INTERPRETATION OF AMBIGUOUS VISUAL STIMULI IN DEPRESSION

- A Behavioral Response Study

Iina Julkunen

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Department of Psychology

University of Jyväskylä

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Masennuksen kognitiivisten teorioiden mukaan kielteiset vinoutumat tiedonkäsittelyn eri tasoilla ovat keskeisiä depressio-oireiden synnyssä ja ylläpidossa. Näistä vinoumista harvemmin tutkittu tulkintavääristymä (interpretative bias) oli tämän tutkimuksen kohteena. Aiemmat tutkimustulokset ovat antaneet viitteitä siitä, että masentuneilla olisi taipumus suosia negatiivista tulkintaa jopa epäselviä ärsykkeitä kohtaan. Tässä tutkimuksessa tarkasteltiin, antaisivatko masentuneet epäselville kuville ennemmin kielteisiä kuin neutraaleja tulkintoja, ja miten epäselvyyden aste vaikuttaa reaktioaikoihin. Kaksi ryhmää (dysforinen ja ei-dysforinen) osallistuivat silmänliikekokeeseen, jossa heille näytettiin sisällöltään neutraaleja ja negatiivisia kuvia, jotka vähitellen tarkentuivat sumeasta kirkkaaksi. Jokaisen kuvan kohdalla koehenkilöitä pyydettiin kategorisoimaan kuva joko neutraaliksi tai negatiiviseksi neljässä vaiheessa kuvan kirkastuessa (sumennustasot 1-4). Vastaukset ja reaktioajat mitattiin. Tilastoanalyysit eivät osoittaneet eroa dysforisten ja kontrollien välillä, joten oletus negatiivisen tulkintavääristymän olemassaolosta masennuksessa ei saanut tukea. Tuloksista löytyi kuitenkin molemmissa ryhmissä selkeä reaktioaikojen kasvu negatiivisia kuvia kohtaan sumennustasolla 3, verrattuna muihin sumennustasoihin (sumennuksen ja kuvan valenssin vaikutus reaktioaikaan oli tuolla asteella merkitsevä $p>.0001$). Tämä tulos saattaa liittyä kielteiseksi koettujen epäselvien ärsykkeiden kognitiiviseen kuormittavuuteen.

Avainsanat: havainnot, kognitiivinen psykologia, kognitiiviset prosessit, masennus, tulkinta

Abstract

According to cognitive models of depression, negative biasing of cognitive resources is estimated to be central in the onset and maintenance of depressive symptoms. One scarcely researched bias in depression, the interpretative bias, was the focus of this study. Previous research has indicated that depressed individuals have a tendency to favour negative evaluations even toward ambiguous stimuli. To test this hypothesis, our study examined whether dysphoric individuals would rate ambiguous visual stimuli as negative more often than the control group, and if there was a difference in reaction times according to blur level. Two groups, non-dysphoric and dysphoric, took part in an eye tracking experiment where negative and neutral pictures were shown starting from extremely blurred and ending in a completely clear image. The participants were asked to categorize each picture on each blur level (levels 1-4) as either negative or neutral. The reaction time and categorization data were gathered. No difference between dysphoric and control group was found in the analyses, and thus the existence of a negative interpretative bias in dysphoria did not gain support. However, an increase in reaction times for both groups was found on blur level 3 towards negative pictures, in comparison to other levels (the effect of blur and image valence on reaction time was highly significant on that level, $p>.0001$). This finding might reflect cognitive effort brought on by negative ambiguous stimuli.

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1. INTRODUCTION

1.1 Depression and cognitive biases

Depression is a concept that holds beneath a myriad of affective disorders marked by a pervasive and general lowering of mood. These disorders are characterized, according to the International Classification of Diseases (ICD-10), by a depressed mood, loss of energy, lack of enjoyment and interest in normally enjoyable activities, problems with concentration, sleep disturbances, diminished appetite and loss of self-esteem that may be episodic, recurrent or persistent. The Diagnostic and Statistical Manual of Mental Disorders (DSM-V) recognizes the same disorder, often simply known as clinical depression, by the name of major depressive disorder (MDD). Clinical depression has earned a lot of research interest for a reason; many studies have indicated that depression is the leading cause of disability worldwide (World Health Organization [WHO]; Moussavi, Chatterji, Verdes, Tandon, Patel, & Ustun, 2007).

In Finland the annual prevalence of depression in adult population is estimated to be around 5%. In addition to causing personal suffering, clinical depression also affects the society as a whole as it may either temporarily or permanently remove the depressed from work life and their rehabilitation requires public healthcare resources. In Finland the number of people applying for disability pension on grounds of depression has doubled since the 1990s – in 2007 the pension was admitted to 4 600 people. (Kaypahoito.fi) It is also estimated that around 600-700 people in Finland die annually as the result of suicidal behaviour connected to clinical depression. Depression is often accompanied by other disorders, such as personality disorders, anxiety and substance abuse, and relapses are very common. The severity and number of depressive states greatly affect the prognosis of the disorder – the longer the depression has persisted and the more severe it is, the higher the suicidal risk. Usually depression begins with milder pre-symptoms, and therefore early identification and intervention are possible (Isometsä 2007). In scientific literature the term ‘dysphoria’ is often used instead of ‘depression’; in Merriam-Webster Dictionary dysphoria is defined as “a state of feeling unwell or unhappy”. Usually dysphoria is seen included as a symptom in depression. In many studies concerning depression the subjects have either been identified as depressed or dysphoric; the main difference usually is that the term ‘depression’ marks a medical diagnosis, whereas depressive mood changes without a clinical diagnosis are defined as ‘dysphoria’. 'Dysphoric' is often also used to describe the stimuli presented for the participants in depression studies; a stimulus designed to provoke sad emotions would be described as a dysphoric stimulus. In this thesis too the stimuli and the participants are described as dysphoric instead of depressive/depressed.

The causing factors of depression have been searched for e.g. in neurobiological dysregulations (Clark & Beck 2010; Disner, Beevers, Haigh & Beck 2011; Murrough, Iacoviello, Neumeister, Charney, & Iosifescu 2011), genetic backgrounds and hormonal abnormalities, and it has also been explained on grounds of personality-, psychoanalytic and interpersonal theories. Cognitive biases in information processing have long been of interest in the maintenance of depressive symptoms. Aaron T. Beck famously proposed this cognitive component for the theoretical model of depression, noting that clinical depression is characterized by the presence of intrusive, negative thoughts. This well-known cognitive theory of depression, first introduced in Beck’s book *Depression: clinical, experimental, and theoretical aspects* (1967) postulates that depression is maintained through negative evaluations and beliefs that the depressed individual holds concerning the surrounding world, the self and the future. These dysfunctional interpretations stem from negative cognitive schemata, i.e. deep-rooted, organized mental maps that guide the perceptual process and the formation of meaning we give for the things we perceive. The schemata are shaped by our life events and their function is to allow us to quickly regard what’s meaningful for us and in concordance with our beliefs and expectations, and to dismiss irrelevant information. These schemata also lead us to ignore evidence that contradicts our schema. A negative bias in a cognitive schema guides an individual to perceive the world and his/her own self and the future in negative ways, “leading to selective attention to negative aspects of experiences, negative interpretations, and blocking of positive events and memories” (Beck 2008). The depressed may only attend to negative feedback and ignore the positive, and overgeneralize, overpersonalize or exaggerate negative events that occur. In total, different components of Beck's model include negative biases in allocation of attention, information processing, thoughts, memory, and dysfunction in attitudes and schemata. Research has linked all of them with the onset and maintenance of depression (Disner et al. 2011; Murrough et al. 2011). Negative cognitive styles and attentional biases may also provide vulnerability to depression (Abramson, Alloy, Hogan, Whitehouse, Donovan, Rose et al. 1999) and to emotional stress (MacLeod, Rutherford, Campbell, Ebsworthy & Holker 2002). As an addition to

Beck's model Koster, De Lissnyder, Derakshan and De Raedt (2011) have proposed a so-called impaired disengagement hypothesis, which postulates that difficulties in disengaging attention from negative self-referent information play a central role in vulnerability to depression. The term ‘deficit in cognitive inhibition’ has also been used (Gotlib & Joormann 2010). A negative cognitive style also seems to cause vulnerability to experiencing negative life events which in turn may fuel depression, especially in women (Safford, Alloy, Abramson, & Crossfield 2007). Recognizing these cognitive styles might thus help identifying the at-risk individuals beforehand.

Cognitive depression research examines how these malfunctioning schemata and the persisting negative cognitive cycles present themselves, and in what stages of cognitive processing they operate. The negative cognitive biases in depression are e.g. seen to manifest themselves in the ways in which depressed subjects shift their attention to or between presented stimuli. These shifts and disengagements have indeed been the main interest of several studies where the research question has concerned the attentional bias of depressed individuals (e.g. Bradley, Mogg & Lee 1997; Caseras, Garner, Bradley & Mogg 2007; Eizenman Yu, Grupp, Eizenman, Ellenbogen, Gemar et al. 2003; Ellenbogen & Schwartzman 2009; Kellough, Beevers, Ellis, & Wells 2008; Koster, De Raedt, Goeleven, Franck, & Crombez 2005; Sears, Thomas, LeHuquet, & Johnson 2010). Studies have found out that depressed/dysphoric subjects take longer times to disengage their attention from dysphoric stimuli (Bradley, Mogg & Lee 1997; Caseras et al. 2007; Eizenman et al. 2003; Ellenbogen & Schwartzman 2009; Kellough et al. 2008; Koster et al. 2005; Sears et al. 2010) and that they exhibit longer gaze durations on dysphoric stimuli (see meta-analysis by Armstrong & Olatunji 2012). In general depressed/dysphoric individuals seem to spend more time looking at negative pictures than non-depressed/non-dysphoric participants (Eizenman et al. 2003; Kellough et al. 2008) (although in contradicting results Sears et al. [2010] found no difference between dysphoric and non-dypshoric participants) and less time on positive pictures (Kellough et al. 2008; Sears, Newman, Ference, & Thomas 2011). All of this reflects a general tendency to dwell on negative material in states of depression and dysphoria. Peckham, McHugh and Otto's review (2010) and Armstrong and Olatunji (2012) also report reduced initial attention to positive stimuli in depressed participants (a so-called anhedonic bias). Some evidence has also emerged that while the depressed are slow in shifting their attention away from depressive/anxiety-related stimuli, they are actually faster than non-depressed participants in disengaging their attention from positive stimuli (Koster et al 2005; Sears et al. 2010). These results support Beck's theory on the depressed mind revolving around saddening or anxiety-evoking stimuli without easily abandoning them for more positive stimuli. On the other hand, there's also some evidence that for dysphoric people highly emotional stimuli in general – those of positive affect as well – are difficult to ignore (Derakshan, Salt & Koster 2009). All in all, it seems that in depression the attention and information processing become selective, focusing rather on negative than positive, and rather on highly emotional than on neutral content. As an explanation for this, some neuropsychological findings suggest that the rewarding system of the brain becomes malfunctioned, impairing the individual's natural tendencies to orient towards rewarding, positive stimuli (Disner et al. 2011), causing an impairment in a so-called protective bias usually seen in cognitive styles of non-depressed people. It has also been shown in some studies that dysphoric individuals exhibit a tendency to remember anxiety-related stimuli better than their non-dysphoric counterparts (Sears et al. 2010), suggesting that the negative cognitive style not only impairs the shifting and concentration of attention, but also the ensuing memory processes (Peckham, McHugh & Otto, 2010). Emotional arousal has been shown to impair working memory, and the effects may be especially robust for depressed individuals, for whom the viewing of pictures of negative valence hinders memorising location features of those images, suggesting that negative emotional arousal indeed causes pronounced problems for their cognitive performance (Mather, Mitchell, Raye, Novak, Greene, & Johnson 2006). Depression has also been linked with an overgeneral memory, especially concerning autobiographical details, and the extent to which individuals retrieve such memories has been connected to slower recovery from affective disorders (Dalgleish, Spinks, Yiend, & Kuyken 2001; Williams, Barnhofer, Crane, Herman, Raes, Watkins et al. 2007).

Although some preconscious attentional biases have been found in dysphoria and depression, research literature suggests that cognitive biases of depression become more evident at later stages of information processing. The biases seem to operate especially in prolonged cognitive processing, which in part lends explanation to the act of rumination, a recurrent retrieval of and wallowing in negative self-referent thoughts and memories, which is typical in depression. (Kellough et al 2008; Siegle, Steinhauer, Carter, Ramel, & Thase 2003) Research on visual material has suggested that depressive biases become most evident in extended viewing tasks (see review of Armstrong & Olatunji 2012); when stimuli are presented for a brief time or as masked (i.e. sub-threshold for conscious perception), the attentional biases aren't as evident in depression as they are in anxiety (Caseras et al. 2007; Gotlib & Joormann 2010; MacLeod, Mathews & Tata 1986; Mogg & Bradley 2005). Caseras et al. (2007) found that in dysphoria the bias seems to lie in the maintenance of attention, not in the initial orientation to a stimulus. Azorin, Benhaïm, Hasbroucq and Possamaï (1995) have also suggested that in depression stimulus preprocessing is largely unaffected but that instead response selection to a stimulus is impaired. A bias in interpretation has also been witnessed; depressed individuals have a tendency to make global and stable negative interpretations and inferences about life events (Fresco, Heimberg, Abramowitz, & Bertram 2006) and social signals such as facial expressions (LeMoult, Joormann, Sherdell, Wright, & Gotlib 2009; Surguladze, Young, Senior, Brébion, Travis, & Phillips 2004; Yoon, Joormann & Gotlib 2009).

Sears et al. (2011) studied attention for emotional images in never-depressed, previously depressed and dysphoric groups, finding that previously depressed subjects exhibit the same bias of attending less to positive images and orienting more frequently to negative images as dysphoric subjects. The same cognitive biases that accompany depression have also been found in at-risk individuals, for example in daughters of depressed mothers (Dearing & Gotlib 2009). Anxiety-related pictures have also been found to be strongly attention-binding emotional stimuli for individuals who have experienced depressive episodes but are not depressed at the time of experiment (Sears et al. 2011). All of this provides intriguing evidence that attentional biases in depression might exist even without a current depressive state or depression diagnosis, they are long-lasting and that they are also found in individuals with a heightened risk for depression. Negative cognitive biases may also be latent and emerge under stress, for example while performing a strenuous cognitive task in experimental conditions; the reason for this is speculated to lie in the burden of trying to suppress intrusive negative emotions and thoughts in the middle of a demanding activity (Sears et al. 2011; Wenzlaff, Rude, Taylor, Stultz, & Sweatt 2001).

It should be noted that some of the attentional biases for negative information in the form of threat in depression are also present in anxiety disorders, and thus their manifestation in depression might be explained through the high comorbidity of depression and anxiety. Especially pre-conscious orienting to negative content has more consistently been linked to anxiety than to depression. (Bradley, Mogg & Lee 1997) There's also some evidence that cognitive biases might be witnessed only in the most severe cases of depression: an attentional bias for depression-related pictures seems to be most pronounced in severe and chronic cases of depression (see Sears et al. 2011).

New information on cognitive biases in depression may be used in targeting the corresponding neural circuits and brain areas in treatment. One direction for future research would be applying these results for more efficient depression interventions and cognitive-behavioral treatments. There is some preliminary evidence that computer-based implicit training paradigms may be useful in the re-shaping of cognitive biases. (Murrough et al. 2011)

1.2 Emotional stimuli

Naturally, quick detection of negative and self-threatening stimuli and the preference of emotional over neutral stimuli aren't characteristic only for depression. In general, as the result of evolutionary processes, human cognition has been hardwired to identify threats as quickly as possible (LoBue 2010; Öhman, Flykt & Esteves 2001). In addition to possible evolutionary biological background, this attentional bias toward threat-relevant stimuli may also be a result of conditioning and cultural learning (e.g. LoBue 2010). In general, motivationally relevant pictures capture attentional resources more efficiently than non-relevant ones (Calvo & Nummenmaa 2007). Emotional responses help our cognition in identifying the stimuli relevant for our survival and in choosing which stimuli pass the attentional barriers and get into further processing in our brain; in this so-called defensive-appetitive reaction decision the organism chooses whether a flight or fight reaction would be more appropriate in the situation (Beaver, Mogg & Bradley 2005; Mogg & Bradley 1999; Phelps, Ling & Carrasco 2006). This means that stimuli with perceived affective value capture our attentional resources more profoundly, a result which has indeed been obtained in studies with subjects suffering from anxiety (e.g. MacLeod, Mathews & Tata 1986; Williams, Mathews & MacLeod 1996). An emotional stimulus is usually detected faster (Calvo & Nummenmaa 2011) and remembered better (Dolan 2002; Dolcos, LaBar & Cabeza 2005), and in congruence with the theory of evolutionary bias for threats, some studies have also proposed that unpleasant stimuli capture attention more easily than pleasant stimuli (Öhman, Flykt & Esteves 2001; Öhman, Lundqvist & Esteves 2001). In general, research methods that look at the capture of attentional resources by motivationally relevant stimuli, suggest greater allocation of attention to emotional pictures compared to neutral ones. There is some evidence, however, that when pleasant and unpleasant stimuli share the same emotional arousal rating, no difference for valence is found - highly arousing pictures capture attention more greatly than pictures rated low in arousal, regardless of the motivational valence (pleasant vs. unpleasant) of their content (Nummenmaa, Hyönä & Calvo 2006; Schimmack 2005; Verbruggen & De Houwer 2007; Vogt, De Houwer, Koster, Van Damme, & Crombez 2008). Nevertheless, using a naturalistic visual scanning approach in an eye tracking study Eizenman et al. (2003) found that the differences in fixation times between depressed and non-depressed correlated with picture valence but not arousal, suggesting that the perceived valence of image content does play a role of its own in captivation of cognitive resources. In many studies depression seems to be characterized by reduced emotional reactivity to both positively and negatively valenced stimuli (Bylsma, Morris & Rottenberg 2008). Since the activation of emotional networks is associated with cognitive processing and perception, this so-called emotional blunting phenomenon might contribute to a lowered identification accuracy of emotional stimuli, which has sometimes been found in depression (see e.g. Azorin et al. 1995 for discussion).

1.3 Visual saliency and ambiguity

In general, emotional stimuli undergo more excessive processing in the brain than neutral ones (Mikels, Fredrickson, Larkin, Lindberg, Maglio, & Reuter-Lorenz, 2005). This evokes the idea that in order to cause cognitive processing, the stimulus should be clearly categorizable as emotionally relevant. Some studies (e.g. Calvo & Nummenmaa 2011; De Cesarei & Codispoti 2008) have examined the sufficient amount of visual information that would allow this categorization to be made. In their research on critical threshold for discriminating emotional facial expressions in pictures, Calvo and Nummenmaa (2011) noticed that sufficient amount of visual information in mouth region was crucial for efficient identification of the expression. They suggest that early recognition of some perceptual factor, a visual clue, activates affective retrieval and higher-level semantic networks, and that this interplay of semantic and perceptual factors leads into decision about the category of the stimulus. Perception of semantic information would thus be greatly dependent on visual saliency in early stages of visual perception, and disrupting the amount or quality of visual clues could therefore greatly hinder the recognition and semantic categorization of the picture. It has been speculated that more detailed stimuli activate our inner representations and their associative networks (sensory, semantic, procedural) in our brain via a more straightforward route than less vivid stimuli (De Cesarei & Codispoti 2008; Lang 1979) - impoverished or corrupted versions of a stimulus thus would have less potential to activate the mentioned networks. The greatest cognitive activation is indeed caused by real world stimuli which are perceived to be physically close or large in size (Codispoti & De Cesarei 2007; Detenber & Reeves 1996) - for example, a picture of a snake is a weaker stimulus compared to an actual snake in the room

(Teghtsoonian & Frost 1982). On the other hand, De Cesarei and Codispoti (2008) have found out that while changes in the detailedness of pictures decreased the subjective affective value of the stimulus, even the most degraded pictures had the same capability as intact pictures to capture attention in the middle of an unrelated task. Human cognition in general seeks to complement imperfections in the perceptual world and thus trying to make sense out of incomplete stimuli strains our cognitive resources, which may be one explanation why blurred pictures too bind our attention so effectively. The psychoanalytic concept of projection may also be used here – when gazing at a blurred picture, the mind tries to supplement the lack of actual visual information by using previous experiences, expectations and ideas, schemata, as its basis. De Cesarei and Codispoti's result about the blurry pictures' ability to catch attention tells us that something about ambiguity is considered motivationally important or at least important enough in its affective value to be attended to, even though individuals may subjectively report less emotional arousal when looking at degraded pictures.

Concerning the cognitive binding caused by ambiguous or unclear stimuli, some studies have also found implications of unclear information's ability to excite our nervous system, suggesting that unclear stimuli also cause activation preparation. Berlyne and Borsa (1968) noted more activation in EEG and GSR (Galvanic Skin Response) when the participants encountered stimuli which were in-between the states of clear and unclear. In the results obtained by De Cesarei and Codispoti (2008), however, the attention-capturing effect of un-detailedness was most pronounced when the blurred stimulus was based on a stimulus rated high in arousal; thus it is likely that no matter the amount of corruption in the picture quality, a stimulus low in arousal and survival significance (e.g. a coffee cup) doesn't entice attention as strongly as an arousing picture (such as that of a mutilated body). De Cesarei and Codispoti (2008) also studied the difference between two types of ambiguity and their effects on cognitive processes, both manipulating the picture size and filtering the picture into a foggy mass losing the fine details. They noticed that the amount and method of degradation were irrelevant – both methods led to a decline in reported emotional arousal, but even a very unvivid picture based on highly arousing content (i.e. erotic couples or mutilated bodies) caused an increase in reaction times in a task where the subjects had been asked to ignore the picture and press a button when hearing a certain sound. (In contrast it should be noted that fear-relevant pictures have been shown to initiate faster reaction in some studies [Flykt 2005]). The arousal ratings were slightly higher for filtered than for resized pictures, suggesting that blurriness is slightly less disruptive for perceived emotional relevance of the stimulus, compared to the distancing of the stimulus. This might reflect the evolutionary need to determine the affective value of objects in the fog faster, rather than ones that are at distance.

Human mind's ability to make decisions about the nature of perceived stimuli based on very little sensory information is a feature which has undoubtedly been important for our survival as a species; in cases of detecting a predator in the fog or thick woods, for example. De Cesarei and Codispoti (2008) have demonstrated in their studies about emotional picture processing that while subjective emotional response requires high spatial frequency in the clarity of the picture, the picture captures attention at a very early stage of visual processing – at a point where the amount of information is just above sufficient level to allow the categorization of picture content. Emotional processing of the picture also seems to be unaffected by whether the stimulus is shown in colours or black and white, indicating that emotional sensitivity to certain colours is not an explanation for the response (De Cesarei & Codispoti 2008). An interesting question arises: since we use schemata to complement incomplete data in order to form an understanding of what we perceive, in the lack of proper visual information, would a malfunctioning schema lead an individual to complete the picture, even if it's based on a neutral-content picture, in a congruent malfunctioning way?

1.4 Interpreting ambiguity in depression

From Beck’s theory and the results of previous research we may deduce that a clear bias toward depressive or emotionally negative stimuli exists in individuals in depressive mood. One question arises: if depressed/dysphoric people have a tendency to mostly attend to negative material and to process it, does this mean that they also tend to attribute negative meaning to stimuli more easily? Some studies suggest that they do, at least in the case of facial information: Bourke, Douglas and Porter (2010) conclude in their review that participants suffering from major depression have a tendency to rate happy, neutral and even ambiguous facial expressions sadder or less happy than non-depressed participants. Similar results about a depression-related negative bias in the perception of facial expressions has been found in induced depressive moods as well: Bouhyus, Bloem and Groothuis (1995) noticed that subjects in depressive mood perceived more rejection and sadness in ambiguous faces and less happiness in non-ambiguous faces, and subjects also perceived more fear in non-ambiguous faces expressing less intensive emotions. Dearing and Gotlib (2009) noticed that individuals at heightened risk for depression – here daughters of depressed mothers -

interpreted ambiguous words and stories more negatively than the control group. Using the magnitude of blink reflex as an indicator of negatively valenced imagery that is caused by the individual's negative interpretation of an ambiguous stimulus, Lawson, MacLeod and Hammond (2002) found a bias towards negative interpretation of ambiguous stimuli in depressed participants. Contradicting results have also been obtained: in a study where the participants' reaction time to respond to words that were presented after ambiguous sentences was used as an indicator of bias, no interpretative bias was found in depressed participants (Lawson & MacLeod 1999). Surprisingly, in Lawson and MacLeod's results high amounts of depressive symptoms were associated with a *lower* tendency to make negative interpretations of ambiguous textual stimuli. Bisson and Sears (2007) used a similar task, but didn't find evidence of an interpretation bias in depression even when using a dysphoric mood induction as reinforcement. There's been some speculation that the negative results obtained in self-report interpretation tasks may also result from depressed individuals' tendency to *report* negative evaluations more easily, even though they might process both the negative and neutral inferences of ambiguous material - in other words, they may have a negative reporting bias, not a negative interpretative bias (Lawson & MacLeod 1999; Mogg, Bradbury & Bradley 2006). Favouring negative interpretations of ambiguous stimuli has also been connected to anxiety (e.g. Yoon & Zinbarg 2008): in a forced choice task anxious individuals favoured the negative classification for ambiguous emotional expressions (Winton, Clark & Edelmann 1995).

Some studies have suggested that in depression stimulus identification in itself is impaired (see discussion in Azorin et al. 1995; Brand & Jolles 1987), which might reflect inner schemata overriding available sensory information in some cases, especially in cases of ambiguous information. There is also some evidence that in depression the required amount of visual information for cognitive processing increases. LeMoult et al. (2009) used images of facial expressions which slowly changed from neutral to intense to determine a point where previously-depressed and never-depressed subjects had enough information to make a correct interpretation about the expression, noting that previously depressed made the correct categorization at later stages than never depressed. Surguladze et al. (2004) similarly noticed that depressed subjects exhibited an inability to accurately identify subtle changes in facial expressions. The results indicate that at least in the case of facial expressions, subjects with depression history require more intense visual clues in order to make the correct categorization. One explanation may lie in the blunted emotional responses which don't provide help in the categorization process. Depressed individuals' schemata guiding the interpretation process might be also more resilient to change than those of non-depressed individuals' and thus hinder the shifting between categorizations.

1.5 Reaction time measurement in research of cognitive biases

The detection of emotionally relevant stimuli has in many cases been examined by the traces of physical arousal they cause. The arousal is taken as an indicator of action preparation caused by a stimulus deemed relevant. In numerous studies, the cognitive strain caused by the processing of arousing stimuli has been noted through its physical correlates, such as heart rate modulation (HR), cortical activity and event-related potentials (ERP) (Codispoti, Ferrari, De Cesarei & Cardinale 2006; Cuthbert, Schupp, Bradley, Birbaumer & Lang 2000; De Cesarei & Codspoti 2008). Usually these experiments include showing the participant a number of pictures, and assuming that emotionally relevant ones cause changes in physical or neural activation which is an indicator of action preparation.

Research strategies of cognitive biases have also traditionally focused on the paradigm of quicker detection of motivationally relevant information, and on how the presenting of such information hinders performance of different cognitive tasks at hand (Williams, Mathews & MacLeod 1996). Reaction times have traditionally been used as a measure in these studies. Concerning biases on visual stimuli, it's been noticed that when participants are asked in an experiment to ignore the pictures shown and to press a button as fast as possible upon hearing a noise, emotional pictures cause longer reaction times compared to neutral ones (e.g. Bradley, Cuthbert & Lang 1996; Mikels et al 2005). Selective attention to images has also been examined through visual search tasks. Dot probe tasks, where the target stimulus is shown either after a neutral or an emotional stimulus in different areas of the screen and then the fastness of detecting the target stimulus is measured to determine the viewer's allocation of attention, have been especially popular in attentional bias research (Gotlib & Joormann 2010). Free viewing tasks of competing stimuli have also been used to shed some light on the questions about the types of pictures that people attend to, in what order and at what lengths (e.g. Eizenman et al. 2003). Behavioral response measurements in form of reaction time studies have been popular in the history of cognitive bias research (Eizenman et al. 2003). Lately they have been supplemented by other methods, such as eye movement methodology.

Traditional reaction time paradigm states that cognitive load caused by an emotional stimulus hinders reaction, therefore causing an increase in reaction time. This cognitive load may be caused by an emotionally relevant stimulus shown in the middle of a cognitive task requiring reaction (as in Stroop tasks where the colour-naming task is interrupted if the viewer encounters a relevant word; e.g. MacLeod, Mathews & Tata 1986) or very likely also by the ambiguity of the stimulus; Berlyne and Borsa (1968) noticed more skin conductance and EEG activity at the middle stages of blurring of the picture. This result might reflect the fact that in the case of unclear stimuli the cognition is heavily strained by uncertainty; the cognitive system needs to work fast to decide whether to activate appetitive or aversive reaction systems towards the stimulus - failing this task in nature could be fatal. Evidence for elevated information processing toward schema-congruent emotional stimuli has been obtained by e.g. Gotlib and McCann (1984) who noticed that depressed participants were slower at naming the font colour of negative words, and by Mathews and MacLeod (1985) who noticed that if the threat word in Stroop test was congruent with the anxious subject's source of worry, the performance was slower. It should be noted that depressed people usually perform slower than control subjects in reaction time experiments, a feature which may result from overall physical slowness and cognitive deficits (difficulties in concentration etc.) which are a symptom of depression, or drowsiness caused by possible medication, or, as discussed in Azorin et al. (1995) from possible pervasive cognitive impairments in different stages of information processing.

Previous research suggests that the cognitive biases of depression operate at voluntary, elaborative states of cognitive processing, such as response selection, rather than at unconscious orienting states (e.g. Azorin et al. 1995; Eizenman et al. 2003; Mogg & Bradley 2005). While eye tracking methodology has proven invaluable at pinpointing these preconscious processes and initial orientation of attention, reaction time methods might still measure the later stages of attention with more validity. Reaction times by default measure the behavioral response; for example in case of manual responses requiring categorization, they tell us about the perceived semantic information seen in the stimuli (Calvo & Nummenmaa 2011). Reaction time studies have also faced criticism: Kellough et al. (2008) have suggested that reaction time methods and especially traditional dot probe tasks are strenuous for participants, and therefore provide an insufficient method of examining actual, natural sustained processing - instead they may actually show us only the early stages of information processing. Armstrong and Olatunji (2012) have also criticised reaction time measures in comparison to eye movement methods, but it might be that a longer gaze duration for dysphoric material in depression could also be seen as one component causing the longer reaction times in behavioral tasks. Reaction time measurements don't provide insight to temporal characteristics of attentional processes either (Caseras et al. 2007). Manual motor movement may also vary individually (with factors such as age), and therefore the time a manual response takes to perform doesn't necessarily indicate the fastness of decision-making (Calvo & Nummenmaa 2011, footnote 1). In Calvo and Nummenmaa's (2011) experiment the subjects' discrimination accuracy in the facial expression categorization task was greater when the method was manual responses, compared to eye movement method. They speculate this may be due to visual input receiving more cognitive processing in a reaction task. Thus, especially in experiments examining semantic categorization, we might conclude that a traditional manual response with reaction time as measurable quantity is a valid tool.

1.6 Aims and hypotheses of the present study

In this experiment we studied whether depressed individuals are more prone to give negative meanings to ambiguous stimuli than non-depressed individuals. The cognitive process we are studying is categorization of pictures. Based on Beck’s cognitive model and previous evidence about depressed people perceiving and processing negative information more straightforwardly and profoundly than non-depressed, our hypothesis is that depressed subjects would rate blurred pictures, regardless of their actual content, more often as negative than non-depressed control subjects and this should be seen especially as more negative answers toward neutral pictures in the dysphoric group than in non-dysphoric group. Based on the results of LeMoult et al. (2009) and Surguladze et al. (2004) we also conclude that dysphoric individuals may have difficulties identifying changes that occur due to the un-blurring which may lead to inaccurate categorization of the picture content. We expect to see more correct categorization at later, un-blurred stages on the picture trials from both groups, and maybe a bit earlier from the non-depressed, because dysphoric individuals require more visual information for the basis of their decision-making. Previous research and cognitive models of depression suggest that depressed individuals have a tendency to get stuck on negative interpretations, and therefore we hypothetize that the dysphoric group would exhibit a pattern to abandon a negative categorization for a neutral picture at later, clearer stages than non-dysphoric.

Concerning the differences between the groups' reaction times we might expect two findings: first, the depressed subjects should perform slower throughout the trials, both towards negative and neutral images, due to motor slowness being one of the symptoms of depression, and because categorization processes in lack of visual information seem to pose more difficulties for them than for controls. Or second, they should perform a bit faster, because negative evaluation (in contrast to 'neutral') is an evaluation that's congruent with their cognitive schema and could thus pre-wire them to perform such a reaction quicker than their control counterparts. From both groups we expect a decline in reaction times as the picture comes clearer, since less ambiguous stimulus should cause less cognitive effort, which in turn should be evident in reaction times. From grounds of evolutionary psychological theories (Flykt 2005) we also expect the categorization of negative pictures to be faster for both groups.

2. METHODS

2.1 The participants

The experiment was run as part of a larger depression study "Effectiveness of a brief psychological intervention for mood disorders: evidence based on psychological and brain measures" (funded by Academy of Finland) at the University of Jyväskylä. This longitudinal study followed and recruited people for both control groups and depression groups along the way, but mainly followed the same depressed groups to test the effects of a brief psychological intervention. The experiment of blurred pictures was run for the depressed individuals as part of one of their follow-up visits at the laboratories of the university in autumn 2012. Some additional subjects for the experiment were recruited and tested in summer and autumn of 2013. Both eye movement and reaction time data were gathered – the results of eye movement data are reported elsewhere (see e.g. Alakoskela 2014). In addition to taking part in the blurred picture experiment, the subjects also participated in other eye tracking studies.

Sixty-six participants in total took part in the experiment, the majority of which were recruited from the larger depression study. Twenty-four control participants were recruited outside the study with messages out in town and in mailing lists. The participants’ age ranged between 19-65 years, with the median falling on 50 years and the mean on 46 years. Fifty of the subjects were female and sixteen male. In order to take part in the series of eye tracking experiments the participants had to have normal or corrected-to-normal eyesight, with eyeglasses/contact lenses no stronger than +/-2 dioptres. Lenses too strong would have produced too much error in the camera of the eyetracking device.

As part of the study, the participants filled a number of depression and anxiety inventories and questionnaires: Beck Depression Inventory-II (BDI-II), Depression Anxiety Stress Scale (DASS-42), General Health Questionnaire (GHQ-12), Automatic Thoughts Questionnaire (ATQ), Adult Hope Scale, Kentucky Inventory of Mindfulness Skills (KIMS), Action and Acceptance Questionnaire (AAQ-II) and Cognitive Fusion Questionnaire (CFQ). Only the scores of BDI-II were included in this experiment.

The depressed participants originally recruited for the larger depression study had a previous psychiatric ICD-10 -based diagnosis for depression, but since they had been subjected to interventions before taking part in the blurred picture experiment, the diagnosis alone might not have been a valid way to determine their actual level of depression at the time of testing. Thus the BDI-II scores were also taken into account. The threshold indicating depression in the BDI-II scores was set at 10 points, although the cut-off point for depression proposed in the BDI-II manual is 14 points. Different thresholds have often been utilized in research; for samples comprising of university students a cut-off point of 20 has been used (e.g. Sears et al. 2010), as recommended by Dozois, Dobson and Ahnberg (1998). The cut-off point of 10 was selected for our experiment because it comes arguably close enough to the depression threshold suggested by the manual, and also because it produced two groups of equal *n*:s and equal age distributions in our sample. These two sub-groups were formed to enhance the contrast with the depression variable in our analyses. This division also allowed us to control the possible effects of age and previous depression on the results. Because the threshold of 10 points doesn't warrant the use of the clinical term 'depressed', our groups are referred to by the term 'dysphoric'. Dysphoric group (n = 15) consisted of the participants who had been diagnosed as depressed upon entering the study and who still exceeded the BDI-II limit of 10 points at the time of our blurred picture experiment. Non-dysphoric group (n

= 15) comprised the control group, i.e. participants with no previous depression diagnosis who also had BDI-II scores lower than 10 at the time of the experiment.

The BDI-II scores weren't obtained from all participants at the time of the experiment, but were selected from a visit as close to the eye movement experiment as possible. Although this procedure may be criticized for not giving us an exact picture of the participants' depression levels on that specific day, there's been some speculation that depression questionnaires may actually prime the participants' mood for the experiment (Derakshan, Salt & Koster 2008). Therefore not filling the inventory at the time of the trials may actually have ensured a more natural mood for our subjects. In some previous experiments the depressive mood has been caused by induction (see e.g. Bradley, Mogg & Lee 1997) before running a cognitive test, and in others the criteria for clinical depression have been used.

Generalising results from dysphoric samples to a depressed population has been subject to debate, especially when student samples are used (see e.g. Sears et al. 2011 for discussion; Cox, Enns, Borger, & Parker 1999). The use of naturally depressed samples with varying socio-economic backgrounds has a greater ability to produce results that are applicable for wider populations. Since on grounds of past research cognitive biases seem to be most evident in chronic cases of depression (Armstrong & Olatunji 2012), ensuring that our depressed sample had both depression history and current depressive experiences should make interpretation biases as visible as possible.

2.2 The procedure

The apparatus used in the experiment was Dell Precision T5500 workstation with Asus VG-236 (1980x1040, 120 hz) monitor. Measurements were performed with Eyelink 1000 table mount eye-tracking system (SR Research Ltd, Canada) which employs 1000 Hz sample rating while tracking the right eye of the participant. The trials were designed on and run by SR Research Experiment Builder v. 1.10.165 computer program (SR Research).

At the beginning of the experiment the participants were seated directly in front of the eyetracking camera on a chair, with their chin lying on a rest located 60 cm from the monitor where the picture trials were shown. The participants were instructed to look at the pictures on the screen and then, after hearing a noise signal, to choose whether they thought the picture was negative or neutral and to indicate their decision by clicking a button on a mouse in front of them. The button order was mixed between participants – for some participants the button order was left for negative interpretation and right for neutral, and for the rest vice versa. This mixing of button orders helped decrease the possibility that the probable underlying expectancy about the order of the buttons would be guiding the clicks. The participants were also instructed to keep their index finger on the left button and their middle finger on the right button.

Before running the trial, the participant's eyes were calibrated for the EyeLink –eyetracking device. Calibration means checking that the participant's right eye pupil was clearly seen and that its movements could be reliably tracked by the camera and the program. The calibration was made by instructing the participant to follow a cross on the screen. The ideal value for calibration was set at $\leq 0.3^{\circ}$, allowing a maximum 0.3° error in calibration. With some participants, however, the trial was allowed to proceed even with a bigger value. The reason for this was the suspected tiredness seen as fidgeting, restlessness etc. in the participant's behaviour that hindered the exact calibration – the experiment was carried out if it looked like that at least sufficient amounts of data could be gathered. The restlessness of the participant was marked down in the experiment journal. Tiredness/fidgeting was evident at least with some of the depressed participants, and thus if we had only accepted the data that was gathered with the ideal calibration value of ≤ 0.03 we would've eradicated a lot of participants from the dysphoric sample. The reaction time data could still be gathered nonetheless.

The reaction time was measured from the beginning of the picture-video to the button press. After each trial the EyeLink program asked the researcher to perform a quick drift correct check (to ensure that pupil calibration was still in place) before continuing the experiment. The minimum time one trial took from a participant could be around 15 seconds.

2.3 The stimuli

The stimuli in this experiment were a mixture of pictures of IAPS (International Affective Picture System, developed by Center for the Study of Emotion and Attention [CSEA], University of Florida, 1999) and others, received to our use from Mather and Nesmith who employed the same picture set in their study (e.g. Mather & Nesmith 2008). The IAPS consists of colour photographs and it has been developed to create a set of normative emotional stimuli for research purposes, so that all the pictures could be assessed on three basic affective dimensions of pleasure, arousal and dominance (Lang, Bradley & Cuthbert, 1997). In our experiment the pictures were all standard size of 500 x 500 pixels and contained negative and neutral situations, characters and objects. In the photo set each neutral picture (a) has a counterpart that includes a negative version of its contents (b). One picture would e.g. depict a sleeping dog, and its counterpart a dead body of a dog. In this experiment the pictures were shown in random order chosen by the computer software. In earlier research the IAPS pictures have for example been used to provoke a startle reaction (see e.g. Mather & Nesmith 2007).

The pictures were handled in Adobe Premiere Pro –program where a Gaussian Blur effect was added to them, providing each picture with four distinctive levels of blurredness. These individual levels were shown to the participants as videos, where they'd first see the picture un-blurring from 100 degrees of blurring to 75 degrees (blur 1); in the second picture the level of blurring would decrease from 75 to 50 (blur 2); in the third from 50 to 25 (blur 3) and in the last step they'd see the picture un-blurring from 25 degrees to 0, leaving the participants with a completely clear picture (blur 4). These four levels of blurring of one picture produced one picture trial. Each un-blurring video – one step of the trial - lasted three seconds, and after each video a sinusoid sound of 305 Hz was given to signal the participant to make a button press to decide whether the picture they had seen was neutral or negative in their opinion. Each participant saw 79 picture trials, rating 79 x 4 = 316 picture-videos in total. The first two trials were meant for training and were thus excluded from the eventual data. After 39 trials a break was taken.

Morphing or transforming stimuli with a stage of ambiguity have not often been used in research; LeMoult et al. (2009) used images of facial expressions which slowly changed from neutral to intense to determine a point where previously-depressed and never-depressed subjects had enough information to make a correct interpretation about the expression. Liu, Huang, Wang, Gong, & Chan (2012) also used morphed emotional stimuli in a facial expression task where the images of faces formed a continuum with transformations between expressions, to see if depressed subjects had difficulty distinguishing boundaries between emotions. Since interpersonal problems greatly contribute to depression, it's no wonder that a lot of interpretation bias research has focused on biases concerning facial expressions (e.g. LeMoult et al. 2009; Liu et al. 2012; Surguladze et al. 2004; Yoon, Joormann & Gotlib 2009). To the author's knowledge, no previous study of cognitive biases in depression has used ambiguous morphing pictures which would include images of other themes than people and faces as well.

Our study differs from traditional emotional response studies in the sense that we did not ask the participants to rate their own emotional state invoked by the picture (like DeCesarei & Codispoti 2008 did), but to give a semantic evaluation (‘neutral’ or ‘negative’) about the nature of the picture they see.

2.4 Statistical analyses and variables

The variables of interest were the button clicks, e.g. categorization/evaluation made by the participant about the picture, reaction times (variable of 'time'), level of blur (1-4, 'blur'), the pre-determined valence of image ('valence', 1= negative, 2= neutral) and group (dysphoric=0/non-dysphoric=1, variable 'group'). The categorizations and reaction times were aggregated to get an average profile of categorization and reaction time for pictures per person. These measures for finding averages in the data are supported by the fact that reaction time isn't a normally distributed phenomenon and it contains a lot of variance inside an individual – therefore aggregating the data in reaction time analyses is recommended (Whelan 2008). The picture categorization/evaluation made by the participant was turned into a variable of 'occurrence (of negative evaluation)'. Descriptive graphs of the co-operation of these variables were drawn: the mean occurrence of negative evaluations on all blur levels and for both valences, and the development of mean reaction times throughout blur levels for both valences. Since the main interest in this experiment is the effect of dysphoria on evaluations and reaction times and on which blur levels exactly this effect operates, additional statistical analyses were carried out. A repeated measures analysis of variance was carried out to search for interaction between the variables of blur, valence and group. Paired samples t-tests were run as a post hoc procedure to test variance within subject; whether the reaction times differed across blur levels in the two different valences, and whether the occurrence of negative categorizations varied according to blur level.

3. RESULTS

3.1 Picture categorization

The mean occurrences of negative categorization towards both neutral and negative images in both groups are depicted in figure 1. The dysphoric group seems to exhibit a slight tendency to categorize images as negative more often than their non-dysphoric counterparts on blur level 2 in the case of negative images and on all blur levels in the case of neutral images. Towards negative images, for both the dysphoric and non-dysphoric group the occurrence of negative evaluations increased in the course of un-blurring of the picture.

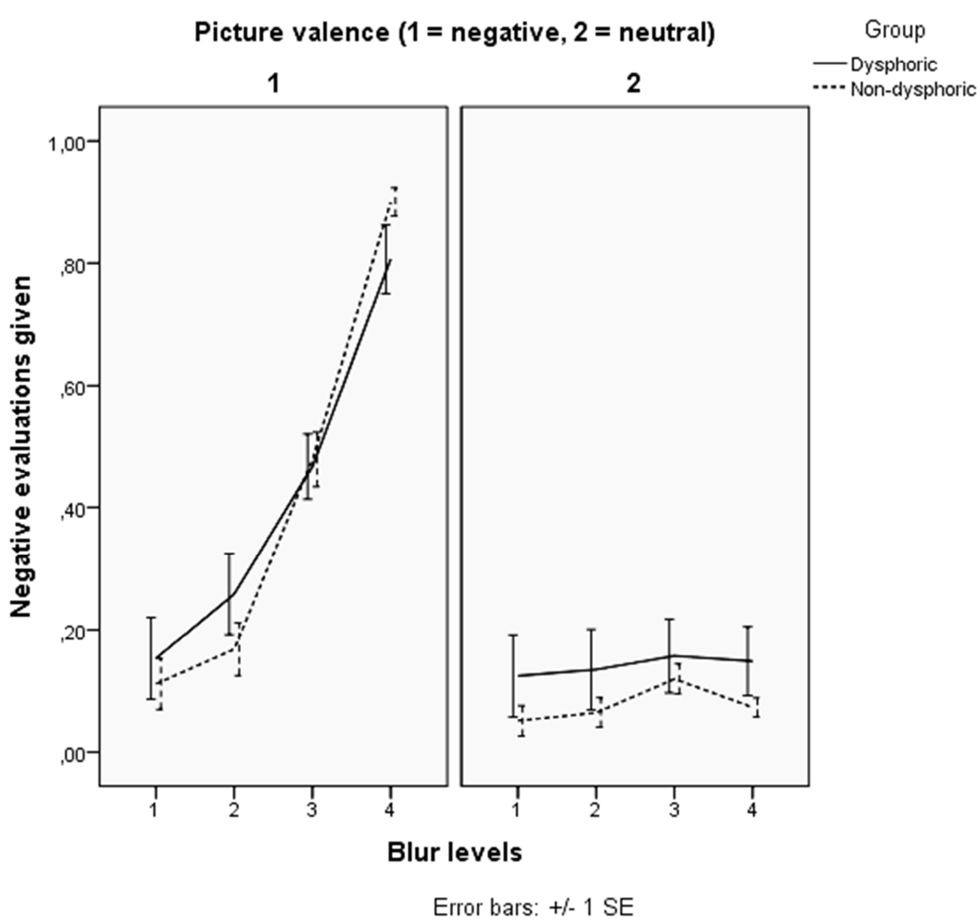

Figure 1. The mean amount of negative categorizations made for negative and neutral images in dysphoric and non-dysphoric group on different blur levels. Error bars represent standard deviation.

A repeated measures analysis of variance checking for interactions between valence, group and blur showed no group effect, $F(1,28)=.454$ $p=.506$. A moderate effect for group (dysphoric / non-dysphoric) was observed between blur levels 1 and 2, $F(1,28)=5,744$ $p=.023$. Blur*valence interaction was highly significant $F(3,26)=58,029$, $p>.0001$. The interaction was significant for all blur levels. Univariate analysis of variance for testing the interception between blur and valence proved significant $F(1,27)=1181,228$ $p> .0001$.

Now that a blur*valence co-effect had been established, a post hoc –test was conducted to see how it operated in the data. T-tests were run for the occurrences of negative categorizations, on each blur level and for both valences. Results for paired samples t-test for occurrence of negative categorizations are presented in table 1.

Table 1.

Results of T-tests for Differences in the Occurrence of Negative Categorizations on All Blur Levels for Both Negative and Neutral Pictures.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Occurr. 1.1 – Occurr. 1.2	1.86	2.73	.49	.84	2.88	3.73	29	.001
Pair 2	Occurr. 2.1 – Occurr. 2.2	4.63	4.13	.75	3.08	6.17	6.13	29	.000
Pair 3	Occurr. 3.1 – Occurr. 3.2	13.50	7.28	1.33	10.77	16.22	10.14	29	.000
Pair 4	Occurr. 4.1 – 4.2	29.80	11.85	2.16	25.37	34.22	13.76	29	.000

All the occurrences of negative categorizations vary on all blur levels according to valence. A slight decrease in p-value is observed as the levels near a completely clear image.

3.2 Reaction time

Figures 2 and 3 depict the development of mean reaction times in both groups toward both picture valences throughout blur levels. As figure 2 shows, the dysphoric participants' reaction times for both neutral and negative pictures come rather close to one another. The non-dysphoric, on the other hand, seem to exhibit a slight difference in reaction times between neutral and negative evaluations, being slower in evaluating the picture as negative than neutral. (Fig. 3) Both figures also show a distinctive peak in the reaction times on blur level 3 for negative pictures. According to a repeated measures analysis of variance blur*valence effect was significant $F(3,26)=7{,}266$, $P=.001$. No group effect was found, $F(1,28)=1{,}580$, $p=.219$.

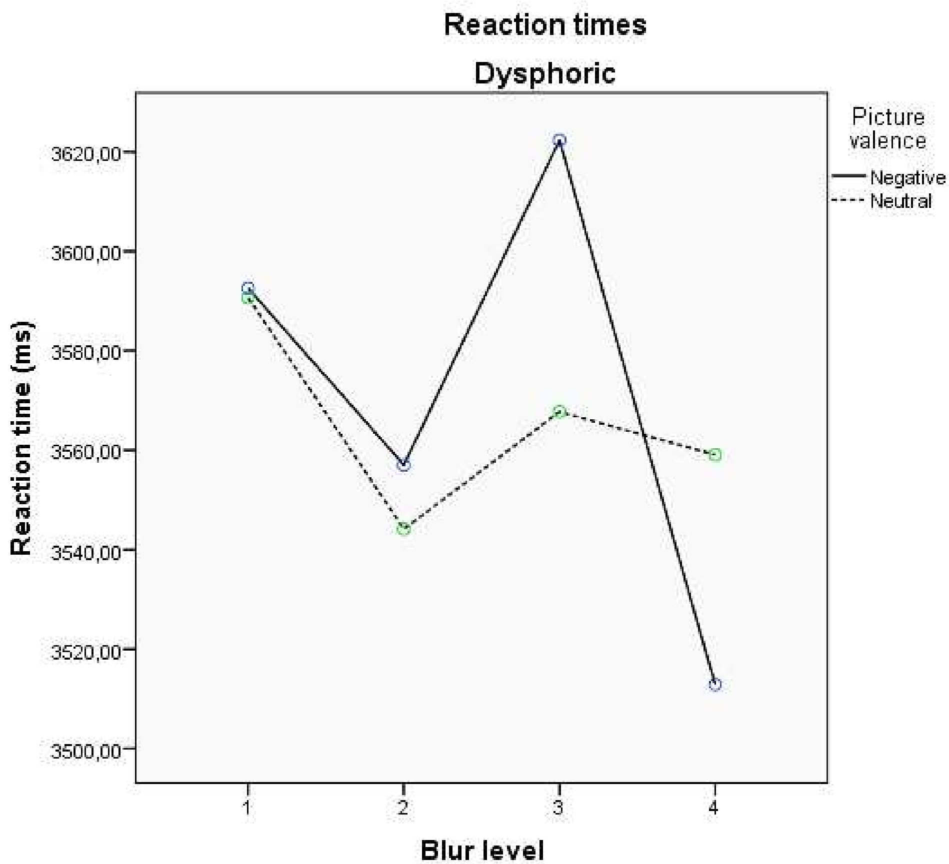

Figure 2. Mean reaction times in the dysphoric group for negative and neutral pictures throughout blur levels.

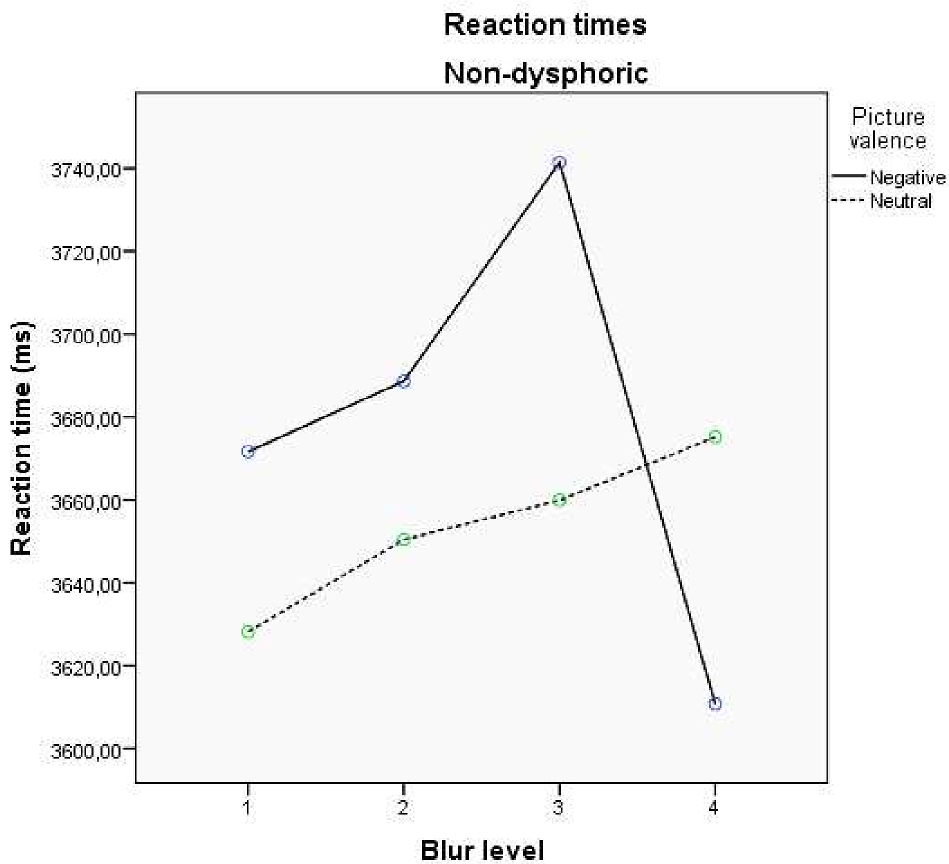

Figure 3. Mean reaction times in the non-dysphoric group for negative and neutral pictures throughout blur levels.

A post hoc paired samples t-test was conducted for the reaction times on each blur level (1-4.x) for both valences (x.1 = negative, x.2 = neutral) (resulting in eight t-tests in total), to test how reaction times differed between blur states in different valences within a subject. The results of t-tests for reaction times are presented in table 2. Note that the result is significant in pairs 2 and 3, especially in pair 3. On these two blur levels valence affects the reaction time.

Table 2.

Results of T-tests for Differences in Reaction Times on All Blur Levels for Both Negative and Neutral Pictures.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Time 1.1 – Time 1.2	22.68	78.94	14.41	-6.79	52.16	1.57	29	.126
Pair 2	Time 2.1 – Time 2.2	25.53	68.09	12.43	.11	50.96	2.05	29	.049
Pair 3	Time 3.1 – Time 3.2	68.06	75.85	13.84	39.73	96.38	4.91	29	.000
Pair 4	Time 4.1 – Time 4.2	-55.33	156,79	28.62	-113.88	3.21	-1.93	29	.063

4. DISCUSSION

As expected, blur and picture valence affected the categorization process, leading e.g. to a greater number of negative categorizations towards negative images as the picture un-blurred. Contrary to our hypothesis, no group effect was found in the analyses, leading to a conclusion that the level of dysphoria didn't affect the categorization of visual stimuli as negative or neutral. A moderate group effect was observed between blur levels 1 and 2, which might reflect a schema-based projection towards a stimulus at a state of ambiguity. This difference is seen in figure 1 as a slight difference between groups in the number of negative evaluations given towards negative images. In total, however, the group effect remained statistically insignificant. It is also possible that the group effect result for blur levels 1 and 2 is partly due to one slightly deviant participant who had a tendency to favor negative categorizations in all situations. After excluding this person from the data, a repeated measures analysis yielded lower significances for group effect: the multivariate test table gave a value of $F(3,25)=3{,}321$, $p=.036$ (which is still significant, though) and tests of within subjects effects –table read with Greenhouse-Geisser correction $F(3,81)=2{,}145$, $p=.123$. In general, all participants regardless of their level of dysphoria seem to favor a neutral categorization, switching it to negative only when image clarity provides visible clues about the negative nature of image content. The result is contradictory in light of previous knowledge: the dysphoric didn't prefer a schema-congruent negative interpretation or get stuck on it. In our sample the dysphoric didn't exhibit a categorization strategy that would differ from the non-dysphorics'. Both groups seemed to be flexible about their evaluations, and to alter them based on visual valence clues.

Concerning reaction times, as seen in the t-test results (table 2), the greatest difference between reaction times for negative and neutral image was witnessed on blur level 3. This is manifested, as seen in figure 1, as a rise in reaction times while categorizing negative images on level 3. No group effect was found for dysphoria on reaction times; the same increase is present in both the dysphoric and the non-dysphoric group. The slight differences between the two groups – the non-dysphoric seem to be a bit slower at making a negative categorization, for example - observed in figures 2 and 3 are suggestive, but didn't prove statistically significant. This finding differs from what we might have expected on grounds of past research and theory on cognitive biases; in a dysphoric cognitive pattern things are deemed bad, harmful and generally negative very fast, without dwelling on alternative evaluations for too long. The negative categorization is also congruent with a dysphoric schema, which in theory could have contributed to a fast reaction toward negative images. This was not the case in our sample: the participants' performance speed didn't differ according to their level of dysphoria. It was the interaction of blur level and image valence that affected their reaction time. As expected, both groups were faster at their responses toward negative images than neutral ones. The general quickness at detecting negative stimuli and taking quick action in relation to it (here a button press) can be explained on grounds of natural evolution of human cognition (Flykt 2005; Öhman, Flykt & Esteves 2001).

In summary, the group effect wasn't statistically significant for either of the two variables; dysphoria didn't affect the reaction times nor the categorization choices. The conclusion is that dysphoria doesn't affect the categorization process and a negative interpretation bias for ambiguous visual stimuli was not found, which is a contradicting result in light of previous research and doesn't lend support for the cognitive models of depression (Beck 2008). However, since cognitive biases of depression have been shown to be most evident in chronic and severe cases (e.g. Armstrong & Olatunji 2012), it may be that our sample didn't meet the criteria. There have also been suggestions that examining cognitive biases in dysphoria with induced dysphoria might provide more results than the use of merely naturally dysphoric samples (Sears et al. 2011). Response latency methods have also failed to provide evidence for interpretation bias in depression in some other previous studies (Bisson & Sears 2007; Lawson & MacLeod 1999), and therefore other methodology should probably be considered in future research. Lawson, MacLeod and Hammond (2002) demonstrated for example that blink reflex is a sensitive indicator of negatively valenced imagery brought on by the individual's negative interpretation of an ambiguous stimulus. Their results suggest that in the research of interpretation biases, a blink reflex paradigm could be a strong assessment method (Gotlib & Joormann 2010). Self-report measures of the interpreted valence of the stimulus have also faced criticism, and it might be that the results about the dysphoric group's negative categorization tendencies (in our experiment seen only on blur levels 1 and 2) could also be explained by a reporting bias, not an interpretative bias (Lawson & MacLeod 1999; Mogg, Bradbury & Bradley 2006). To sum up, supplementing methods should be used alongside with the response quality and reaction time data to gain a more profound grasp of the phenomenon. The eye movement and pupil size data which were gathered at this same experiment will be applied to the results presented in this thesis for more results in other research papers in the future.

On the other hand, our experiment yielded a significant result in reaction times towards negative images on blur level 3. Both our groups exhibited a notable increase in reaction times on that same level, as seen in reaction time graphs and in table 2 (significance of differences in reaction times between two valences is extremely high on level 3). Something about that specific level of ambiguity hinders response-making about a negative stimulus more greatly than other levels. In their 1968 study Berlyne and Borsa found out, rather intriguingly, that the uncertainty an individual experiences while looking at stimuli is at its highest when the stimulus is fuzzed with ”an intermediate degree of blur”. This uncertainty factor is further enlightened by Berlyne and Borsa as a state where the almost-clarity of the picture evokes “perceptual curiosity” in a person, leaving him/her cognitively in a state where he or she is making hypotheses of what the stimulus might be and trying to decide an appropriate reaction to it. In their study Berlyne and Borsa could witness this state as arousal seen in the GSR (Galvanic Skin Response). This finding serves to demonstrate that ambiguous stimuli – such as the blurred pictures used in this study - pose a clear cognitive challenge for an individual, even causing arousal on a neural level. This provides one possible explanation for the sharp rise in reaction times in the intermediate level of blurring. At the most blurred level the picture might be too unclear to evoke the said perceptual curiosity and thus wouldn’t motivate a decision-making about it, and at its clearest there probably wouldn’t be much ambiguity for the cognition to solve, whereas in-between there just might be. From the results of e.g. De Cesarei and Codspoti, and Calvo and Nummenmaa (2011) we may also conclude that even blurred pictures cause the categorization process to begin, and therefore it's likely that blur level 3 is a stage where the individual needs to reassess his/her hypotheses and expectations about the stimulus. On most blurred levels a person may have been free to attribute and project his/her inner expectations on the image, but when new information arises, the cognition must take this into account. This reappraisal of whether what I see matches my schema could arguably cause cognitive effort and therefore a slowing in reaction, a reactive “freezing”. The situation might be compared to an evolution-psychological scenario where a human needs to make a correct approach-avoidance - decision about a blurry figure in a fog. This would also explain why a negative stimulus, high in its survival significance, would especially cause such cognitive strain.

The visual stimuli in our study pose some problems. We did not ask the subjects to rate the vividness/clarity of the picture (like De Cesarei & Codispoti 2008 did), meaning that we can't be sure to which extent the subjects actually viewed the stimuli as unclear or ambiguous. Although all of the pictures had undergone the same Photoshop manipulation, some of the pictures in our experiment had clearer visual elements than others even at the most blurred state. In subsequent inspection, some images in the stimulus set turned out to be pictures that all the participants deemed negative, beginning from blur level 1; e.g. a dark-hued picture of an angry, open-mouthed dog was one of them. The result is probably explained by the results of Calvo and Nummenmaa (2011) about the importance of visual clues in the mouth region in stimulus categorization processing: the dog didn't lose its visual saliency in the mouth area even at the most blurred level, which probably accounts for its unanimous unpleasantness. The open mouth of an angry dog lost its clarity and thus categorization clues definitely less drastically than that of an unidentifiable mass of food on a plate which could be categorized as rotten only at later stages of un-blurring. This is why checking for the actual loss of details in the picture set would have been important: some stimuli were less ambiguous than others, which might be one reason for not finding a difference in their categorization between groups. Controlling the perceived vividness of the picture would've let us know if the participants had enough visual clues to categorize the picture. For future reference, such methods could be used to produce a set of equally ambiguous stimuli. In general, the contents of our stimulus pictures were less controlled than in some other studies on the same subject: De Cesarei and Codispoti (2008) for example had chosen pictures only belonging to some clear content categories (opposite sex nudes, babies, animal attack, mutilation etc.) and made sure their brightness etc. were matched., and the analyses were also run on those categories (arousal, valence and vividness were checked for each of the categories, not just depending on neutral/negative scale) separately. As studies concerning the affective cognitive processes of anxious individuals have shown (MacLeod, Mathews & Tata 1986), the content of the stimulus causes very different effects depending on the content's relevance to the viewer's own worries, and since anxiety is highly comorbid with depression, a question arises whether the content of the test subjects' worries should be more severely taken into account also in cognitive depression studies, or if the results reflect their anxiety rather than depression. Cognitive biases for threat-relevant stimuli, for example, seem to exist in anxiety, but not in depression (MacLeod, Mathews & Tata 1986; Armstrong & Olatunji 2012), which complicates the interpretation of subjects' reactions towards threat-related pictures (attacking animals, guns etc.) and especially attributing the reactions to depression. A more careful selection of only certain types of threat- or dysphoria-related pictures could help researchers control the type of negativity used as a stimulus and thus get more detailed results on the subject. In addition, some of the stimulus pictures in our study reached noticeably different valence ratings even at their clearest stage, suggesting that some pictures could not be reliably categorised as neutral or negative to begin with – a problem which obviously compromises the evaluation of whether subjects made a “wrong” categorization induced by a negative bias when pressing a 'negative' button for a neutral image. Majority of the pictures had a consistent rating pattern in this experiment though, and therefore we may conclude that the problem doesn't compromise the results. Other researchers in the area of cognitive biases in depression (e.g. Sears et al. 2011) have also called for more detailed analysis for separate types of pictures, and future research is hoped to address the issue. The random order of the pictures in our trials may also have produced a priming effect in some cases; seeing a highly disturbing clear picture may have led the subject to interpret the following picture in a negative way too. This phenomenon has been speculated to explain some of the results in cognitive bias studies, at least in some cases of Stroop tests (Williams, Mathews & MacLeod 1996). The fact that previous research on interpretation of ambiguous visual stimuli in depression has focused on facial expressions (LeMoult et al. 2009; Liu et al. 2012) hinders the comparability of our results with them; our pictures contained also animals and objects. More studies employing other than facial stimuli are hopefully conducted in the future.

In conclusion: although this study failed to find evidence for an interpretative bias in dysphoria, the slight tendencies seen in our results might prove statistically significant and an effect for dysphoria might be found if the study was replicated with larger samples and with a more carefully constructed picture set. One of the strengths of our experiment was the sample that covered different ages and socio-economic backgrounds, which aids in generalizing our results. A phenomenon which gained new evidence in our study was the cognitive effort caused by uncertainty evoked by ambiguous, negative visual stimuli, which happens regardless of an emotional disorder. This adds to our knowledge about human cognition in general, replicating results in the area of ambiguous stimuli that has seldom been studied in recent times (e.g. Berlyne & Borsa 1968). The result also yields interesting future applications for the study of visual stimuli, in areas such as cognitive neuroscience and neuroaesthetics of visual art forms. The results might in part explain the popularity of employing visual ambiguity as a feature in some art forms and especially in the art styles described as grotesque; ambiguity with a hint of negativity seems to entice our cognitive resources in a way so effective that it stirs nervous activity and - as seen in our study – increases in reaction times.

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