson and Spivey (2000) conducted an experiment in which participants saw four faces that articulated factual statements. After doing so, the faces disappeared, and participants heard a statement referring to one of the four facts. Their task was to say whether the statements were true or not. Richardson and Spivey found that participants were spontaneously looking at the empty location where the face that articulated the statement was presented during encoding. The same results were observed when the faces were changed to spinning crosses. The looking at nothing effect had no influence on participants' fact-accuracy on the fact verification task that they had to do afterwards (Richardson & Spivey, 2000).

However, there are other studies that show that looking at nothing plays an active and functional role in memory retrieval. Laeng and Teodorescu (2002) conducted two experiments, where participants viewed images of stimuli and were asked to form mental images of the stimuli while keeping their eyes open. Subjects, who were free to move their eyes during perception but had to maintain central fixation during imagery, showed decreased ability to recall the stimuli

(Laeng & Teodorescu, 2002). A study by Johansson et al. (2012) reported compatible results where a fixed gaze condition during recall led to an altered and impaired recollection of the encoded scene as compared to free viewing. Johansson and Johansson (2014) provided further evidence of a facilitative role of eye movements. In their experiment, they demonstrated that episodic memory retrieval also can be improved if eye movements are manipulated towards a blank area overlapping with the position where the sought-after memory was originally encoded (Johansson & Johansson, 2014).

Reproducing gaze behavior established during encoding thus seems to both reflect and support the reactivation of episodic memories. However, less is known about how other factors such as emotional states might affect these processes.

Gaze Behavior and Emotional Stimuli

Eye-tracking has been used in several studies to investigate how attention is deployed when subjects are presented with emotionally loaded material. This has yielded several different outcomes. Regarding clinical groups, Shechner et al. (2013) found that youths with anxiety fixate faster on angry faces than neutral faces. Kellough et al. (2008) showed images from four emotion categories to clinically depressed and never depressed young adults and saw that depressed individuals spend more time viewing dysphoric images and less time viewing positive images. This group difference was consistent over the course of the trials. It has also been found in a study that participants with GAD often fixate first and faster on threatening faces compared to neutral faces and that they differed significantly from participants with depression and non-clinical participants in this regard (Mogg et al., 2000).

Eye movements and attention to emotionally charged material has also been investigated regarding rumination. Owens and Gibb (2017) indicate that brooding rumination is linked to sustained attention to sad faces compared to neutral ones and Duque et al. (2014) found that a ruminative style among subjects correlated with time spent attending to negative information (i.e. angry and sad faces). Hilt et al. (2017) investigated attentional deployment among ruminating young adolescents in a dot-probe task and found through eye tracking that their gaze seemed to linger more on emotional faces compared to neutral faces. This indicates a problem with disengaging from emotionally charged material rather than an initial attentional bias towards emotional material, where only tendencies towards faster reaction times for emotional faces in the dot probe task among the ruminating youths supported the latter.

Acunzo and Henderson (2011) found results similar to Hilt et al. (2017). In this case a non-clinical sample was used. When investigating a potential pop-out effect of emotionally charged stimuli in natural scenes, it was found that subjects did not locate negative targets faster than neutral targets, but once located, negative targets held the participants' attention longer (Acunzo & Henderson, 2011).

None of the aforementioned studies that linked clinical conditions or dispositions such as anxiety, depression, GAD, brooding and rumination to biases in attention can give an indication of directionality, because these dispositions were pre-existing. It is possible that attentional biases increase the risks of these conditions and behaviors as well as attentional biases being the consequence of them.

While it is unclear how emotion is involved in the interplay between memory and gaze behavior, the research above highlights the overall probable influence of emotionality upon gaze behavior and provides a plausible link between RNT, gaze behavior and remembering.

Aims and Objectives

As our background and overview of research on RNT shows, there is a gap in the literature regarding RNT during recall of episodic memories. Eye tracking research has shown that repetitive negative thinking can affect how attention (gaze) is directed and sustained when processing emotional material, but not whether RNT also influences gaze behavior during episodic recall. The present study therefore aims to investigate whether such a pattern exists for stimuli of neutral and negative charge respectively. As there also is a lack of research examining how gaze behavior and RNT affects participants' subjective experiences of emotionally charged material, a further aim is to investigate whether different gaze behaviors can affect experiences of discomfort.

As there are different models for repetitive negative thinking in the current literature and due to the lack of research on RNT in connection to recall, there are several possible outcomes. For example, following Borkovec's model of GAD (1994), it is conceivable that participants with a high level of RNT would like to avoid negative stimuli as much as possible and by doing so would engage in reduced looking at nothing behavior when recalling negative content (compared to participants with a low level of RNT). However, following Newman & Llera's (2011) theory of contrast avoidance, participants with high RNT could in fact engage in increased looking at nothing behavior when recalling negative images in order to keep their level

of arousal consistent. Because of these different scenarios and the unclear stance on RNT regarding recall, we have made our hypotheses non-directional.

Research Questions

1. Do different levels of RNT modulate the level of experienced distress when recalling information of neutral and negative content?
2. Does gaze behavior modulate this interplay between RNT and experienced distress?
3. Do levels of repetitive negative thinking affect participants' gaze behavior when they are free to look wherever they want during recall of neutral and negative material?

Hypotheses

1. i) Because there are correlations between repetitive negative thinking and negative affect, we hypothesize that subjective experiences of distress will be affected by RNT.
ii) We also expect the emotional charge of stimuli to modulate the effect of RNT on experienced distress. These hypotheses will be tested by comparing ratings of experienced distress of negative images compared to neutral images for participants with different levels of RNT.
2. We also hypothesize that differences in subjective distress experiences are dependent on whether participants are allowed to look back to where the images were encoded, meaning different gaze behaviors will result in different subjective distress experiences depending on levels of RNT and image content. This hypothesis will be tested by comparing ratings of experienced distress for participants with different levels of RNT when they were free to look back to where the image had been shown previously (free viewing) versus when they were instructed to look at a fixation cross on the screen (fixed viewing) during recall.
3. We hypothesize that RNT in interaction with image content will influence how much participants during recall look back at a target area (i.e. the area where an image that the participants are trying to recall was previously shown). This will be tested by comparing proportions of gaze fixations in the target area during recall of negative and neutral images for participants with different levels of RNT.

Method

Participants

We did not take part in developing or administering the experiment, as our thesis is based on analysing existing data within a bigger project by Sabine Schönfeld and Roger Johansson at Lund University. Thus, the descriptions concerning those parts have merely been translated and re-written for the purpose of our thesis and are based on other students' work (Stenberg & Hildeman, 2019; Löf, 2020) during said project. Sixty-eight people (35 women and 33 men) participated in the study during two different occasions. Ages ranged from 19 to 48 with the average age being 23.78 ($SD = 3.656$). One of those participants was excluded due to missing data. Because our thesis is concerned with how gaze conditions affect ratings, five participants were also excluded because they did not follow instructions properly during one of the conditions (they fixated on a cross less than 50% out of all fixations when they were instructed to keep their gaze fixed on the cross). 62 participants then remained, 33 of them being women and 29 of them being men. Ages still ranged from 19 to 48, now with a mean of 23.65 ($SD = 3.75$). All participants were students at Swedish universities. They signed consent forms and guaranteed that they either had no visual impairments or that those had been corrected to normal vision. Participants were recruited through social media and told to contact the experiment leaders to book an appointment. A majority of the participants were acquaintances to the experiment leaders in one way or another. Movie tickets were given as an incentive for participation.

Participants were assigned to different RNT groups based on their score on *The Perseverative Thinking Questionnaire* (PTQ). Two RNT groups were created based on the median of the group - a low RNT group and a high RNT group. *T*-tests were used to show that there were significant differences between the two RNT groups. The low RNT group scored an average of 20.47 ($SD = 4.89$) and the high RNT group 34.73 ($SD = 7.95$), showing that there was indeed a significant difference between the groups ($t(60) = -8.57, p = .002$).

Design

This experiment was part of a bigger project with the aim to study the relationship between memory, emotions and gaze behavior. The conditions were free or fixed gaze conditions and negative or neutral images. The free gaze condition meant that the participants were allowed to look wherever they wanted on the screen during the experiment's different phases. The fixed

gaze condition meant that they had to look at a fixation cross during the recall phase of the experiment.

The experiment consisted of 32 blocks. Each block had an encoding phase with two images (see Figure 1), a distraction task, a recall phase (Figure 2) and three questions about the images at the end. These questions were supposed to collect data about the participants' experiences of their recollections. Every image pair consisted of one neutral and one negatively charged image. The two images in the pairs were grouped together based on similarities in semantic content by the experiment leaders. Only valence and arousal differed significantly; the images did not differ in salience and other factors that could potentially affect participants' gaze behavior. The order and location of the two images (neutral and negative) were counterbalanced over each condition and across the whole experiment. Also, to avoid order effects over conditions, every other participant started with the fixed condition and the free condition respectively. The participants saw the same 32 image images, but in a random order and randomly distributed over the two gaze conditions.

The main experiment was designed to take approximately 35 minutes to complete. The entire procedure, which included the practice task, the memory test and the self-assessment forms, took approximately 60 minutes.

Material

The images used as stimuli have previously been used in similar studies comparing emotional and neutral stimuli. Out of 1554 images, 32 neutral and 32 emotional images were selected from the databases International Affective Picture System (IAPS; Lang et al., 2008) and Emotional Picture Set (EmoPicS; Wessa et al., 2010). The selection of images was based on the ratings of valence and arousal in the databases that had been established in earlier studies. On a scale from 1-9, low valence indicated a negative charge and high valence a positive charge. Images with low valence and high arousal were selected for the category of negative stimuli, and images with neutral or high valence and low arousal were selected to be used as neutral stimuli. The emotionally charged images had the valence = >2.06 , <3.55 with the mean 2.66 ($SD = 0.44$), and arousal = >5.74 , <6.96 with a mean of 6.35 ($SD = 0.33$). The neutral images had the valence = >4.03 , <7.24 with the mean being 5.56 ($SD = 0.78$), and arousal = >2.51 , <4.92 with the mean 3.38 ($SD = 0.56$). The categories were tested for significant differences using a paired sample t -test with the result being ($t(31) = 21.83$, $p = < .001$) for valence and ($t(31) = 25.319$, $p = < .001$)

for arousal. Image pairs were created based on thematic similarities with one image from each category.

Stimulus was presented on a Tobii Pro Spectrum-screen, (EIZO FlexScan EV2451) with the resolution 1920 x 1080 pixels (52.8 x 29.7 cm). Participants were positioned 63 cm from the screen with their head in a chin and forehead rest. During the experiment stimuli were presented in PsychoPy3. Since this study takes interest in long time memory functions, a BrownPeterson task (Brown, 1958; Peterson & Peterson, 1959) that has been proven to effectively empty working memory (Proctor & Fagnani, 1978) was used as a distraction between encoding and recall to prevent the participants from maintaining information about the images in working memory.

Because of the broad scope and interest of the study, participants were also given four self-assessment questionnaires to fill out after the experiment. These included State-Trait Anxiety Inventory (STAI; Spielberger et. al., 1983) for measuring anxiety in the present moment, Perseverative Thinking Questionnaire (PTQ; Ehring et al., 2011) for measuring tendencies to dwell on negative thoughts, Hospital Anxiety and Depression Scale (HADS; Snaith, 2003) that is meant to measure depression and anxiety, and Difficulties in Emotion Regulation Scale (DERS; Victor & Klonsky, 2016), which gives an indication of participants ability to identify and regulate emotions.

Perseverative Thinking Questionnaire

The Perseverative Thinking Questionnaire (PTQ) is a self-rating questionnaire designed to measure levels of repetitive negative thinking independently of specific disorders such as depression or generalized anxiety disorder. It consists of 15 items that in contrast to previous questionnaires do not explore the specific content of an individual's thoughts. The maximum score of PTQ is 60. PTQ was validated in two studies on a German and an English-speaking population, including both clinical and non-clinical participants (total $N = 1832$). A confirmatory factor analysis was performed and supported a model consisting of one higher-order factor (RNT) and three lower order factors (Core characteristics of RNT, Unproductiveness of RNT and RNT capturing mental capacity). The total PTQ score and the three subscales all showed good internal consistency (total score of all three samples from study 1: $\alpha = .95$; $\alpha = .94$; $\alpha = .95$, Study 2: $\alpha = .95$), re-test reliability and convergent validity as well as predictive validity. However, the authors note that two subscales consist of only three items and may have to be

extended for further reliability (Ehring et al., 2011). We used PTQ as a measure of RNT in our analyses ($\alpha = 0.94$).

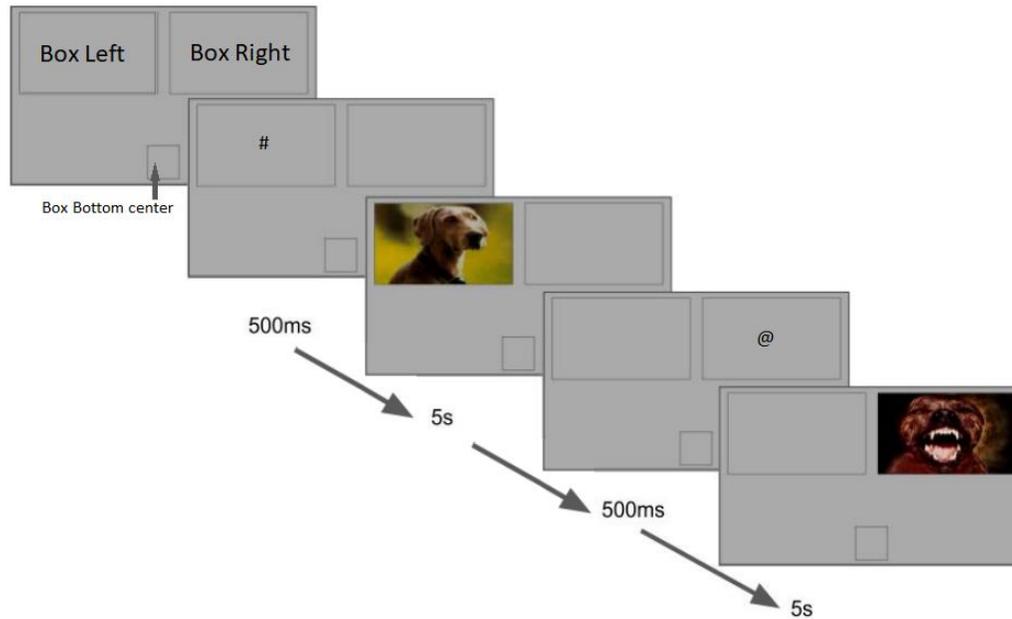
Procedure

The data we used was collected by Svante Hildeman and Philip Stenberg under supervision of Sabine Schönfeld and Roger Johansson at Lund University. Participants were initially informed about the purpose of the study was to measure pupil dilation. In the computer lab, they were assigned a computer where they were instructed to read and fill in a consent form. The participants either started with the fixed or free condition depending on what computer they were assigned. Their age and gender were filled in digitally before a practice session was initiated. Instructions were provided on the screen during both the practice and the real task, where participants clicked manually through the information. They were instructed to raise their hand after the practice so that an experiment leader could calibrate the eye tracking-device to the participants eyes. After these steps, the experiment was initiated.

The experiment consisted of two phases; encoding and recall. During the encoding phase, participants were first shown a fixation cross in a box (from hereon called box Bottom center) in the lower part of the screen. This box was consistently shown during the experiment, as well as two larger boxes shown in the upper part of the screen; one on the left (box Left) and one on the right (box Right). After fixation, a symbol appeared in either box Left or box Right. The symbols used as a cue for recall were # and @. When the participants had seen the recall cue for 2 seconds, an image that participants had been instructed to remember appeared in the same box. Thereafter the other symbol appeared in the other box with a different image. This concluded the first part of the task. Participants were then instructed to count backwards from a randomized three-digit number for 10 seconds (The Brown-Peterson distraction task).

Figure 1

Illustration of the Encoding Phase

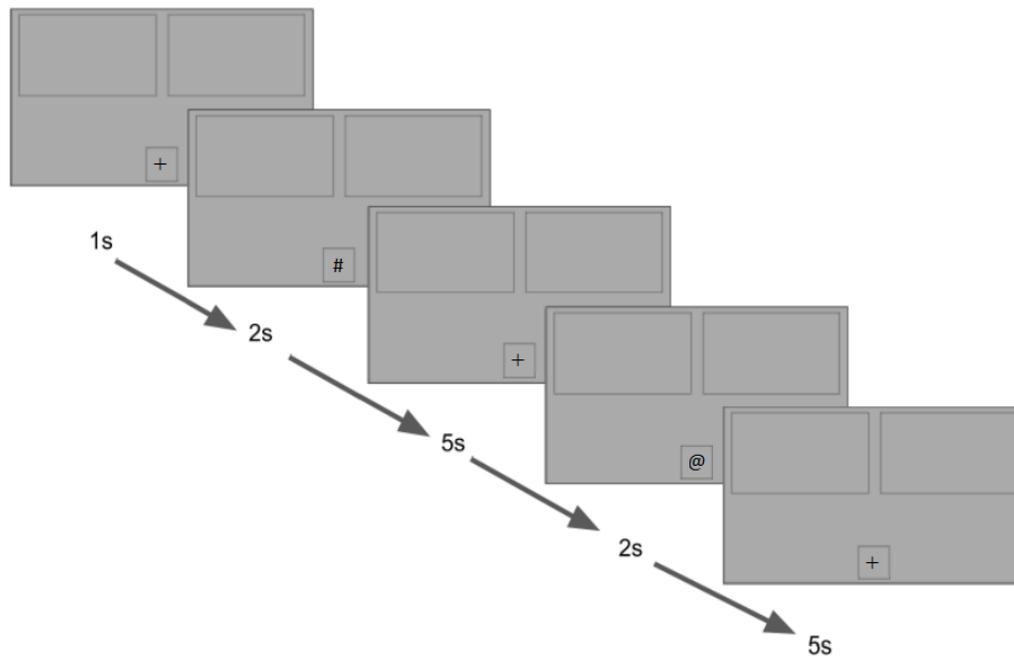


Note. Participants were presented with image pairs and instructed to remember which symbol preceded each image so that these could be used as retrieval cues in the recall phase. From “*Emotioners roll i samspelet mellan ögonrörelser och minne*” by Stenberg, P. & Hildeman, S, 2019. [Bachelor’s Thesis, Lund University]. LUP Papers. <http://lup.lub.lu.se/student-papers/record/9025495>

After this, the recall phase of the task started. A fixation cross in box Bottom center appeared for 1 second, followed by one of the symbols (# and @) that had been associated with an image during the encoding phase. In the fixed condition, the symbol was replaced with the fixation cross once again and participants were told to look at it while they tried to recall the image. In the free condition, the symbol disappeared and nothing but the empty boxes Bottom center, Left and Right showed for 5 seconds as the participant tried to recall the image. The participants were free to look wherever they wanted on the screen while trying to recall the image.

Figure 2

Illustration of the Recall Phase - Fixed Condition



Note. During the recall phase, participants' objective was to recall the image that corresponded to the symbol shown in the smaller box. During the free condition, the fixation cross was not present. From "Emotioners roll i samspelet mellan ögonrörelser och minne" by Stenberg, P. & Hildeman, S, 2019. [Bachelor's Thesis, Lund University]. <http://lup.lub.lu.se/student-papers/record/9025495>

After the recall phase, three questions inquiring about recall, discomfort and avoidance appeared on the screen: 1. *Was your memory of the image clear and detailed - almost as if you could see the image in front of you again?* 2. *How distressed were you by the memory?* 3. *How much would you like to avoid thinking of this image?* The participants rated their experiences for each question on a scale from 1 ("not at all") to 6 ("a lot").

The same procedure was repeated for the second image. The condition changed after 16 rounds so that the participants who started with the fixed condition switched to the free condition and vice versa. Information and instructions about the new condition appeared on the screen. After 16 more rounds, the participants were finished with the main experiment. The instructions on the screen told them to raise their hands to receive further instructions from the experiment leaders.

Analysis of Data

First, we did a reliability test on PTQ with an excellent outcome of $\alpha = 0.94$. We then calculated the mean and median values for the whole group and constructed our RNT groups based on the overall median value on the PTQ-questionnaire, which was 26. Participants with a score of 26 or lower were assigned to the low RNT group during our analysis. Participants with a score of more than 26 were assigned to the high RNT group. The low RNT group consisted of 32 participants and the high RNT group of 30 participants ($N = 62$). The RNT groups were t -tested and found to be significantly different from each other ($t(60)$, $p = < 0.001$).

To test our hypotheses of whether participants' ratings of neutral and negative images would differ based on their level of RNT as measured by PTQ, three 2 x 2 mixed ANOVAs were performed; one for each rating/dependent variable (vividness, discomfort, avoidance). Image type (negative or neutral) was the within subjects variable, and RNT group (low or high) was the between subjects variable in these analyses.

In order to further investigate our prediction that gaze condition would affect an eventual connection between RNT group, image type and ratings, we ran the same tests again with gaze condition (fixed or free) as an additional within subjects variable in a 2 x 2 x 2 mixed ANOVA.

Three areas for analyzing eye movement in the experiment were predefined as *areas of interests* (AOI). The AOIs corresponded to the places where the images had previously been presented (box Left and box Right) and where the fixation cross was presented (box Bottom center). Our eye tracking data was analyzed by measuring the proportion of fixations during recall in the two AOIs where the pictures were presented during encoding (box Left and box Right). This is what we call "proportion of fixations in the target area", with "target" meaning the AOI where the picture that they were recalling had previously been presented during encoding. Using this data, we ran a mixed ANOVA with image type as a within subjects variable and RNT group as a between subjects variable and number of fixations in the relevant area during recall as the dependent variable, in order to test our hypothesis of whether RNT would result in a different recall behavior. Participants who did not fixate their gaze on the fixation cross for a minimum of 50% out of all fixations during the fixed condition were excluded from all analyses.

Ethics

This experiment did not have an ethics approval. SFS 2003:460 is a law concerning the requirement of an ethical review in scientific research on humans. This law states that research on an advanced level of education is excepted from this requirement. It must then not encompass sensitive personal information according to General Data Protection Regulation (GDPR). The research should not contain information about crime. Neither should it include physical interventions on participants. It should also not have the aim of affecting participants physically or psychologically. In addition to that, the research must also not pose a risk of physical or psychological injury or use biological materials from humans. This experiment did not include sensitive personal information, information about crime, physical interventions on participants or biological materials from humans. To minimize the risk of harm, there were no images depicting blood, dead bodies or sexual motives. The reasoning behind this was that the experiment leaders did not want to cause the participants any kind of harm, or at the very least no more harm than what participants are exposed to in their everyday life.

All participants were informed about the study before participating. They were given both written and verbal information, explaining to them that participation was voluntary, that they could withdraw from the study whenever they wanted to without giving an explanation, how their data would be stored and used in the analysis, and that their data could be presented and used in future teachings and seminars. They were also informed about the exposure to emotional stimuli and that they would fill in questionnaires about themselves.

Before starting the experiment, the experiment leaders gave the participants information about what kind of emotional stimuli they would be exposed to; there would be no images depicting blood, dead bodies or sexual motives. The participants were also given information about the questionnaires and what kind of information these would assess. None of the questionnaires included questions about suicidal thoughts or traumatic memories because the experiment leaders did not have the possibility to control or follow up the effects of such questions. Every participant was granted anonymity by being assigned a number related to their results. This number was separated from their signature on the consent form, meaning that the number could not be connected to a specific participant.

After completing the experiment, the participants had the opportunity to ask questions about the experiment. They were also given an information sheet about the study, where it was stated who they should contact if they had questions or opinions about the experiment.

Results

RNT, Image Type, Gaze Behavior and Rating Scores

Below we present results corresponding to our first research questions (see Table 1 and Table 2).

We found a main effect of effect of RNT group on disturbance and avoidance ratings, but not on vividness. People in the high RNT group overall rated their recollection experience higher on disturbance ($M = 2.42$, $SD = 0.53$) and avoidance ($M = 2.32$, $SD = 0.66$) than the low RNT group (disturbance: $M = 2.10$, $SD = 0.56$, avoidance: $M = 2.10$, $SD = 0.56$).

There was no significant interaction between image type and RNT group on the dependent variables vividness, disturbance and avoidance.

Although not part of our hypotheses, we also found a significant main effect of image type on all three rating scores, showing that negative images were rated higher overall.

Table 1

ANOVA between Image Type and RNT Group on Rating Scores

| | | <i>df</i> | <i>F</i> | η_p^2 | <i>P</i> |
|-------------|------------------------|-----------|----------|------------|----------|
| Vividness | Image type | 60 | 27.43 | .31 | < .001** |
| | RNT group | 60 | 0.10 | .002 | .76 |
| | Image type x RNT group | 60 | 1.98 | .03 | .17 |
| Disturbance | Image type | 60 | 177.38 | .75 | < .001** |
| | RNT group | 60 | 5.59 | .09 | .02* |
| | Image type x RNT group | 60 | 0.89 | .02 | .35 |
| Avoidance | Image type | 60 | 112.46 | .65 | < .001** |
| | RNT group | 60 | 4.14 | .07 | .05* |
| | Image type x RNT group | 60 | 0.29 | .005 | .59 |

* $p < .05$

** $p < .001$

Confidence Intervals are 95.0 %

The results corresponding to our second research question show that there was no three-way interaction for gaze condition, image type and RNT group on either of the ratings. Again, a main effect of image type was found for each rating.

Table 2*ANOVA between Image Type, RNT Group and Gaze Condition on Rating Scores*

| | | <i>df</i> | <i>F</i> | η_p^2 | <i>P</i> |
|-------------|--|-----------|----------|------------|----------|
| Vividness | Image type | 60 | 37.45 | .38 | < .001** |
| | RNT group | 60 | 0.24 | .004 | .63 |
| | Image type x RNT group | 60 | 0.42 | .007 | .52 |
| | Gaze condition | 60 | 0.24 | .004 | .63 |
| | Gaze condition x RNT group | 60 | 0.29 | .005 | .60 |
| | Image type x gaze condition | 60 | 0.38 | .006 | .54 |
| | Image type x gaze condition x RNT group | 60 | 1.74 | .03 | .19 |
| Disturbance | Image type | 60 | 219.46 | .79 | < .001** |
| | RNT group | 60 | 5.16 | .08 | .03* |
| | Image type x RNT group | 60 | 0.68 | .01 | .41 |
| | Gaze condition | 60 | 0.006 | < .001 | .94 |
| | Gaze condition x RNT group | 60 | 0.39 | .006 | .54 |
| | Image type x gaze condition | 60 | 0.41 | .007 | .52 |
| | Image type x gaze condition x RNT group | 60 | 0.32 | .005 | .57 |
| Avoidance | Image type | 60 | 153.24 | .72 | <.001** |
| | RNT group | 60 | 3.37 | .05 | .07 |
| | Image type x RNT group | 60 | 0.41 | .007 | .52 |
| | Gaze condition | 60 | 0.09 | .001 | .77 |
| | Gaze condition x RNT group | 60 | 1.05 | .02 | .31 |
| | Image type x gaze condition | 60 | 0.56 | .009 | .46 |
| | Image type x gaze condition x RNT group | 60 | 0.001 | < .001 | .98 |

* $p < .05$ ** $p < .001$

Confidence Intervals are 95.0 %

RNT, Image Type and Gaze Fixations

There was no significant interaction between RNT group and image type in regard to proportion of fixations in the target area on the screen during recall ($F(1,60) = 0.02, p = .88, \eta_p^2 = < .001$). There was also no significant main effect for image type ($F(1,60) = 0.70, p = .41, \eta_p^2 = .01$), nor RNT groups ($F(1,60) = 0.41, p = .53, \eta_p^2 = .007$).

Explorative Analyses

RNT, Image Type, Gaze Conditions and Looking at Nothing

Following the analyses relevant to our hypotheses, we also performed an exploratory analysis, adding a fourth variable to our previous mixed ANOVA that contained image type, gaze condition and RNT groups as independent variables. However, the tendency to look back to where the sought-after memory was originally encoded (looking at nothing) varies from person to person, where some people engage in it more than others (cf. Gurtner et al., 2021; Johansson et al., 2011; Kumcu & Thompson, 2020). While the specific effects of such individual differences are unknown in the current literature, it is conceivable that it is related to different ways and/or strategies of remembering. Thus, it is plausible that individual differences in "look back behavior" could interact with how the participants were affected by the gaze restriction (fixed viewing) - and that this interaction varies for participants with different levels of RNT. Therefore, we created new groups based on the proportion of fixations in the target area (i.e. proportion of fixations in the area where the image participants are trying to recall was shown previously) by averaging each participants fixation proportion for neutral images and their fixation proportion for negative images, and then creating groups based on these averages using a median split. Participants with a score equal to the median 0.45 or lower were assigned to the low look-back (LB) group and participants with a score higher than the median were assigned to the high LB group. The two LB groups were also *t*-tested and it was then confirmed that they were significantly different in regard to proportion of fixations in the target area ($t(60) = -12.93, p = < 0.001$).

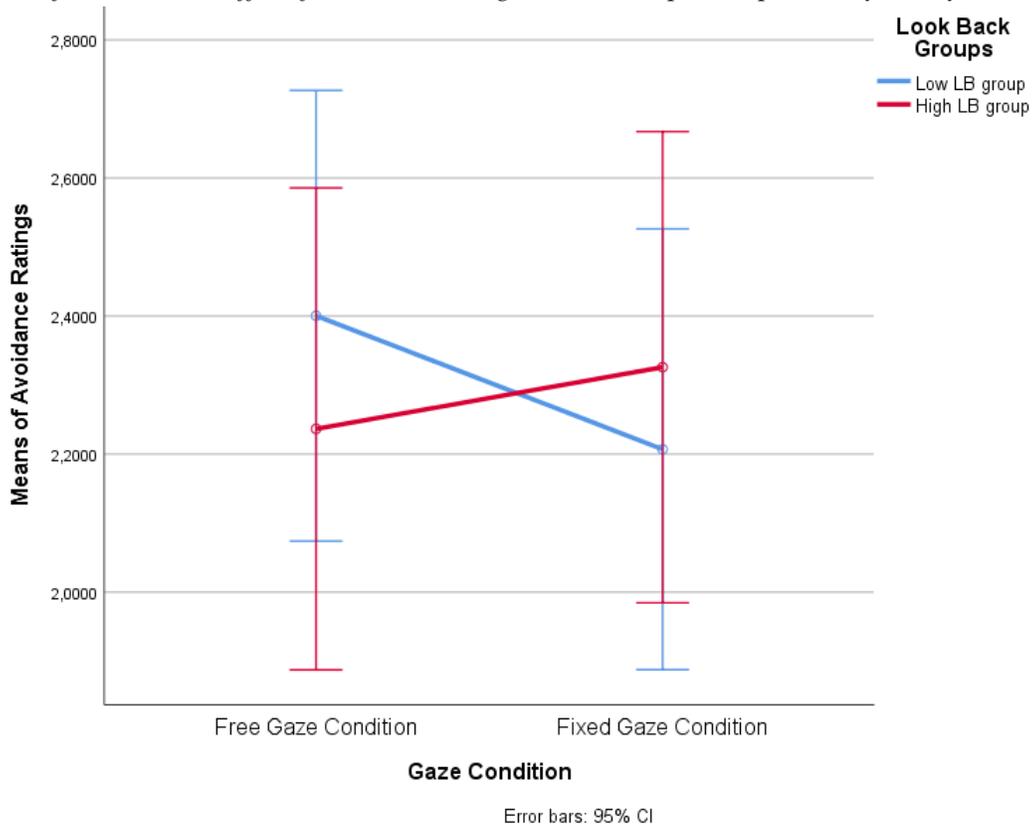
We then ran a four-way mixed ANOVA for each dependent variable (vividness, disturbance, avoidance) with image type and gaze condition as the within variables and RNT groups and LB groups as the between variables. Results showed a significant three-way interaction between gaze condition, LB group and RNT group for avoidance ($F(1, 58) = 4.52, p$

= .04, $\eta_p^2 = .07$). Interaction effects were also found for image type, gaze condition and LB group on the dependent variables avoidance ($F(1,58) = 6.06, p = .017, \eta_p^2 = .10$) and disturbance ($F(1,58) = 7.40, p = .009, \eta_p^2 = .11$). Although interesting, we decided not to investigate the two latter interaction effects further since they are not related to our thesis and its focus on RNT.

To make our understanding of the interaction between gaze condition, LB group and RNT group clearer, we studied the interaction and ran post-hoc *t*-tests. One plot (see Figure 3) indicated an interaction where people who were in the high RNT group and the low LB group rated images (regardless of image type) higher on avoidance in the free gaze condition, whereas people who were in the high RNT group and also in the high LB group seemed to do the opposite; they rated images higher on avoidance in the fixed condition. To confirm whether this was the case, we created new groups based on RNT and LB so that we had one group of people with high RNT but low LB ($n = 16$) and one group of people with high RNT and high LB ($n = 14$). We then ran a *t*-test for each of these groups, with gaze condition as the independent variable and avoidance ratings as the dependent variable. A significant difference was found for the group with high RNT and low LB ($t(15) = 2.57, p = .02$). No significance was found for the high RNT and high LB group ($t(13) = -1.13, p = .28$).

Figure 3

Illustration of Interaction Effect found in the High RNT Group in Exploratory Analysis



RNT, Image Type and Gaze Fixations in Recall-Irrelevant Area

Our main results showed that there was no main effect of RNT or image type or an interaction between the two on proportion of fixations in the target area. We decided to follow up this analysis with another exploratory analysis by checking if there is a significant effect of RNT or image type on proportion of fixations in the non-target area (i.e., the box *opposite* to where the image that participants are trying to recall was shown). It is possible that a significant difference can be found for how much participants look at the non-target area even if there is no difference in gaze fixations in the target area. Some people might look at the non-target area and others might look at other parts of the screen when not looking at the target area as expected. By doing this exploratory analysis in the context of the non-target area, we could see if the non-target box acts as a kind of distraction depending on image content or RNT during recall. To test this, we ran a 2 x 2 mixed ANOVA with image type as a within subjects variable and RNT as a between subjects variable with proportions of gaze fixation in the non-target area during recall.

The results showed no significant interactions (image type x RNT: $F(1,60) = 2.51, p =$

.12, $\eta_p^2 = .04$) and no main effects of image type ($F(1,60) = 0.27, p = .61, \eta_p^2 = .004$) or RNT ($F(1,60) = 1.12, p = .28, \eta_p^2 = .02$).

Discussion

Discussion of Main Hypotheses

One of the aims of our study was to investigate whether different RNT levels and gaze behavior modulated the level of experienced distress when participants were instructed to recall neutral and negative images that they had seen in the encoding phase of the experiment. Another one was to see if different RNT levels, image type and different gaze behavior had an interaction effect on participants' level of experienced distress.

Our results show that there was no such significant interaction between image type and RNT group on the level of experienced distress, as measured by our dependent variables vividness, disturbance and avoidance. We also did not find an interaction when adding gaze condition as an independent variable. Thus, our predictions are not supported by the data. We did however find a significant main effect of image type on all three rating scores of experienced distress in both analyses. This was not part of our research questions, but it was expected based on earlier studies on this experiment that showed similar results (Löf, 2020; Stenberg & Hildeman, 2019). This gives an indication that the chosen images were different enough regarding valence and arousal and thus affected ratings as intended.

We also found a main effect of RNT group on two of the three ratings (disturbance and avoidance), which supports one of our hypotheses that different levels of RNT will result in different ratings of experienced distress. The results showed that the high RNT group overall rated higher on disturbance regardless of image content. A comparison can be drawn to Skodzik et al. (2016) who found that worrying led to increased negative affect. However, their results were based on induced worrying rather than trait RNT that is the subject of this thesis, so it could still be interesting to speculate about the implications of the main effect of RNT in our scenario. This finding could be explained by the contrast avoidance model that we have described in the background. Llera and Newman (2014) tested the main tenet of this model in one of their studies, and their results showed that participants in the worry condition were indeed in a more negative emotional state than others. However, in our study the ratings of distress were regarded images rather than general state of emotional distress. In order to make a clear comparison, participants could also give ratings of their current mood in the future. It is also interesting that we did not

find an interaction effect between image type and RNT group on the distress ratings. This indicates that our high RNT group rated both neutral and negative images higher on disturbance, which is also in line with the contrast avoidance model. According to the contrast avoidance model, extensive worrying is used to avoid sudden increases in negative affect. It is possible that this is the reason behind the high RNT group's higher disturbance ratings for both neutral and negative images.

As can be seen in our table (Table 1), RNT group also had a main effect on participants' ratings on avoidance. People in the high RNT group rated higher on avoidance (and this did not interact with image type). It could be argued that this is in line with Borkovec's model of GAD (1994). According to this model, worry functions as a cognitive avoidance response and mutes emotional and somatic responses to fear inducing images. However, we did not find an interaction effect between RNT group and image type on avoidance ratings and because of this, we cannot comment on whether our data can be explained by Borkovec's model that says that people with high levels of rumination wish to avoid processing negative emotions. It could be the case that our negative stimuli were too weak to yield such an effect. We will discuss the possibility of weak material further on in the discussion. It is also possible that a rating of participants' self-perceived wish to avoid certain images does not translate to actual avoidant behavior.

According to our results neither image type or levels of RNT (separately or in interaction) affect the proportion of gaze fixations in the area where an image that the subject is trying to remember was previously presented. Our hypothesis stated that we expected to find an interaction between the two. As already mentioned in the background, a study by Southworth et al. (2017) found that participants with high levels of brooding rumination show slower disengagement from negative material. Based on this kind of studies, one could expect to find an interaction effect of image type and RNT group on proportions of gaze fixations, indicating that participants with high RNT would struggle more with disengaging from the negative images compared to the neutral ones. There are however differences in this experiment compared to ours, such as the fact that our experiment focuses on recall and does not induce negative mood. Also, our experiment did not require participants to attend to and assess probes that were shown in conjunction to emotional stimuli. In the free condition of our experiment, participants could view the screen however they pleased and thus there would be less reason for them to disengage,

as this was not the main focus of this study. But as this niche of RNT, eye movements and recall is a fairly new area of research and because we did not find a lot of literature that clearly indicated that RNT and image type would affect gaze fixations during recall the way we expected, it is possible that there is no such interaction. However, it could also be explained by limitations in our design. Although not a part of our hypotheses, we were surprised to not find a main effect of image type on gaze fixations in the same way that image type affected rating scores as we thought that negative images would have a kind of pull effect during recall similar to the pull effect during encoding that makes us detect and linger on negatively charged stimuli (Kellough et al., 2008; Shechner et al., 2013; Owens & Gibb, 2017). Previous work in this project (based on a smaller sample size) has yielded the same result that we got; image type does not seem to impact gaze fixations (Löf, 2020; Stenberg & Hildeman, 2019). We did an exploratory analysis to have a closer look at whether the non-target box acts as a distractor depending on image type or participants' level of RNT. Our results showed no significant effect for RNT, image type or an interaction between these two variables regarding proportions of fixations in the non-target box. This can be interpreted as that the other image (the one that participants were not instructed to recall) does not interfere during recall and that participants do not use the non-target box to avoid remembering or distracting themselves from the target image.

Gaze behavior also did not significantly affect ratings. It is possible that had our images been more unsettling, graphic, or individually chosen for each participant based on fears and experiences, they would be more intrusive and thus force the gaze back to where they had been encoded, and maybe ratings would have been affected in the fixed condition where this behavior is not allowed. Images could have been selected based on more extreme levels of arousal and valence. Perhaps images that were individually fitted to the participants could also have yielded support for our predicted interaction between RNT and image type. Because RNT is concerned with pre-occupations of the self (Segerstrom et al., 2003), it could be hypothesized that self-referential material would have affected people with high levels of RNT more strongly.

Kornacka et al. (2019) found that participants in general disengaged slower from RNT-related words chosen by the participants themselves compared to neutral words, whereas negative words not chosen by the participants led to faster disengagement from neutral words. Possibly something similar could have been done in this experiment but with image content instead. However, having individualized stimuli come at the expense of internal validity.

Regarding more individual-specific content and strongly negative content, exceedingly traumatic material would of course not be possible to use because of ethical reasons, but perhaps subjects could be screened for general, non-trauma related fears that are not too debilitating and be informed about the potential usage of such images in the experiment before giving consent to participation. As a caution, participants' well-being should then be followed up as to not cause harm.

RNT groups also did not affect gaze fixations during recall of negative or neutral images. It seems that it did not implicate any top-down or bottom-up factors that guided participants with high RNT in any particular direction depending on image type, as we had expected it might. One explanation for this could be that the RNT group in correspondence with the GAD participants in the study by Denefrio et al. (2019) have an impaired ability to discriminate between negative and neutral stimuli. This could mean that in the high RNT group, gaze fixations in the target area would not be affected by image content.

Discussion of Exploratory Analyses

By adding the fourth variable of LB behavior to our ANOVA, we did find an interaction effect. In this case, image type did not affect the interaction that was found between RNT group, LB group and gaze behavior. Because this was not based on our original hypotheses and due to the complex nature of three-way interactions, these results should be interpreted very cautiously.

What inferences can be drawn if it was confirmed that people who are at the same time high in RNT and low in LB behavior report that they want to avoid images more in the condition where they can move their eyes around freely, but the same is not found for participants that are high in RNT and LB? It could indicate that although transdiagnostic, there is variation in causes for and consequences of RNT. The result from our exploratory analysis suggests that people with high RNT might make use of different strategies in order to regulate emotional experiences during recall of episodic memories, depending on how much they engage in looking at nothing. If there are participants that act according to Borkovec's theory (1994) and thus are driven by avoidance of certain emotions, and at the same time there are participants that like Newman and Llera (2011) suggest aim to keep their level of arousal consistently high, these groups might behave differently and cancel each other out in our other analyses even though they all display high levels of RNT, which could possibly explain the lack of our significant results in regard to the hypothesis that RNT would affect gaze fixations. In this line of thought, if there is a subgroup

with a narrowed scope of attention which Whitmer and Gotlib (2013) suggests to be a cause or consequence of ruminative thinking, these participants could be less distracted by the other box during recall and less inclined to move their gaze there because it's not within their attentional scope. It could possibly also be the case that worry and rumination despite their similarities hinge on different functions and that they have different implications in behavior and thought processes, which might make it harder to see results based on PTQ compared to more narrow questionnaires. It does however have the advantage of making potential results more generalizable by not being connected to specific diagnoses.

Strengths and Limitations

Using a within-subjects design made the most of the available participants because it increases statistical power compared to if the participants were to be divided into two groups, one with the fixed condition and one with the free condition or one with negative images and one with neutral images etc. Another advantage with a within-subjects design is that it makes it possible to compare the same individuals over different conditions. A common confounding variable with this design however is order effect, for example where subjects might be tired out by the first trial, thus performing worse in the second condition. This was accounted for by counterbalancing order.

Another strength is that the selection of images is taken from established databases with well-tested material. The experiment leaders also decreased the risk of participant reactivity (for example that they would guess the purpose of the study and based on that start to behave in ways that affect the outcome of the experiment) by stating that they were interested in looking at pupil dilation rather than eye movements.

There are some limitations worth taking into consideration when reading this thesis and interpreting the data from the experiment. As already mentioned, this study exists within a larger research project about eye movements, emotions and memories. The data has been collected on two different occasions and two studies have already used data from the first assessment to answer their research questions. Our original plan was to change some aspects of the experiment and collect new data. For example, we were interested in adding positive images as stimuli and comparing these with neutral and negative ones. We were also thinking about adding a third gaze condition that would be a moving object, like a cross or circle. This would force participants to keep their eyes moving during the recall phase of the experiment but hinder them from looking

back at the area where the picture had previously been. By including a free condition, a fixed condition and a restricted condition that still allows eye movements it could be investigated whether potential differences in experienced distress is dependent on whether the gaze is allowed to wander freely, or if it is linked to eye movements in general in contrast to when eye movements are not allowed at all. Unfortunately, these adjustments and additions were not possible due to the covid-19 situation in Sweden. Therefore, we decided to formulate new research questions and base these on the existing data, but we did not have the option of improving upon the experimental design to make it more tailored to our area of interest.

To begin with, we had 68 people participating in the experiment on two different occasions. Since the experiment was the same on both occasions and because we did not compare these groups against one another, we do not think that this should have affected our results greatly. We did however have to exclude people before doing our analyses. One person was excluded due to missing data and another five people because they did not follow the instructions for the fixed condition (they fixated on the fixation cross less than 50% out of all fixations). The fact that five people did not follow instructions could indicate that the instructions were too complicated or difficult to understand and that they should be improved upon in research further on. The risk of this should however be decreased due to the practice before each trial where the results were controlled by the experiment leader, so there is also a possibility that the participants had understood the instructions but did not follow them because of other reasons that are unknown to us. What remained after that was 62 participants, who were then assigned to different groups depending on their RNT levels and/or LB behavior. Some of these groups are relatively small, especially the ones we use in our t-tests in the exploratory analysis. These consist of only 14-17 participants each. It is possible that these small groups are limiting us in our analysis, and that the effects that appear are not reliable. Our other groups, like RNT groups, have more participants so the analyses based on this group should be more reliable. Our recommendation to students and researchers interested in this experiment is to continue collecting data since bigger samples could increase effect sizes.

There are also other issues related to the participants. We saw that there was a difference in the gender distribution of the two RNT groups. The low RNT group consisted of 19 men and 13 women, while the high RNT group had 10 men and 20 women. This was somewhat expected as there is indeed a gender difference in RNT, as mentioned in the background of the thesis. It

has been shown that women generally score higher on rumination and the subtypes brooding and reflection (Johnson & Whisman, 2013).

The RNT groups were based on the sample's mean on PTQ and while t-tests showed us that these groups are indeed significantly different from each other, it is still possible that they are not different enough. Maybe our results would look different if we were to base our groups on something else than the median value on PTQ. A median split was used in order to not lose any participants (and thereby decreasing power). However, the dichotomization of a continuous variable also leads to loss of power and with it the risk of making a type II error, so perhaps more extreme groups with fewer participants would have been the better option. In the future participants could be recruited on the basis of reaching a threshold level of RNT and others could serve as controls in the study.

Other factors that could have affected statistical power are fatigue effects that lead to lowered performance and engagement over time, and practice effects, meaning that when familiarity with the task performance increases performance. This could possibly lead to less valid ratings and thus potentially decrease our statistical power.

It could be an option to use more than just one questionnaire to check the participants' level of RNT. For example, it is possible to use Generalized Anxiety Disorder 7-item scale (GAD-7) and The Ruminative Response Scale (RRS) since they are closely related to RNT. By using GAD and depressive rumination measures in our analyses, we could more accurately interpret results based on diagnosis-specific theories of RNT. Questionnaires like the Ruminative Response Scale that have their focus on RNT but also include other subscales such as brooding (which is not included in PTQ) could also be useful to include in future studies, because it provides an option to further investigate differences between subtypes within RNT. Another option would be to use more objective measures for distress such as skin conductance level like Skodzik et al. (2016) did in their experiment, or cardiovascular response which is what Borkovec et al. (1993) used in their study.

While checking the assumptions for mixed ANOVAs, we found that some of our dependent variables were not normally distributed in our sample. We tried to transform these, which did not bring them any closer to normal distribution. We looked at the histograms and decided that although it was not normally distributed, we would still do the tests we had planned

for since they are known to be robust and other assumptions were met. It is however possible that this has affected our results and increased the risk of making a type 1 error.

Another factor that might have affected our results is the experiment itself. The main experiment took 35 minutes to complete, and it was essential to maintain focus on the screen throughout the experiment. As mentioned before, some participants might have struggled with following the instructions and this could have partly been because of the length of the experiment.

Lastly, all participants were students in Sweden and around the same age. This raises questions about the generalizability of the data. Since some participants knew the experiment leaders, it is possible that they acted in a manner that they thought would be helpful for the experiment leaders. This could affect our data, especially ratings of experienced distress and ratings in questionnaires about one's mental health. It could be an option for the experiment leaders to ask participants what they think the purpose of the study is, and possibly exclude them if they have guessed it correctly and their ratings are exceedingly high or low (the previously mentioned concealment of the purpose of the study has possibly prevented this from happening in regard to eye movements). Another way to mitigate this could be to use experiment leaders that are not connected to the test subjects, if possible.

Further Research

The exploratory analysis we did shows that people with high RNT react differently to images depending on their LB behavior. The graph (Figure 3) indicates that the high RNT group is a heterogeneous group and that while some people in this group might benefit from looking back at where a previous picture has been, others do not. It would be interesting if future research investigated this but with a sample that is larger or more extreme regarding PTQ scores.

As mentioned earlier, our original plan was to include a third gaze condition - a moving object. This would force participants to keep their eyes moving but hinder them from looking back to where the image had been presented. By comparing a free condition, a fixed condition and a restricted condition where some eye movements are still allowed, it could indicate whether potential differences in experiences of distress is dependent on being able to move the gaze freely or eye movements in general compared to a condition where eye movements are not allowed. It could also be interesting to look at induced RNT, because it makes it easier to make statements about directions in potential correlations compared to relying on trait RNT, which

was the case in our thesis. One option is to induce different types of RNT, worry versus rumination, and investigate how they correlate with how much participants engage in look back behavior. It could also be an option to compare the two (trait and state RNT) and what effects they respectively could have on eye movements and negative affect.

Conclusions

In this thesis we have investigated the potential effect of RNT, emotionally charged images and gaze conditions on experienced distress. We also explored the potential effect of RNT and emotionally charged images on gaze fixation proportions in areas that are relevant for recall. Although our thesis did not come to many conclusive results that were in line with our hypotheses, it has paved the way for future research in this territory that is in many ways still uncharted. Suggestions about changes in the experimental design that might yield results where there in this thesis were none have been given, as well as speculations about the results that were found. One of the most interesting speculative implications is the possibility of subgroups within RNT based on LB-behavior and how these subjects might be affected differently by constraints such as a fixed gaze.

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Tillåtelse att använda data från projektet ”Minnesbilder, kognition och välmående”

Jag godkänner härmed att mitt testmaterial får användas i forskning om kognition, minne och välmående. Detta innefattar såväl olika slags statistiska och kvalitativa analyser, som publicering av artiklar, böcker eller på vetenskapliga konferenser och seminarier.

Jag ger slutligen också mitt tillstånd till att datamaterialet används i undervisning om kognition och minne.

Jag har blivit informerad om

- att det är frivilligt att delta och att jag kan dra mig ur när som helst
- syftet med inspelningarna
- att mina data behandlas anonymt i all analys och redovisning
- i vilken form mina data sparas
- att jag har rätt att kontakta Svante Hildeman eller Philip Stenberg och få mina inspelningar borttagna ur undersökningen
- att jag kan kontakta Svante Hildeman eller Philip Stenberg för att ta del av undersökningens resultat

Ort och datum

Underskrift

Namnförtydligande

”Minnesbilder, kognition och välmående”, Svante Hildeman, sv3307hi-s@student.lu.se, eller Philip Stenberg, ph5377st-s@student.lu.se

Appendix 2

PTQ

I det här frågeformuläret ombeds du beskriva hur du *vanligtvis* tänker kring negativa upplevelser och problem. Var god läs följande påståenden och skatta graden av hur väl de passar på dig när du tänker kring negativa upplevelser och problem.

| | Aldrig | Sällan | Ibland | Ofta | Nästan Alltid |
|--|--------|--------|--------|------|---------------|
| 1. Jag tänker samma tankar om och om igen. | 0 | 1 | 2 | 3 | 4 |
| 2. Jag har påträngande tankar. | 0 | 1 | 2 | 3 | 4 |
| 3. Jag kan inte sluta älta tankarna. | 0 | 1 | 2 | 3 | 4 |
| 4. Jag tänker kring många problem utan att kunna lösa dem. | 0 | 1 | 2 | 3 | 4 |
| 5. Jag kan inte göra något annat när jag tänker på mina problem. | 0 | 1 | 2 | 3 | 4 |
| 6. Mina tankar upprepar sig. | 0 | 1 | 2 | 3 | 4 |
| 7. Tankar dyker upp utan att jag vill det. | 0 | 1 | 2 | 3 | 4 |
| 8. Jag hakar upp mig på vissa saker och kan inte gå vidare. | 0 | 1 | 2 | 3 | 4 |
| 9. Jag frågar mig själv saker utan att finna en lösning. | 0 | 1 | 2 | 3 | 4 |
| 10. Mina tankar hindrar mig från att fokusera på andra saker. | 0 | 1 | 2 | 3 | 4 |
| 11. Jag fortsätter att tänka på samma saker hela tiden. | 0 | 1 | 2 | 3 | 4 |
| 12. Tankar dyker upp i mitt huvud utan anledning. | 0 | 1 | 2 | 3 | 4 |
| 13. Jag känner mig tvungen att fortsätta älta samma saker | 0 | 1 | 2 | 3 | 4 |
| 14. Mina tankar hjälper mig inte så mycket. | 0 | 1 | 2 | 3 | 4 |
| 15. Mina tankar upptar hela min uppmärksamhet. | 0 | 1 | 2 | 3 | 4 |