Toward a Better Understanding of the Mechanisms Underlying Accurate Emotion Recognition

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Abstract

Several studies measured accuracy in recognizing other people's emotions. However, not much is known yet about the process underlying accurate emotion recognition. For instance, little is known about which information processing style is favorable for emotion recognition. More precisely, it might make a difference whether a person tries to form an overall, Gestalt-like image of a facial expression or whether he or she focuses on detailed information in a face when trying to recognize emotions. Factors such as the affective state of a person (e.g., whether he or she feels sad or happy) or gender might influence how information is processed and might affect the ability to recognize emotions. For instance, it has been suggested that mood states are related to information processing styles; happy mood is supposed to evoke a processing style that focuses on the whole Gestalt, whereas sad mood should trigger a processing style that focuses on detailed information (Schwarz & Bless, 1991). However, empirical data that confirms these suggestions for emotion recognition is still missing. Clarifying how different factors affect emotion recognition was the aim of my thesis. This is of interest, because recognizing emotions is part of everyday interpersonal interactions; moreover, it is crucial for the experience of positive social interactions. Study 1 examined the role of configural versus featural information in emotion recognition. Study 2 looked at how global and local eye movements were related to emotion recognition performance, and whether eye movements and accuracy were influenced by the perceiver's gender and mood. Study 3 again investigated the influence of the perceiver's mood on emotion recognition with a focus on mood-congruity effects. A further interest of Study 3 was whether the intensity of an emotional expression influences its recognition when the perceiver is in a happy versus sad mood. Study 4 aimed at inducing global and local information processing styles by a priming procedure. We explored whether the information processing priming affected performance on an emotion recognition task in a similar way as the performance on another nonverbal decoding accuracy task which was assessing a person's intentions. Further, we were interested in whether it is possible to reduce the well-documented female superiority in emotion recognition with the information processing priming. Finally, the effect of the information processing priming on global and local eye movements was investigated. Findings were then integrated and a new model of global and local processing for nonverbal decoding was proposed.

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Key words: Emotion recognition, information processing, mood, gender

Mots clés: Reconnaissance des émotions, élaboration des informations, humeu
genre

A) UMBRELLA

Introduction

My thesis focuses on how emotions can be recognized on the basis of changes in a person's facial expression. But what is an emotion? A lot of different definitions for emotions have been suggested. For instance, Keltner and Gross (1999) defined emotions broadly as "…episodic, relatively short-term, biologically-based patterns of perception, experience, physiology, action, and communication that occur in response to specific physical and social challenges and opportunities" (p.468). Based on an evolutionary approach emotions are often supposed to have adaptive functions; they allow a rapid attention shift towards threats or opportunities, which is important for survival and reproduction (Oatley, Keltner, & Jenkins, 2006). Moreover, emotions relate people to each other: Parental love attaches parents to their child, a loss might elicit sadness in one person which might in turn evoke feelings of pity in others and as a result new social bonds might establish. In general, one can say that life evokes emotions. That might be love for the partner, pride and joy after a successful exam, sadness after the loss of a significant other, or anger when being treated in an unfair way.

An emotional experience can become perceivable for others, for instance through facial expressions, changes in the voice, or gestures (e.g., Frijda, 1986; Grandjean, et al., 2005). When in the following I talk about emotion recognition accuracy, I am referring to the ability to correctly decode other people's emotions on the basis of their facial expression. Emotions are often only expressed for a short time on a face; typically between 1 and 10 seconds (Bachorowski & Owren, 2001). Nevertheless, people are generally quite good at recognizing other people's emotions (Ekman, 1982; Izard, 1971). Reasons for that might be that it is difficult to fully suppress an emotional expression as well as to express a non felt emotion and make it look authentic. This is because some muscle actions involved in facial emotional expressions are difficult to manipulate, say to voluntarily activate or deactivate (Kappas, Bherer, & Thériault, 2000). As a result, facial expressions might be quite reliable cues for emotion recognition.

Emotion recognition has important social functions. For instance, the accurate recognition of emotions is important for the experience of positive social interactions because it enables to react appropriately to other persons' emotions (e.g., Scherer, 1994). An employee might avoid asking his or her boss for a salary raise when he or she detects that the boss is in a bad mood. If a friend is sad because he or she has lost a family member, it would not be the right moment to fool around or to tease him or her. These examples illustrate that the ability to correctly recognize other people's emotions can lead to more agreeable interactions; moreover, it can prevent social faux-pas. A correlation study by Carton, Kessler, and Pape (1999) showed that high performance on emotion recognition is linked to better relationship well-being and to less feelings of depression. This further suggests that emotion recognition might play an important role in everyday life. Other people's emotions can also have effects on the perceiver. This can occur by evoking similar or complementary emotions in the perceiver which in turn results in better coordinated interactions (e.g., Keltner & Bonanno, 1997; Keltner & Kring, 1998; Knutson, 1996). For example, when two people interact and one person smiles, this can evoke a positive feeling in the interaction partner. As a consequence, the atmosphere between the two interaction partners might become more relaxed and harmonious.

Although emotion recognition is important for social life, relatively little is known about the mechanism underlying the correct recognition of emotions. The main goal of my thesis was to fill in this lack of research. Several sub goals have been defined. These are listed below:

- Identifying which facial information is important in order to recognize emotions accurately: We focused on configural versus featural as well as on global versus local information. (Studies 1, 2 and 4)
- Exploring gender effects on emotion recognition: Women typically outperform men on emotion recognition (McClure, 2000). Might women rely on more favorable information processing styles (global versus local) when recognizing emotions? (Study 2)
- Examining mood effects on emotion recognition: Are happy or sad people better at recognizing emotions? Are there mood-congruity effects? Do people in happy versus sad mood rely on different information processing styles (global versus local)? (Studies 2 and 3)
- Gaining information about how variations in the intensity of emotional expressions might influence emotion recognition accuracy and whether this depends on different mood conditions. (Study 3)

- Investigating whether people's information processing styles can be modulated by a priming procedure and whether this priming has consequences for emotion recognition accuracy. (Studies 4a and 4b)

- Testing whether the assessment of other people's intentions requires the same information processing style as the recognition of emotions. (Study 4a)

Emotion recognition involves not only a perceiver attempting to read another person's emotions but also a target person, who experiences an emotion and expresses it on his or her face. I will first provide some information about how emotions evolve and how they are experienced and expressed before concentrating on emotion recognition.

1. Emotion theories

Several theories have been proposed in order to categorize emotions and/or to explain how emotions evolve and how they are experienced and expressed. I will focus on some of the most common emotion theories: the categorical theories, the dimensional theories, and the appraisal theories. Note that I will illustrate only the basic and original ideas of these models in order to differentiate them among each other. Not all aspects of the theories will be discussed; the focus lies primarily on the contribution of those models to facial emotion recognition. Thus, detailed information and refinements of the models will not be provided.

1.1 Categorical theories

Categorical theories suggest that there is a limited number of basic emotions. Each basic emotion is assumed to have a biological basis and to share characteristics such as being discrete, innate, and universal. Basic emotions are supposed to be fundamental elements of the emotional life. They can be combined and as such they represent more complex emotional experiences. An example for such a complex emotional experiences would be the situation when the train is delayed and as a consequence one comes too late to an exam. This could elicit a complex negative feeling consisting of fear (because of the situation of the exam and the possibility of not to be accepted at the exam because of the delay) and of anger (because the late arrival at the exam was not one's own fault but a result of the delayed train).

Ekman (1972) originally proposed six basic emotions which were anger, disgust, fear, happiness, sadness, and surprise. However, there is a disagreement between categorical theorists regarding the amount of basic emotions. Oatley and Johnson-Laird (1996) pointed out that the concrete number of the proposed basic emotions is less important. Moreover, it is of significance that categorical theories agree when it comes to the definition of the characteristics of basic emotions. Note that although there is some disagreement, most categorical theorists include happiness, sadness, anger, and fear in their list of basic emotions (Ekman & Friesen, 1976; Izard, 1971; Oatley & Johnson-Laird, 1987; Plutchik, 1980). In categorical theories emotions are seen as specific response patterns elicited in highly prototypical situations. Each emotion is expressed in a specific way: More precisely, an innate neural program exists for every basic emotion and elicits specific motor response patterns. Emotions can therefore be recognized on the basis of the corresponding motor response patterns.

Most emotion recognition tests include emotional expressions of basic emotions. One of the most widely used stimulus sets is the Ekman and Friesen (1976) series containing Ekman's originally proposed six emotions: anger, disgust, fear, happiness, sadness, and surprise (see *Figure 1*). Other widely used stimulus sets are Izard's (1971) test of emotion recognition including Izard's defined basic emotions happiness, anger, surprise, disgust, shame, fear, sadness, and interest, and the Diagnostic Analysis of Nonverbal Accuracy 2 Adult Faces (DANVA 2-AF; S. J. Nowicki & M. P. Duke, 1994) containing four basic emotions (fear, anger, sadness, and happiness).

Figure 1. **Ekman and Friesen's (1976) pictures of facial affect expressing anger, disgust, fear, happiness, sadness, and surprise, from the left to the right.**

Besides the debate concerning the amount of basic emotions it is unclear whether basic emotions really activate a discrete motor program. Carroll and Russell (1997) for instance failed to find such discrete motor programs. These were reasons why it was put into question whether basic emotions really exist. Alternative emotion theories have been proposed such as the dimensional theories. These theories do not longer propose distinct basic emotions but a categorization of emotions in dimensions.

1.2 Dimensional theories

In the dimensional theories, emotions are no longer categorized in terms of a definition of discrete basic emotions, but emotions are placed in two-or more dimensions. Most often two dimensions are proposed; a valence dimension (e.g., misery versus pleasure) and an activation dimension (e.g., arousal versus sleepiness). See Russell's circumplex model (1980) in *Figure 2* as an example. The main assumption of dimensional models is that each emotion is defined by a specific degree or value on the dimensions.

The valence and the activation dimension are supposed to have an independent neurophysiological system. This assumption could be underpinned with empirical data: For instance, specific changes in the facial muscle activation as well as cardiovascular responses (e.g., heart rate) were related to the valence dimension (Lang, Bradley, & Cuthbert, 1997). The activation dimension could be represented in electrodermal responses such as skin conductance magnitude (Lang, Greenwald, Bradley, & Hamm, 1993).

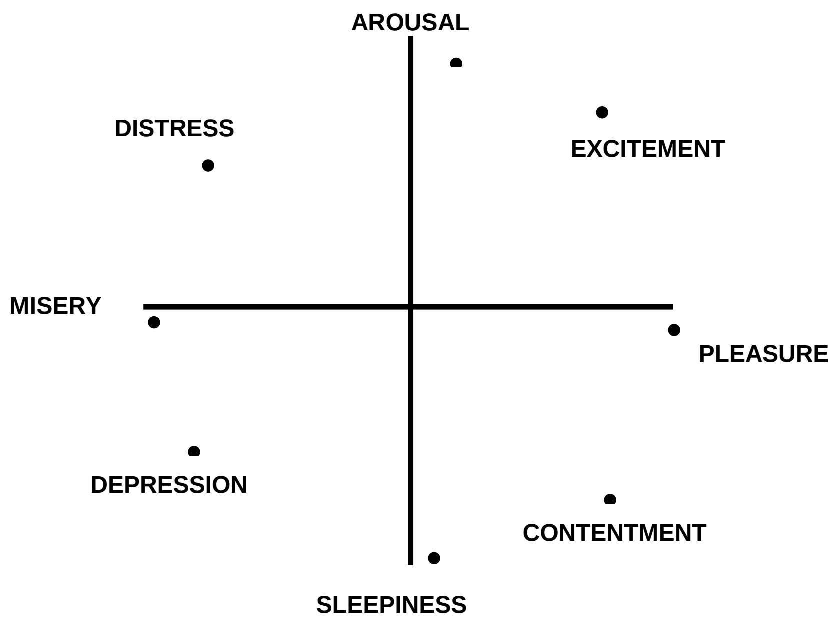

***Figure 2*. Russell's (1980) circumplex model (redrawn) containing two dimensions: the dimension of activation (arousal versus sleepiness) and the dimension of valence (misery versus pleasure).**

The focus of dimensional theories lies on the subjective experience of the emotions. It is assumed that people are able to classify their emotions within the two dimensions. Furthermore, people seem to be able to classify other people's emotions in the dimensional model. It has been argued that this is because the subjective experiences of emotions are highly intercorrelated between people (Russell & Carroll, 1999). One's own experiences with emotions might therefore be helpful to categorize other people's emotions. As a result, people are able to reliably recognize others' emotions (Russell & Bullock, 1986).

A debate among dimensional theorists was whether the structure of the model is simple or circumplex. A simple structure model would categorize emotions in four clusters: unpleasant/activated, pleasant/activated, unpleasant/deactivated, and pleasant/deactivated. A circumplex model suggests that variables (ratings of emotion terms) intercorrelate and that these relations are systematically arranged in a cycle. Dimensional models have been criticized because of their reliance on self-report data which implies that emotions are conscious and namable. Other theories such as appraisal theories propose models that also include automatic, often unconscious processes of emotions.

1.3 Appraisal theories

The appraisal approach takes into account that people can experience different emotions in the same situation because they might evaluate an event in a dissimilar way. For example, when a romantic relationship breaks, one person might feel rather disburdened, whereas another person might feel sad and hurt. A person's traits as well as situational factors influence how one experiences emotions.

One of the most influential appraisal model is Scherer's (1987, 2001) component process model of affective states. The component process model as well as other appraisal models (e.g., Frijda, 1986; Smith & Lazarus, 1993) posit that when a person feels an emotion, he or she feels a series of appraisals. An appraisal includes a number of evaluations (stimulus evaluation checks). According to Scherer (1987) stimulus evaluation checks are made on the basis of novelty (is a stimulus novel, predictable?), intrinsic pleasantness (positive or negative evaluation), goal significance (is it relevant to pursue my goal?), coping potential (can I deal with it?), and compatibility with social or personal standards (is it acceptable for me and others?). Note that the defined stimulus appraisal checks might differ between different appraisal models; however, novelty, pleasantness, and goal relevance are included in most theories. According to the component process model, stimulus evaluation checks are often automatic, unconscious, and occur sequentially. Despite the temporal sequence, they influence each other continuously - a later stimulus evaluation check might modify the state of an earlier stimulus evaluation check. Stimulus evaluation checks are just one component or subsystem of emotions, called the cognitive component. Four other components have been defined: the peripheral efference component (refers to physiological symptoms), the motivational component (refers to action tendencies), the motor expression component (e.g., facial expressions), and the subjective feeling component (e.g., the feeling of happiness). All components have specific functions and an underlying organismic subsystem. See Sander, Grandjean, and Scherer (2005) for a more detailed description of the components and their functions.

The motor expression component is important for my thesis. Motor expressions in the face communicate emotions and they are the information on which the perceiver can rely on when recognizing emotions. With each stimulus evaluation check a distinct change in muscle actions occurs. Appraisals and their evaluations have consequences for the other four components or subsystems; however, the other components might in turn affect stimulus evaluation checks by causing re-appraisals. This whole process evokes changes in the emotional expression. Scherer (1986, p. 148) described an emotional expression as "… the net results of the effects of the outcomes of preceding stimulus evaluation checks […] and the total effect of the changes in the other subsystems impinging on the somatic nervous system".

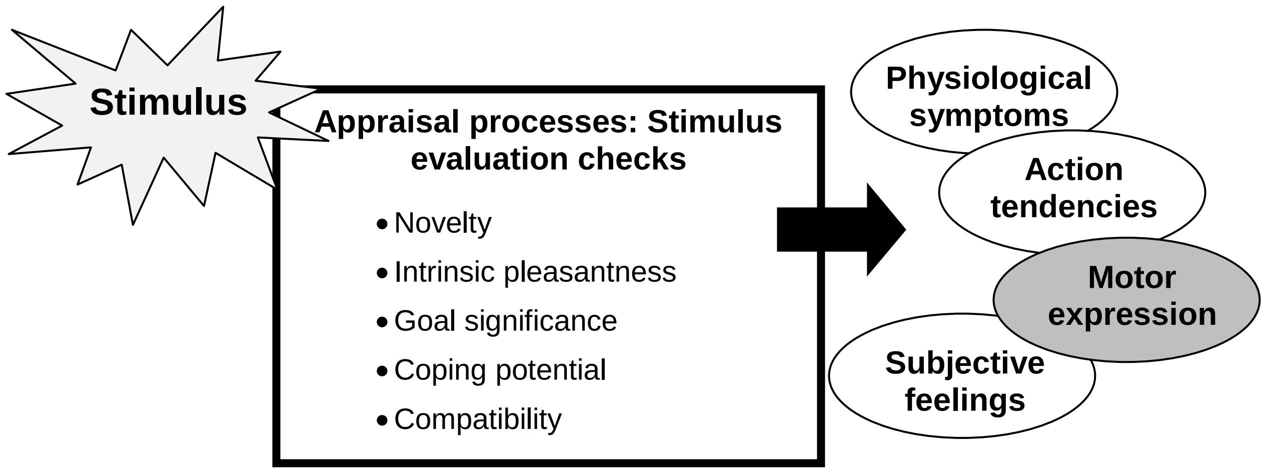

Figure 3. **A representation of some aspects of Scherer's (1986, 2001) appraisal theory. A stimulus evokes a series of stimulus evaluation checks. Each stimulus evaluation check has consequences on the other four emotion components (e.g., physiological symptoms, action tendencies, experienced feelings, and motor expressions). The latter can in turn lead to re-appraisals.**

Categorical theories and appraisal theories both explicitly suppose that emotions often result in emotional expressions in the face. Whereas categorical theories posit that the appearance of these emotional expressions is innate, appraisal theories postulate that they are the result of the stimulus evaluation checks. Assuming that emotions can be recognized on the basis of specific patterns of muscular actions in a face, Ekman and Friesen (1978) developed the Facial Action Coding System (FACS). The authors first defined action units (AU) that refer to the smallest visible muscular actions in the face. In the FACS specific patterns of AU that underlie emotions are defined, which allows to code facial expressions. Buck (1984) and Frijda (1986) also confirmed that there is a direct link between facial expressions of emotions and the emotional state experienced by the sender. This direct link is obviously crucial for the correct recognition of emotions in faces. The following sections will now focus more specifically on the facial emotion recognition and will start with an overview over some emotion recognition theories.

2. Emotion recognition

The ability to correctly recognize other people's emotions is highly relevant for social functioning (e.g., Carton, et al., 1999; Keltner & Kring, 1998). Darwin (1965) even suggested that this ability is hereditary. However, little is known about the cognitive processes underlying emotion recognition. Some models have been developed in order to describe how emotions are recognized in others. Moreover, face identity recognition has been found to share some (but not all) processes with emotion recognition (e.g., Haxby, Hoffman, & Gobbini, 2000). The following sections will deal with some emotion recognition theories, reveal common processes in face and emotion recognition, and accentuate some factors that might influence emotion recognition accuracy and information processing during emotion recognition tasks. The studies of my thesis will be embedded in these sections.

2.1. Emotion recognition theories

Several authors developed models to describe the process of emotion recognition; some models originate in other domains but have been adapted to emotion recognition. Four models will be presented in the next sections. I will first introduce a neural model of emotion recognition (Adolphs, 2002). This model is of importance for the understanding of neuroimaging studies that will be cited later on. Then, the Brunswikian lens model (Brunswik, 1956) will be explained, a model that has initially been developed in order to describe the perception of the physical environment and which is nowadays often used to describe the process of social perception (e.g., F. J. Bernieri & Gillis, 2001; Gifford, 1994; Schmid Mast, Murphy, & Hall, 2006). Finally, I will introduce the fuzzy logical model of perception (FLMP; Massaro & Cohen, 1990, 1993), and the configural model (Calder, Young, Keane, & Dean, 2000). The former is a model that was proposed to describe the processing of cues and was applied to speech perception and emotion recognition. The latter focus on cognitive processing during face identity recognition and was then adapted to emotion recognition. I will come back to the Brunswikian lens model, the FLMP, and configural model in the discussion section.

2.1.1 Neural basis of emotion recognition

My thesis will not investigate brain activation during emotion recognition. However, one of the goals was to examine information processing during emotion recognition, and brain data provide information about how emotions are processed. For instance, brain studies gave evidence that not all emotional expressions are processed in the same way and that women and men might process information differently during emotion recognition. Both issues will be treated in two of my thesis' studies (Study 1 and 2). I will therefore give a brief overview over the most important brain areas involved in emotion recognition.

Adolphs (2002) reviewed several studies on emotion recognition investigating brain lesions, as well as studies using functional imaging or event-related brain potentials. On the basis of this review, he postulated a neural system for emotion recognition. Adolphs posited that the most important brain areas for emotion recognition are the occipitotemporal cortices, the amygdala, the orbifrontal cortex, and the right frontoparietal cortices.

- **The occipitotemporal cortices (OTC)** are involved in the processing of visual information per se. The **superior temporal gyrus (STG)** has been identified to be highly sensible to changeable aspects of features in a face (e.g., when a relaxed, neutral mouth changes into a smiling mouth) and therefore plays a crucial role in the recognition of emotions.

- The **amygdala (A)** is important for the processing of threat and danger. The amygdala is consequentially involved in the recognition of fear, and to lesser extent also in the recognition of other negative emotions such as anger, disgust, and sadness. The amygdala also responds to the intensity of expressed negative and positive emotions (Morris, et al., 1998). Sander, Grandjean, and Scherer (2005) described that the amygdala might be involved in a more unconscious and automatic processing of some emotions.

- **The orbitofrontal cortex (OFC)** is involved in the recognition of various emotions. There is evidence that it plays a particularly pronounced role in anger recognition. Furthermore, the orbitofrontal cortex seems to play a critical role when emotions have to be explicitly identified.
- The importance of the **somatosensory related cortices (SSC)** in emotion recognition has often been examined in lesion studies. Especially right frontoparietal cortices have been found to affect the recognition of all emotions. This is probably due to an emotional response that evokes in the observer when he or she perceives another person's emotional expression. This results in a mirrored activation in somatosensory cortices. In other words, the observed emotion is simulated which in turn helps to recognize the emotion.
- Lesion studies as well as studies including patients suffering from mental diseases (e.g., obsessive-compulsive disorder, Parkinson, and Hunington's disease) revealed the importance of the **insula (INS)** and the **basal ganglia (BG)** in the recognition of disgust.

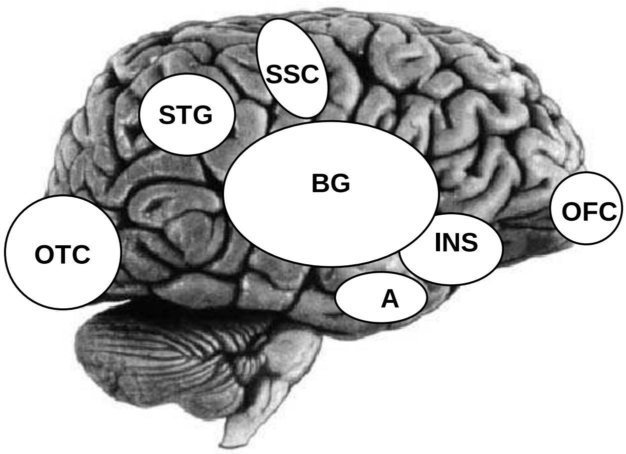

Figure 4. **Brain areas involved in emotion recognition. A, amygdala; BG, basal ganglia; INS, insula; OFC, orbitofrontal cortex; OTC, occipitotemporal cortex; SSC, somatosensory cortex; and STG, superior temporal gyrus**

Note that the previously mentioned brain regions are involved in many other cognitive functions, too. Activations in these brain areas do not only depend on the facial expression of emotions: Functional neuroimaging data provided support for the assumption that the intensity of an emotion (whether it is high or low) is processed by specific brain areas (e.g., the amygdala; Morris, et al., 1998). The intensity of emotional expressions will be a theme of the Study 3 of this thesis.

2.1.2 Brunswik's lens model

Brunswik (1956) developed his lens model in order to describe how a person (referred to as subject) can respond and react to a stimulus (referred to as object) which is not in direct contact with him or her. The model is called lens model because the perceiver sees the reality through the lens of his or her beliefs and preconceptions. The model assumes that the subject only has access to a restricted amount of cues and that these cues do not always provide direct and clear information. Not all cues are ecologically valid and therefore trustworthy. The subject must accumulate and combine cues in order to better understand the information provided by the object.

Figure 5 shows the Brunswikian lens model applied to the process of facial emotion recognition. A target person (object) feels a specific emotion which is his or her true emotion. This true emotion can be expressed in the face through a specific pattern of muscular tensions. The relation between a target person's true emotion and his or her expressed emotion is called the encoding process. When the perceiver (subject) observes the target's emotional expression, he or she is engaged in the decoding process. The decoding process refers to the relation between the target person's expressed emotion and the perceiver's observed cues. However, the target person's expressed cues might not be clear: A smiling mouth (activation of the zygomatic major muscle, AU 12) can be a cue for a happy emotion, but people also smile in order to be polite in a social interaction without feeling happiness. This potential ambiguity in the target person's expression makes emotion recognition more difficult for the perceiver. The perceiver must accumulate other cues in order to form an accurate judgment of the target person's emotion. One possibility is that the perceiver could further take the activations of the orbicularis muscles (AU 6 +7) into account, muscles that show a real-smile specific emotional expression with raised cheeks and tighten eye lids. Those two muscles are mostly not activated during faked smiles (Duchenne, 1990). Thus, a perceived expression can, but does not necessary, correspond to the true emotion felt by the target (with the consequence of an accurate versus inaccurate perception). Another possibility would be to consider additional cues such as situational information, in order to assess another person's true emotion. For example, in a job interview situation in which the applicant is evaluated by the recruiter it might be quite common that the applicant displays a polite smile that does not express happiness but has other social functions such as marking interest. Because the theme of my thesis lies on facial emotion recognition I will not further address additional sources of information (such as situational factors) that might affect emotion recognition accuracy.

The lens model emphasizes that the accuracy of the perceived emotion depends on both the perceiver and the target person. On the one hand, accurate judgments depend on the ecological validity of the target person's facial expression (e.g., faking a smile or true smile). On the other hand, emotion recognition accuracy is influenced by the perceiver, more precisely, on the nature and the amount of the cues that the perceiver accumulates, as well as on his or her interpretation of these cues.

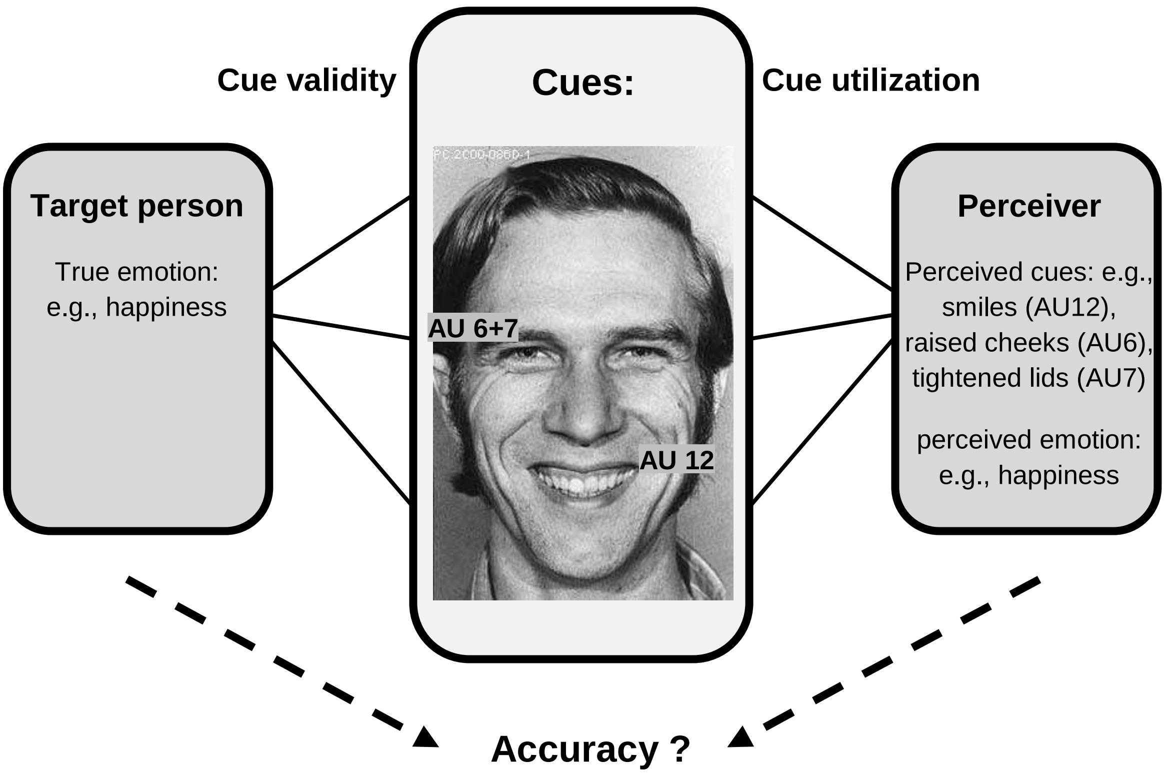

***Figure 5*. The Brunswik (1956) lens model applied to the recognition of facial expressions of emotions. A target person feels an emotion, her true emotion. This emotion is expressed on the face which results in a specific pattern of muscular tensions. Those cues can be valid or invalid regarding the true emotion. The perceiver uses some of those cues, interprets them, and perceives an emotion. This perceived emotion can be accurate or not.**

2.1.3 The fuzzy logical model of perception (FLMP)

The fuzzy logical model of perception (FLMP; Massaro & Cohen, 1990, 1993) is a framework that has been adapted to various types of perception such as speech perception (Massaro & Cohen, 1990), and emotion recognition (Ellison & Massaro, 1997). The central idea of this model is that features are first processed independently and are then integrated in a later step. Features in a face are for example the eyes, the nose, and the mouth (Leder & Bruce, 2000b). Massaro and Cohen postulated three stages between a stimulus event and a response. First, a perceiver evaluates the emotional expression of a target person on the basis of multiple sources such as facial features. Each source is evaluated independently of the other sources. In a second step, the information gained from each source will be compared to a prototype of emotion, in order to evaluate the degree of accordance (e.g., does the target person's emotional expression concord with my prototype of a happy face?). The third step is the decision process in which the perceiver integrates the information in order to determine how representative the target person's expression for a specific emotion category is. The perceiver decides whether the target person expressed a specific emotion or not. The FLMP strongly emphasizes the role of featural information in emotion recognition; but according to the model featural information is integrated during the third stage.

2.1.4 The configural model

The configural model was developed when researchers examined how featural versus configural information influenced face identity recognition. Carey and Diamond (1977) defined configural information as the interrelationship between different facial features: There are first-order relational properties that help to identify a shape as a face. These first-order relations refer to the properties that are shared by all regular human faces (two eyes above a nose above a mouth). Second-order relational properties (also named configural features) refer to the interrelationships between different feature positions, for example how far apart are two eyes. Second-order relations help to distinguish between different faces. In the domain of face identity recognition, the role of configural information is emphasized, but researchers admit that features can to some extent also contribute to face identity recognition. Calder, Young, Keane, and Dean (2000) referred to this view as the configural model. There is evidence that the configural model also holds for the recognition of emotions. This will be discussed later (see sections 2.2.1 and 2.2.2).

The holistic model by Tanaka and Farah (1993) represents a more extreme position compared to the configural model. Tanaka and Farah distinguish between holistic or featural processing and stress the importance of holistic processing in face perception. Holistic processing is characterized by a perception of the whole face. Faces are coded as a whole "Gestalt" and features such as eyes, nose and mouth are not explicitly represented (Tanaka & Farah, 1993) or at least to a lesser degree than in non-holistic processing (Farah, Tanaka, & Drain, 1995). Empirical evidence for the configural model was often seen as empirical evidence for the holistic model. This is because configural and holistic information are often confounded - disrupting the configural information in a face also disrupts its holistic information.

2.2 Shared and distinct processes in the recognition of facial identity and emotion

The cognitive processes underlying face identity recognition are much more examined than the cognitive processes involved in emotion recognition. Facial information is processed in both, face identity recognition and emotion recognition. The question arises whether one can learn from previous research on face identity recognition in order to understand cognitive processes in emotion recognition. There is evidence that some processes but not all are shared. I will first focus on experimental paradigms (the composite paradigm and the face inversion effect) which were used to examine both types of recognition and which revealed that the configural model might hold for face identity and for emotion recognition. Then, I will introduce studies showing that not all processes are similar in face identity and emotion recognition.

2.2.1 The composite paradigm

Young, Hellawell, and Hay (1987a) used the composite paradigm to examine the role of configural or holistic information in face perception. In this task, faces were cut in two halves across the horizontal midline of the face. In the composite condition, two different face parts (an upper half from one person, and a lower half from another person) were aligned and a new face was created. This new face formed novel configurations which did not represent the configural information for either the top or bottom facial identity. In the non composite condition, misaligned faces were created in which the upper and a lower face part were horizontally shifted away from each other. Because faces were misaligned, there were no novel configurations in the non composite condition. The task was to recognize target faces on the basis of the lower (respectively the upper) part of the aligned and misaligned faces; the other half should be ignored. Both, upper and lower parts of the faces were easier recognized in the misaligned, non composite condition compared to the composite condition. Participants could therefore not fully ignore the configural or holistic information in the aligned faces although they were instructed to pay attention solely on either the upper or the lower part of the face.

The same effect was found for an emotion recognition task: Calder, Young, Keane, and Dean (2000) also used the composite paradigm and showed that emotions were better recognized in the misaligned, non composite condition than in an aligned, composite condition. Similar to the finding for face identity recognition, configural information could not be completely brushed aside during emotion recognition. Calder et al. examined in their Study 4 whether configural processing during facial identity and emotion recognition can be selectively disrupted. They prepared composite faces containing pictures of one person expressing different emotions (combination 1), different people expressing the same emotion (combination 2), and different people expressing different emotions (combination 3). When participants were asked to recognize the facial identity of the lower part of the face, they were faster in recognizing combinations that contained the same emotional expression in the upper and lower part of the face (combination 2) compared to faces in which upper and lower parts differed in their emotional expressions as in combinations 1 or 3. When participants were instructed to recognize the emotions in the faces, participants were faster if the facial identity was the same in the two parts of the face (combination 1) compared to the conditions in which the facial identity differed in the two parts of the face (combinations 2 or 3). Calder et al. concluded that people can "selectively attend to different types of configural information; one relating to the representation of facial identity the other to the representation of facial expression" (p. 545). Furthermore they stated that configural information is important for facial identity and for emotion recognition, but the type of the used configural information might be different between the two.

2.2.2 Face inversion effect

The effect of face inversion on face recognition has been extensively investigated (e.g., Diamond & Carey, 1986; Leder & Bruce, 2000b; Scapinello & Yarmey, 1970; Yin, 1969). Inverted faces contain the same configural properties as upright presented faces and inverted and upright presented faces do not differ in complexity, brightness and contrast. Ellis (1986) pointed out that inversion disrupts our usual view of faces and objects, because in everyday life we perceive faces in an upright position and not inverted. However, it was found that inversion hindered face recognition disproportionately stronger compared to object (e.g., house) inversion (e.g., Yin, 1969). Therefore not only the regular view of the stimulus is disrupted in face inversion. Farah et al. (1995) argued that the holistic image of the face is hampered as well. Empirical evidence for that comes from Young et al. (1987a) who showed that composite and non composite faces were identified equally well and equally fast when presented inverted. Remember that in the upright presented condition the non composite faces were more easily recognized. The authors conclude that face inversion hampered the configural or holistic information in the face.

Less research has been done on the recognition of emotions in inverted faces. There is some evidence that face inversion affects different emotional expressions in a dissimilar way. For example, McKelvie (1995) showed that happy facial expressions were not affected by inversion, but others were (sad, fearful, angry, disgusted and surprised emotions). Prkachin (2003b) reported that face inversion generally hampers emotion recognition. But, emotions that were already more difficult to recognize in the upright position (anger, disgust, fear) were even more affected by face inversion than emotions that were recognized more easily (happiness, sadness, surprise). All in all, there is some evidence that configural information is important to recognize both, face identity and emotions. Nevertheless, as is evident from the following section, some processes during facial identity and emotion recognition differ.

2.2.3 Distinct face identity and emotion recognition processes

Evidence for different processing systems for face identity versus emotion recognition comes for instance from studies on patients suffering from prosopagnosia. Prosopagnostic patients usually have bilateral damage in visual association cortices and/or in the higher-order and limbic system structures (Damasio, Damasio, & Van Hoesen, 1982) and suffer from an impaired ability to recognize faces. Tranel, Damasio, and Damasio (1988) tested the face and emotion recognition ability of four prosopagnostic patients. Face recognition was severely impaired; however, three out of four patients were still able to recognize emotions. So, face identity and emotion recognition can be impaired selectively which suggests that face identity and emotion recognition are distinct processes.

Haxby, Hoffman, and Gobbini (2000) argue that the representation for face identity must differ from the representation of an emotional expression in order to still be able to recognize a face when its emotional expression changes. They defined a hierarchical model for face perception. The model contains a core system and an extended system. The core system is responsible for the visual analysis of a face whereas the extended system is also involved in other neural systems for other cognitive functions. The core system involves bilateral occipitotemporal regions in the extrastriate visual cortex, more precisely the inferior occipital gyri, the lateral fusiform gyrus, and the superior temporal sulcus. These core system regions differ from each other in their involvement during face and emotion recognition. Invariant aspects of a face that are crucial for face recognition are mediated by the fusiform gyrus whereas changeable aspects of a face that are important for emotion recognition are mediated by the superior temporal sulcus. This is also in line with the finding from Vuilleumier, Armony, Driver, and Dolan (2003).

To sum up, although the processes during face identity recognition are not completely similar one can take profit from face identity research for the examination of emotion recognition processes. One could for instance adopt the experimental paradigms used in face identity recognition research to further investigate the role of configural and featural information in emotion recognition. There are already some indications from studies using face inversion or the composite paradigm that configural information might also play an important role in emotion recognition. Those studies do, however, not provide information about the role of featural information in emotion recognition. The contribution of featural information remains unclear. This is why we conducted Study 1 with the aim to clarify the relative contribution of configural and featural information in the correct recognition of emotions.

Study 1: Emotion recognition: The role of featural and configural processing of facial information

In Study 1 (see section B), we chose methods that have been previously used to examine featural and configural processing in face perception. We used face inversion (e.g., Leder & Bruce, 2000b; Yin, 1969), in combination with blurred and scrambled faces (Collishaw & Hole, 2000; Lobmaier & Mast, 2008). When blurring faces, featural information is disrupted but the configural information is still available. Scrambling faces results in discarded configural information, but the features are still visible. Because there is evidence from McKelvie (1995) and Prkachin (2003b) that configural information is more important for the recognition of some emotions than for others, we explored the effects of blurring, scrambling, and inverting for the different emotions separately.

In order to test emotion recognition accuracy, we used the Diagnostic Analysis of Nonverbal Accuracy 2 – Adult Faces (DANVA 2-AF; S. J. Nowicki & M. P. Duke, 1994), a set of 24 face stimuli containing four emotional expressions which were anger, fear, sadness, and happiness. We discarded task-irrelevant information such as the ears, the hair, and clothes, and presented the face in an oval shape. A same-different pre-test was done in order to match blurred and scrambled stimuli with regards to difficulty. We asked participants to indicate whether the person on a target (intact face) was the same on the following presented blurred or scrambled face. Blurring radius was then adapted until there was no difference in the same-different task between scrambled and blurred faces.

In the proper experiment the task was to recognize the emotions in the DANVA 2-AF. Each DANVA 2-AF face was presented six times, intact (containing both, configural and featural information), blurred (featural information was disrupted, configural information was still available), scrambled (configural information was discarded, the features were still visible) and all conditions were presented upright and inverted way. See *Figure 6* for an example.

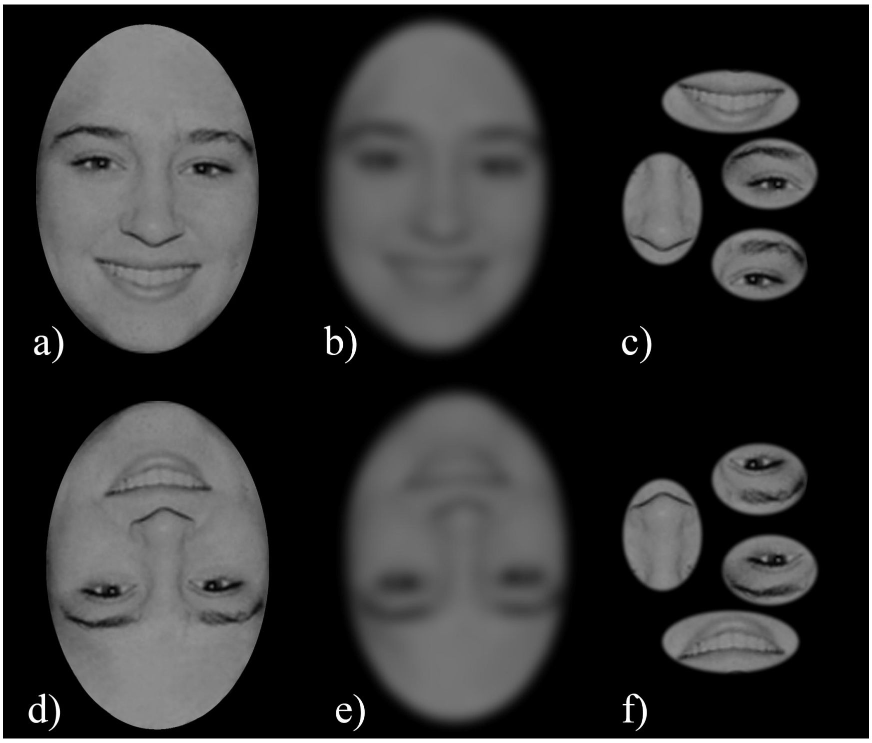

***Figure 6.* The manipulated DANVA 2-AF stimuli: a) intact/upright, containing configural and featural information, b) blurred/upright, hampered featural and permitted configural information, c) scrambled/upright, disrupted configural and permitted featural information, d) intact/inverted, hindered configural, e) blurred/inverted, featural as well as configural information is hindered, and f) scrambled/inverted, configural information is hindered.**

Results showed that emotions were recognized above chance in all six conditions. Happy and fearful emotions were better recognized than angry and sad emotions. When looking at the effects of blurring and scrambling, we found that blurred and scrambled faces were recognized equally well, but the recognition of both was worse than the recognition of intact faces. We looked at each upright presented emotional expression separately to explore whether scrambling or blurring affected their recognition differentially: Overall, happy and fearful faces were better recognized than angry or sad faces. Happy faces were recognized equally well in all conditions (intact, blurred, and scrambled). Angry and fearful faces were recognized more reliably when presented intact compared to the scrambled or blurred conditions. No differences were found between the recognition of blurred and scrambled faces for these two emotions. Sad emotions were recognized equally well when presented intact or blurred; however, scrambling hurt recognition of sadness. See *Figure 7* for the emotion recognition accuracy of happy, sad, angry, and fearful emotions in intact, blurred, and scrambled faces.

Reaction times revealed that participants reacted more slowly when they had to recognize emotions in scrambled faces compared to blurred and intact faces. Blurred and intact faces were recognized equally fast. Participants recognized happy emotions faster than sad emotions, fearful and angry faces were in between (no significant effects between the latter two emotions and happy or sad emotions).

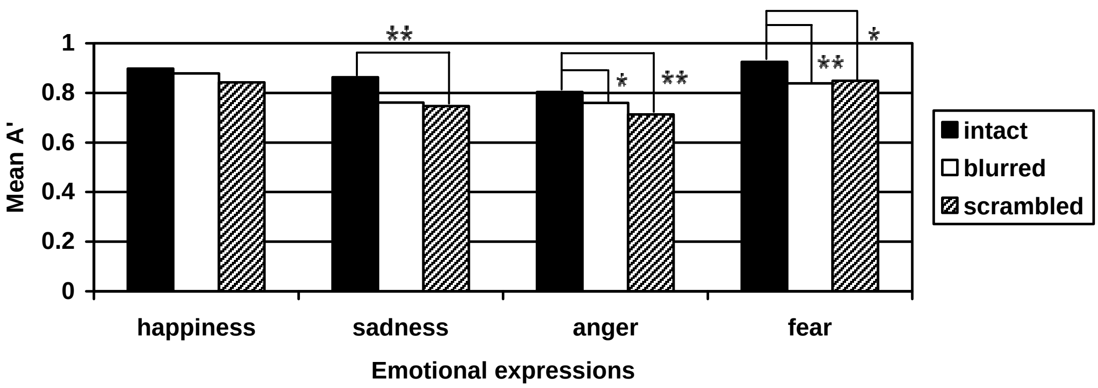

Figure 7. **Mean A' for the recognition of upright presented happy, sad, angry, and fearful emotions in intact, blurred, and scrambled faces. Mean A' is a measure of disciminability. Values vary between 0 to 1; a value of 0.5 indicates that accuracy is at chance level. A' was calculated with the formula suggested by Snodgrass, Levy-Berger, and Haydon (1985): A' = 1/2 + [(pHit -pFA)*(1+pHit-pFA)]/[4pHit*(1-pFA)].**

Face inversion also affected emotion recognition accuracy: Overall, upright faces were better recognized than inverted faces. However, looking at the four emotions separately reveals that face inversion only hindered the recognition of happy, sad, and angry emotions. It had no significant effect on the recognition of fear. See *Figure 8* for an overview over the face inversion effects. As to reaction times, we found that participants were generally faster when recognizing emotions in upright compared to inverted faces.

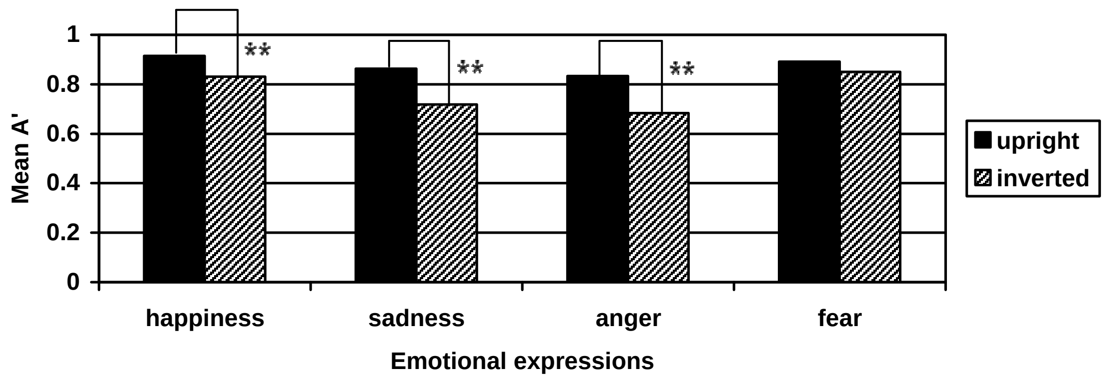

Figure 8. **Mean A' for the recognition of happiness, sadness, anger, and fear in upright and inverted presented faces.**

To sum up, we found that blurring, scrambling and face inversion differentially affected the recognition of the four emotions (happiness, sadness, anger, and fear). We have several indicators that emphasize the role of configural information in emotion recognition. For instance, the slower reaction times for scrambled faces indicate that emotion recognition becomes more difficult when configural information is missing. Moreover, inversion affected the recognition of most of the emotions (happiness, sadness, anger, but not fear), which is as well an indicator that configural information is important for emotion recognition. The fact that blurred faces (reduced featural information, configural information is still available) were recognized less accurately than intact faces can be taken as evidence that featural information contributes to the correct recognition of emotions as well. Furthermore, emotions were recognized at above chance level in all conditions, including those in which configural information was disrupted. Note that inverted blurred faces (in which configural information was disrupted through face inversion and featural information through blurring) were still recognized at above chance level. This suggests that there was still a remain of configural and/or featural information in the blurred inverted faces, and that emotions can be reliably recognized when only little information is available. In line with the configural model we conclude that, both types of information, configural and featural contribute to emotion recognition accuracy, with configural information playing a predominant role.

The starting point of Study 1 was previous research on face identity recognition and studies applying methods used in the face identity recognition field to emotion recognition research. In line with the field, we focused on the role of configural versus featural information in order to clarify their contribution to the correct recognition of emotions. Other terms have been used in other domains to describe similar or related types of information. One of these distinctions is global versus local information (e.g., Navon, 1977). These terms are used in the following studies. Global processing is characterized by forming a Gestalt-like, overall impression, whereas in local processing the focus lies on detailed information. Featural and local processing are related, because both focus on information that lies in the face features (e.g., eyes, nose, and mouth). Configural and global processing are linked as well as they share the underlying idea that it is important how features are interrelated. Moreover, global processing includes some aspect of the holistic perspective: Global and holistic information refer to a Gestalt-like representation of a stimulus.

Hence, Studies 2 to 4 focused on the relation between global and local information processing and on emotion recognition accuracy. Additionally, they were conducted in order to investigate how other factors such as mood, gender, and the intensity of an emotional expression influence how information is processed and how well emotions can be recognized. The following sections give an overview over existing literature that addressed these questions.

2.3 Factors that affect the processing of facial emotions

Several factors might influence emotion recognition accuracy. Some of them are gender, age, general intelligence, mood states, or task-specific attention (Chepenik, Cornew, & Farah, 2007; Herba & Phillips, 2004; Moore, 2001). Although we know that those factors play a role in the recognition of emotions, little is known about how they do so. A possibility is that different people rely on different information when recognizing emotions. Even people's internal states may influence the choice of cues that are taken into consideration. Different information processing styles might in turn have an impact on the performance in emotion recognition tasks. Study 2 of my thesis has been conducted in order to ascertain how two factors - the perceiver's mood and gender - affect information processing during the recognition of emotions. Before introducing Study 2, previous research on the effects of mood and gender on the decoding of emotions will be reviewed.

2.3.1 Mood

Just like emotions, moods are affective states. However, they can be distinguished from each other, at least to a certain extent. Compared to emotions, moods are supposed to last longer and they are less connected to specific stimuli and elicitors than emotions (Watson, 2000). The following paragraphs focus on mood effects on information processing and emotion recognition. In some of the cited studies participants' affective states were manipulated. The manipulation of affective states was either done by inducing mood or by eliciting emotions in the participants. Often it is not completely transparent whether the mood or the emotional state was manipulated. Hence, I will consistently use the term "mood" for both types of affective state manipulations.

Mood-congruity theories

Mood-congruity theories postulate that a person's mood biases his or her perception and interpretation of emotional cues in a specific way: Happy mood evokes a positive bias, for example recall of positive information is boosted or people and situations are judged more positively. Sad mood leads to a negative bias which goes with an increased recall for negative information and with more negative judgments about the environment. Several theories have been developed to explain those mood-congruity effects.

Bower's network theory of affect (Bower, 1981) suggests that mood serves as an affective priming. A person's mood is described as an affective node that is connected with other nodes reflecting the same emotional valence. In the case of a negative mood, connected nodes could be the feeling of loneliness or depression, low self-esteem, etc. When a person is in a sad mood, the connected nodes will be activated (and therefore a whole network of negative concepts is active) and as a result mood-congruent concepts will be more easily accessible. Mood-incongruent information (in this case positive information) will be less available.

Schwarz and Clore (1996) and Schwarz (1990) posit another model to explain mood-congruity effects, the affect-as-information theory. According to this theory mood is consciously accessible information about ongoing, unconscious appraisals. Mood-congruity is explained in the way that mood is used as information in order to make social judgments. As such, mood can lead to mood-congruent judgments when a person inadvertently attributes his or her mood state to people or situations. For instance, after a sad film, a person might judge an interaction partner more negatively because he or she misattributed his or her negative mood to the interaction partner instead of to the sad film.

Mood-congruity effects have most often been examined with regard to learning and memory (see Matt, Vásquez, & Campbell, 1992 for a meta-analysis). There is evidence that these effects also emerge when judging other people. Concerning emotion recognition, mood-congruity theories would predict that a person in a happy mood should be better in recognizing happy compared to sad emotions (positive bias). In contrast, a person in a sad mood should be relatively better in the recognition of sad compared to happy emotions (negative bias).

Empirical evidence for mood-congruity effects in emotion recognition comes from Bouhuys, Bloem, and Groothuis (1995) who showed that sad participants perceived more rejection and sadness in ambiguous schematic faces and less invitation and happiness in unambiguous faces compared to happy participants. Ambiguous schematic faces contained a combination of features of different emotional expressions such as a smiling mouth (representing a cue for happiness) and eyebrows forming a tent (which is a cue for sadness). Unambiguous faces expressed a preponderate amount of either positive or negative emotions. More indications for mood-congruity effects in emotion recognition come from Niedenthal, Halberstadt, Margolin, and Innes-Ker (2000) who induced participants with happy, sad, or neutral mood. Participants were then exposed to faces expressing an emotion (happy or sad). In a morphing procedure, the emotional expressions were gradually changed into a neutral expression. The participants' task was to stop the ongoing morphing process (by manipulating a sliding bar) as soon as they lost the perception of the initially expressed emotion in the face. In happy mood, participants stopped the morphing later for happy compared to sad expressions. The opposite effect was found for participants in sad mood. They perceived the sad expression longer than the happy one. Hence, participants in happy mood perceived relatively more happiness than sadness in faces, whereas participants in sad mood saw more sadness than happiness. Note that the control group in neutral mood stopped the sliding bar at around the same time for happy and sad expressions. These studies provide some evidence that mood-congruity effects can occur in emotion recognition.

However, only few studies examined mood effects on emotion recognition, and the results are not consistent. Whereas the Bouhuys et al. (1995) and the Niedenthal et al. (2000)

studies provide evidence for mood-congruity effects, others found evidence for detrimental effects of sad mood on the recognition of all, not only mood-incongruent emotions. Chepenik, Cornew, and Farah (2007) induced participants with sad mood and compared their emotion recognition accuracy with a control group in neutral mood. Sad participants did not show a negative bias as mood-congruity theories would predict, instead their emotion recognition accuracy was generally decreased. The same inconsistent findings have been reported for clinically depressed patients (who experience sad mood) with regard to emotion recognition. Some studies reported negative biases (e.g., Gur, et al., 1992; Hale, 1998), others found results in line with the assumption that depressive mood leads to a general emotion recognition decrement (e.g., Surguladze, et al., 2004; Zuroff & Colussy, 1986). The effects of depression on emotion recognition are much better examined compared to the effects of mood. Depressed patients have other symptoms in addition to sad mood. For instance, it has been demonstrated that individuals with depression were impaired in the discrimination of visuospatial cues (Asthana, Mandal, Khurana, & Haque-Nizamie, 1998). Comparisons between depressed patients and people experiencing sad mood should therefore be done with caution.

Sad mood decreases emotion recognition

Overall, emotion recognition deficits in sad or depressed mood were most often explained with the idea that mood affects information processing. The theoretical background for such an explanation might come from dual-process models illustrating how different processing strategies affect social judgments. I will now describe such a dual-process model, the elaboration likelihood model (ELM; Petty & Cacioppo, 1986; Petty & Wegener, 1999). The ELM was originally developed in order to understand information processing during the proceeding of persuasion and attitude change. People change their attitudes when they receive new persuasive information. Whether information is persuasive or not depends not only on the information itself, but also on how elaborately this information is processed. Taking this into consideration, two routes were postulated: The central route is used when information is highly elaborated and the peripheral route is used when the degree of information elaboration is rather low. In other words, if the central route is applied, attitude changes occur when a lot of effort is put in the information processing and if information is analyzed in detail and systematically. When information is processed with less cognitive effort, the peripheral route is chosen. Consequently, only strong arguments will change attitudes of people using the central route, but weak arguments might persuade people using the peripheral route, because the arguments are not further elaborated.

Bless, Bohner, Schwarz, and Strack (1990) as well as Mackie and Worth (1989) provided evidence that happy and sad people choose different processing routes when changing attitudes. The authors demonstrated that when participants were in a neutral or negative mood state only strong but not weak arguments were persuasive, thus the central route was used. In happy mood not the strength but the sheer number of the arguments was persuasive, suggesting that happy people tend to choose the peripheral route and process information in a more heuristic, automatic way.

Bless et al. (1996) made a mood-and-general-knowledge assumption to explain why positive and negative mood resulted in different information processing styles. According to the idea that mood serves as information (Schwarz & Clore, 1996, see mood-congruity section) they posit that positive mood informs a person that the environment is not dangerous and that “business is as usual”. Because everything is normal and as usual, people do not have to pay attention to specific information. They process information automatically by relying on so called preexisting general-knowledge structures. Bless et al. further posited that negative mood informs people that something in the environment is dangerous or problematic. In that case, people search for more specific information and process information more deliberately.

Mood and global-local information processing

Gasper and Clore (2002) argue that the research on persuasion may have implications for the role of mood with regard to global and local information processing. The terms global and local information were introduced by Navon (1977). Global information refers to a Gestalt-like, overall view of a figure (seeing the forest, not the trees), whereas local information describes the smaller detailed parts of a figure (seeing the trees, not the forest). Navon conducted an experiment where he presented big letters (global figure) that were composed out of small letters (local figures). An example would be an E that is composed of small Ks. Navon showed that participants were less challenged when they had to focus on the global stimuli compared to the local stimuli. Gasper and Clore stated that people in happy mood rely on more heuristic and automatic processing and therefore use more easily accessible information compared to people in sad mood. The authors assumed that happy people engage in more global processing, because global information is more easily accessible. In order to test this assumption, they induced participants with happy, sad, or neutral mood and asked them to do the global-local focus test (Kimchi & Palmer, 1982). In the global-local focus test a target figure is presented that consists of small triangles or squares (local figure) forming a bigger triangle or square (global figure). Each target figure could therefore be perceived globally or locally. Participants' task was to choose whether a target figure was more similar to a figure that shared the same global form but had a different local form, or to a figure that shared the same local form but had a different global form. Participants in happy and neutral mood matched the target figure relatively more often to the figure that shared its global form (and therefore less often to the figure that shared the local from) compared to participants in sad mood. This is evidence that mood affects a person's focus on global and local information. It remains open whether mood also has an impact on the perception of emotional faces. Further, it is unclear whether the focus of global versus local information in a face is related to emotion recognition accuracy.

As outlined in relation with Study 1, global processing is somewhat related to configural and holistic processing (perceiving the interrelations between the features and forming a Gestalt-like impression), and local processing is close to featural processing (focusing on detailed information in eyes, mouth, and nose). Based on that, one could assume that global processing increases and local processing decreases emotion recognition accuracy. If this was the case, global versus local information processing styles could explain why in some studies, it was found that sad or depressed mood generally has detrimental effects on emotion recognition accuracy not only with regard to mood-incongruent emotions. Sad mood would trigger a local information processing style, which in turn would decrease emotion recognition accuracy. Happy mood would elicit a global information processing style, which would affect emotion recognition performance positively. These assumptions were tested in Study 2.

2.3.2 Gender

A further interest for Study 2 was to examine gender effects on emotion recognition. It is a well-documented finding that women outperform men on emotion recognition (see McClure, 2000 for a meta-analysis). A reason for that might be that women use different cognitive strategies than men when recognizing emotions. There is evidence that women process information more automatically and less locally than men (G. B. C. Hall, Witelson, Szechtman, & Nahmias, 2003). The authors presented a series of two pictures of faces expressing different emotions were presented to the participants simultaneously with a voice speaking about emotional content. The task was to decide which of the two faces expressed the same emotion as the voice. Data from functional magnetic resonance imaging (fMRI) revealed gender differences in brain activation in the limbic system and in the left frontal cortex. In men, left hemispheric frontal cortical activation was higher compared to women. Because activation in the left hemisphere is linked to local and part-based processing (e.g., Lobmaier, Klaver, Loenneker, Ernst, & Mast, 2008; Rossion, Dricot, Devolder, Bodart, & Crommelinck, 2000) this suggests that men engaged in more local processing compared to women. Women had greater limbic activity compared to men. Damasio (1994) and Ledoux (2000) postulated that the limbic system is involved when reacting to primary emotions such as fear and disgust. Fear and disgust are emotions that indicate that there is a threat in the environment and it is essential to react to this threat in a fast and appropriate way. Damasio and Ledoux posited that the reaction to primary emotions is automatic and too fast for analytic processing. Hence, the enhanced limbic activation in women suggests that women process emotional expressions more automatically compared to men. No information was given concerning whether and how women's and men's brain activations (thus their information processing styles) were linked to emotion recognition performance.

Study 2: How mood and gender affect information processing during facial emotion recognition: An eye tracking study

Study 2 (see section C) examined the influence of mood and gender on information processing during emotion recognition as well as their effects on emotion recognition accuracy. To do so, we induced our participants with either happy or sad mood and measured their performance on an emotion recognition task. During emotion recognition, eye movements were registered in order to gain information about the participants' information processing styles. We defined a measure for global and one for local processing. Global processing was assessed by the interfeatural saccade ratio. This ratio was computed by dividing the amount of interfeatural saccades by the amount of all performed saccades. An interfeatural saccade was made when participants left a feature (left eye, right eye, mouth, or nose) after having fixated it for at least 100 ms and jumped to another feature which was again fixated for at least 100 ms. In order to assess local information processing we looked at the mean fixation times of the features. Again, only fixations longer than 100 ms were considered. Consecutive fixations in the same feature were first summed up before the mean fixation times were calculated.

The following hypotheses were tested (see also *Figure 9*): Global processing is positively related (*Hypothesis 1*) and local processing is negatively related (*Hypothesis 2*) to emotion recognition accuracy. Happy mood results in more global processing (*Hypothesis 3*) and less local processing (*Hypothesis 4*) compared to sad mood. Because global processing is positively linked to emotion recognition accuracy and happy mood leads to more global processing we expect that happy mood results in better emotion recognition performance than sad mood (*Hypothesis 5*). Women will do a better job on emotion recognition than men (*Hypothesis 6*), and we expect women to use the better strategy to process information: Women would use more of a global (*Hypothesis 7*) and less of a local information processing style (*Hypothesis 8*).

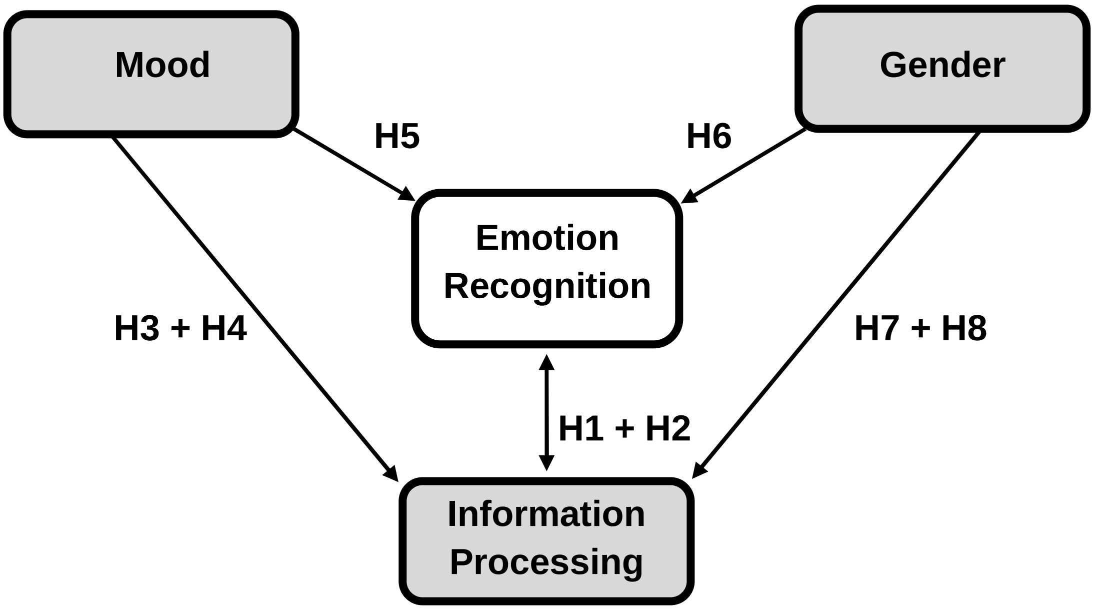

Figure 9. **Overview over Hypotheses 1 to 8 concerning the interplay of mood, gender, and information processing on emotion recognition.**

Results showed that global processing boosted and that local processing decreased emotion recognition accuracy when participants were in sad mood. In happy mood, no correlations between the information processing measures (interfeatural saccade ratio or fixations) with emotion recognition accuracy were found. *Hypothesis 1* and 2 were therefore partly confirmed (only for sad mood). Information processing was affected by mood: In line with *Hypothesis 3*, happy mood resulted in a higher interfeatural saccade ratio (more global processing) compared to sad mood. No effects were found for the fixations (local processing) although there was a high negative correlation between the two measures of global and local processing. No empirical evidence was therefore found for *Hypothesis 4*. Mood did not significantly affect emotion recognition accuracy, solely a tendency for better emotion recognition accuracy in happy compared to sad mood was found in men, but not in women. *Hypothesis 5* is therefore only true for men (on a marginally significant level) but not for women. In line with previous research (McClure, 2000), women outperformed men on the emotion recognition task confirming *Hypothesis 6*. Finally, women and men processed information differently. As hypothesized, women had a higher interfeatural saccade ratio (more global processing; *Hypothesis 7*) and shorter fixations (less local processing, *Hypothesis 8*) than men.

When looking at the four emotions separately, we found no differences in emotion recognition accuracy. Also, displayed emotions did not interact with mood. We further investigated whether some emotions were processed more globally or locally than others. No effects were found. Hence, participants did not change their information processing style between the four emotional expressions; all emotions were processed with the same degree of global and local processing.

A limitation of Study 2 is the lack of a control group in neutral mood. Chepenik et al. (2007) showed that sad mood had detrimental effects on emotion recognition compared to a neutral mood condition. Because of the missing neutral mood condition, we cannot make such conclusions from our study. If sad mood hindered emotion recognition accuracy in our study, happy mood would have impaired emotion recognition as well, because there was no main effect of mood on emotion recognition accuracy. But, when focusing on the tendency in men to recognize emotions better in happy mood compared to sad mood, we cannot conclude that sad mood had a negative effect on men’s emotion recognition accuracy, maybe it was the happy mood that caused the effect. In general accuracy was rather high, on average participants recognized 83% of the displayed emotions correctly. Maybe mood effects would become clearer when using a more difficult emotion recognition test including less intense emotional expressions.

2.3.3 Emotional intensity of the stimuli

As mentioned in section 2.1.1, variations in the intensity of an emotional expression modulate activity in some brain areas (e.g., amygdala) and this occurs independently of the emotional content of the facial expression. This suggests that the emotional intensity is processed independently from the emotional content. Not much is known yet about the factors that influence the processing of emotional expressions in different intensities.

Niedenthal et al. (2000) found that mood can influence the perception of the intensity of emotions. More precisely, sad and happy mood enhanced the perception of the intensity of the mood-congruent emotion compared to the mood-incongruent emotion. This means that in happy mood, happy emotional expressions were perceived more intensively than sad emotional expressions even though the objective intensity of the emotions was the same. In sad mood, sad expressions were seen as more intense compared to happy expressions.

The use of a stimulus set with emotional expressions that includes emotional expressions in different intensities might be more sensible for mood effects on emotion recognition accuracy than a stimulus set with only high intense expressions. Clinical studies showed that the recognition of low and high intense emotions differed between patients suffering from mental disorders such as schizophrenia or depression, and normal controls (Kohler, et al., 2003; Surguladze, et al., 2004). For instance, Surguladze et al. compared emotion recognition accuracy of a clinical depressive group with a healthy control group. They presented happy and sad faces that were either morphed into neutral faces and contained 50% of happiness or sadness, or were not morphed containing 100% of happiness or sadness. When stimuli were exposed during 2000 ms, the control group categorized the faces expressing 50% of happiness more reliably than the depressed group. Also, neutral faces were more often falsely labeled as expressing happiness by the control group compared to the depression group. No differences between depressed and controls were found with regards to facial expression including 50% of sadness and for the faces with the high intense emotional expressions (100% of happiness resp. sadness). Because depressed patients experience sad mood, it is therefore possible that mood effects on emotion recognition emerge when the emotional expression are less intense, but this still has to be properly investigated.

Study 3 was conducted in order to further examine mood effects on emotion recognition accuracy by including emotional expressions in different intensities in the stimulus set. The fact that we did not find evidence for mood-congruity effects in Study 2 might also be due to another methodological reason. In Study 2, participants were induced with happy or sad mood and had to choose between four alternative answers which included happiness, sadness, anger, and fear. So, if an emotion did not display the mood-congruent expression, there were still three other answer options. This might result in different findings than studies comparing only the recognition of two emotions, one mood-congruent and one mood-incongruent. Study 3 examined whether mood-congruity effects emerge when only two different emotions have to be recognized.

Study 3: Mood effects on emotion recognition

Study 3 (see section D) was conducted in order to explore mood effects on the recognition of sad and happy emotions that vary in intensity. We induced participants with happy and sad mood, and added a control group in neutral mood. As stimulus set we used the Facial Expressions of Emotion: Stimuli and Tests (FEEST; Young, Perrett, Calder, Sprengelmeyer, & Ekman, 2002), an emotion recognition test that is based on the original Ekman and Friesen (1976) series. In the FEEST, the original stimulus set was manipulated in order to create different intensities of the expressed sad and happy emotions. This manipulation was done by morphing sad and happy expressions into a neutral expression. We used morphed emotional expressions that contained either 25%, 50%, or 75% of sadness or happiness (see *Figure 10* for examples).

***Figure 10*. A selection of stimuli used in Study 3. The upper line represents examples for happy emotions in 25%, 50% and 75% intensity. The lower line shows emotional expressions of 25%, 50%, and 75% of sadness.**

The stimulus set was restricted to happy and sad emotions which corresponded to the induced moods. According to mood-congruity theories, we hypothesized a negative bias for participants in sad mood; they should recognize sad emotions better than happy emotions. Participants in happy mood were expected to show a positive bias, in that they should recognize happy emotions better than sad emotions. Comparison between the mood conditions and the control group were planned. In line with previous research we expected a female superiority effect on emotion recognition. The impact of the emotion intensities was exploratively tested.

In line with our hypothesis, results indicated a negative bias for participants in sad mood (they recognized sad emotions better than happy emotions). There was a tendency for means of happy participants to point towards a positive bias (happy emotions were better recognized than sad emotions), but the difference between the recognition of happy and sad emotions was not statistically significant. Nevertheless, there was evidence that also happy participants' emotion recognition was biased: When comparing the happy group to the control group in neutral mood, we found that mood-congruent happy faces were recognized equally well in both groups, but the recognition of mood-incongruent sad faces was decreased in the happy group. When comparing the sad group to the control group, mood-congruent sad faces were also recognized equally well, and mood-incongruent happy emotions were better recognized in the control group compared to the sad group. Hence, mood did not boost mood-congruent emotion recognition. Instead it hindered mood-incongruent emotion recognition. There was no difference in overall emotion recognition accuracy between happy and sad mood groups; however, the control group outperformed the mood groups, due to the increased mood-incongruent emotion recognition in the both mood groups (see *Figure 11*).

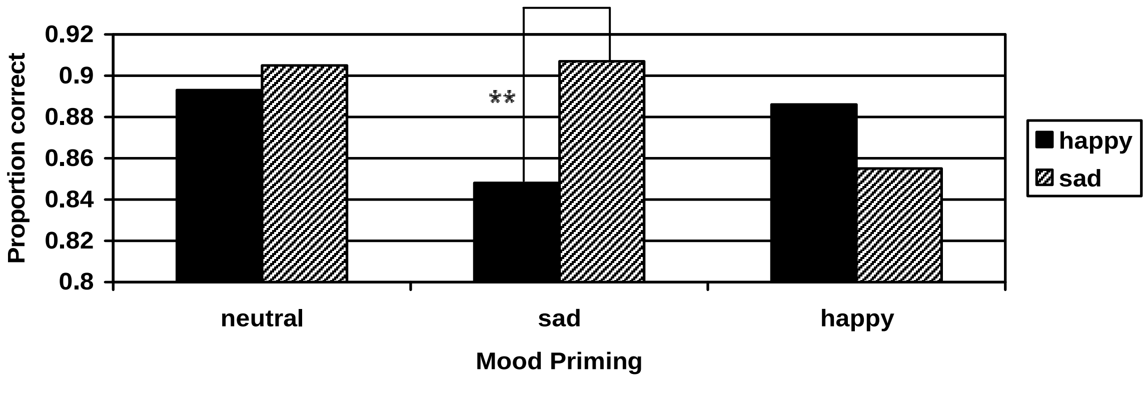

***Figure 11.* The proportion of correctly recognized happy and sad emotions (separately for neutral, sad, and happy mood)**

When looking at the different intensities of the expressed emotions, we found that more intense emotions were better recognized than less intense emotions (75% > 50% > 25%). Further, we found that happy faces were better recognized than sad faces when faces expressed an emotion with 50% or 75% intensity. In emotions with 25% intensity the opposite was found and sad faces were better recognized than happy faces. Results for the intensities 50% and 75% can be explained by the well-documented happy face advantage. The happy face advantage refers to the fact that happy faces are more easily recognized than other emotional expressions (e.g., Kirita & Endo, 1995; Leppänen, 2004). It has been argued that happy faces can be easily detected on the basis of a single feature (smiling mouth) that distinguish the happy emotion from the others (Leppänen, 2004). We showed in Study 1 that blurring and scrambling a face did not hamper the recognition of happy faces which indicates that happy faces might have several characteristics that make them easy to distinguish from other emotions. However, the happy face advantage disappeared when the emotional intensity was only 25%. In fact, in these less intense emotional expressions, sadness was better recognized than happiness. It is known that people tend to label neutral emotions as slightly sad emotional expressions (Leppänen, Milders, Bell, Terriere, & Hietanen, 2004). Negative emotional expressions such as sadness might be more similar to neutral expressions (Johnston, Katsikitis, & Carr, 2001). The less intense emotions (25% of sadness or happiness) are close to neutral emotional expressions, and it seems that participants already perceive more sadness in those less intense, rather neutral, emotions.

Again, and in line with the literature (McClure, 2000), we found a female superiority effect on the emotion recognition task. Gender did not interact with the variables mood, emotional expression, and emotion intensity.

In Studies 1 to 3 we gained information about how configural and featural information contributes to emotion recognition and we found that a global information processing style is of advantage compared to a local information processing style. We reported gender differences in information processing during emotion recognition as well as in emotion recognition accuracy. All three studies focused solely on emotion recognition. However, emotion recognition is part of a larger construct with different labels such as “nonverbal decoding accuracy” or “interpersonal sensitivity”.

2.4 Nonverbal decoding accuracy

A person is highly accurate on nonverbal decoding "…if he or she can perceive or otherwise respond appropriately to the internal states (e.g., cognitive, affective, motivational) of another, understand the antecedents of those states, and predict the subsequent affective, cognitive, and behavioral events that will result" (F. J. Bernieri, 2001, p. 3) on the basis of the nonverbal behavior that is expressed by another person. Nonverbal behavior can be broadly defined as "…communication effected by means other than words" (Knapp & Hall, 2002, p. 5). Verbal and nonverbal behavior can not always be clearly distinguished. For instance, sign language has both, nonverbal and verbal aspects. The nonverbal aspect is the use of gestures; however, these gestures have a distinct verbal meaning and thus also have a verbal aspect as well (Schmid Mast, Klöckner, & Hall, 2009).

Facial emotion recognition is part of nonverbal decoding because facial expressions are nonverbal behavior. As outlined before, nonverbal decoding also includes the assessment of information coming from other nonverbal behaviors such as gestures, posture, touching behavior (touching one-self, or others), eye gaze direction, and vocal behavior (e.g., speech rhythm, tone and volume of the voice) (Knapp & Hall, 2002). Some of those nonverbal behaviors are also relevant for emotion recognition. For instance, the target's person's looking behavior (direct versus averted gaze) can influence the perception of his or her facial expression (Adams & Kleck, 2005; Sander, Grandjean, Kaiser, Wehrle, & Scherer, 2007). Furthermore, vocal and touching behavior has been linked to emotional states (e.g., Grandjean, et al., 2005; Hertenstein, Keltner, & Apps, 2005 cited in Oatley, et al., 2006). However, nonverbal cues do not only provide information about a person's emotional state, they can help interpreting specific characteristics and behaviors of a person. For instance, people are able to correctly assess others' personality characteristics (Ambady, Hallahan, & Rosenthal, 1995), intelligence (Zebrowitz, Hall, Murphy, & Rhodes, 2002a), status (Schmid Mast & Hall, 2004), relationship types (Ambady & Gray, 2002) and people can even read others' thoughts (Ickes, 1993) on the basis of nonverbal cues. Women usually do a better job than men on nonverbal decoding tasks (J. A. Hall, 1978; 1984, for meta-analyses).

Being accurate at decoding others' nonverbal behavior is supposed to facilitate social interactions in everyday life (F. J. Bernieri, 2001). Several standardized tests have been developed in order to measure aspects of nonverbal decoding accuracy. The already introduced DANVA 2-AF for assessing emotion recognition accuracy is one of them. Another widely used test is the Profile of Nonverbal Sensitivity (PONS; Rosenthal, Hall, DiMatteo, Rogers, & Archer, 1979) which measures a person's ability to read other people's intentions. Those two tests were used in Study 4 of my thesis. Nonverbal decoding accuracy is a broad construct; tests measuring this ability tend to have weak intercorrelations (Buck, 1984) Moreover, Bernieri (2001) emphasized that different aspects of nonverbal decoding might involve different cognitive processes. As a consequence, the question arises whether emotion recognition tasks require the same information processing styles as other nonverbal decoding tasks. This question was addressed in Study 4.

Study 4: How global versus local priming affect nonverbal decoding accuracy

Study 4a: Global versus local processing in nonverbal decoding

Study 4a (see section E) was conducted in order to gain information about how global and local information processing styles affect two nonverbal decoding tasks, one focusing on emotion recognition (measured with the DANVA 2-AF), and the other focusing on the assessment of intentions (measured with the PONS). The PONS differs from the DANVA 2-AF in terms of different task characteristics. One difference is the stimuli form; the PONS consists of short film scenes, the DANVA 2-AF of still pictures. The PONS provides always two answer possibilities, and the content of the answer possibilities varies from item to item. The DANVA 2-AF offers four answer possibilities that remain the same over all items. Furthermore, the type of judgment is different: The PONS task is to assess a woman's intentions from her face and/or body and the DANVA 2-AF task focus on facial emotion recognition.

Study 4a had three major aims: Firstly, we aimed to assess whether it is possible to manipulate participants' information processing styles by a global-local priming procedure. Secondly, we wanted to determine how global and local priming affects nonverbal decoding accuracy, once measured with the DANVA 2-AF and once with the PONS. Thirdly, we were interested in gender effects. A female superiority in nonverbal decoding was reported for most nonverbal decoding tasks (J. A. Hall, 1978, 1984; J. A. Hall & Schmid Mast, 2008) and has been found for the DANVA 2-AF and the PONS (e.g., McClure, 2000; Rosenthal, et al., 1979). We investigated whether accuracy differences between men and women would still emerge within a priming group (global or local). Because global eye movements were positively and local eye movements negatively related to emotion recognition accuracy in Study 2, we expected that the global compared to the local priming would result in relatively better performance on both tasks. Further we hypothesized that in the global and local group gender differences would not be observable anymore, because we think that females' superiority is due to a use of a better strategy.

In order to examine our three goals we primed participants with a local or a global information processing style by using Navon global-local letters. Navon (1977) letters consist of small letters forming a big letter (see *Figure 12*). In the global condition, participants had to read out loud the big letters, whereas in the local condition, the task was to read out loud the small letters. The control group had to read out loud letters that were written in different fonts (not containing small letters, see *Figure 13*). Letter reading lasted 10 minutes for all three conditions. After the priming participants performed the DANVA 2-AF and the 40 item short version of the PONS.

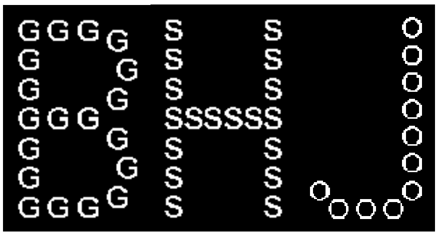

Figure 12. **A selection of Navon global-local letters. The global letters are B, H, and J, the local letters are G, S, and O.**

Figure 13. **Sample letters for the control condition.**

Results revealed that the Navon global-local priming indeed affected performance on the PONS. Answering the first research question, one can assume that the Navon priming can be used to manipulate participants' information processing. To address the second and the third research questions, I will first focus on the results for the PONS. The second goal was to find out how the priming affected accuracy. Contrary to our expectations, it was the local and not the global priming that boosted PONS accuracy. Our third research aim was to test whether gender differences disappear after the global-local priming. As one can see in *Figure 14*, women outperform men on the PONS in the control group. Local priming did not affect women's performance which may indicate that women already used the "better", local processing style in the control group. On men, however, local priming had an effect and boosted their performance insofar that they reached the same performance level as women in the local priming group. Global priming also slightly increased men's performance compared to the control group (marginally significant), and global priming decreased women's performance. Similar to the local priming condition, the gender difference disappeared in the global priming condition. This was due to the slightly improved performance of men and the impaired performance of women.

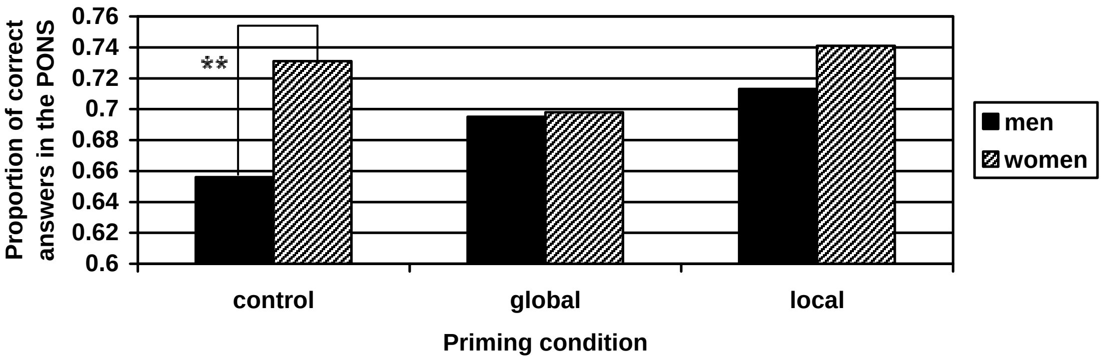

Figure 14. **Men and women's proportion of correct answers in the PONS separately for the control group, the global and the local priming conditions**

Navon global-local priming had no impact on the performance on the DANVA 2-AF. Because Study 2 provided evidence that global processing improved emotion recognition, why did global Navon priming not result in better DANVA 2-AF performance? An explanation for that might be that the Navon priming affected information processing somehow (because the PONS performance was affected), but not global and local eye movements. This hypothesis was tested in Study 4b.

Study 4b: Does Navon priming affect global and local eye movements during emotion recognition?

Study 4b (see section E) was conducted in order to examine whether and how Navon priming affects eye movements during the DANVA 2-AF and to replicate that global eye movements were positively and local eye movements were negatively related to DANVA 2-AF performance. We therefore again used the Navon letter priming to induce a global or local information processing style in our participants. We used the same control condition as in

Study 4a: Participants read out loud the letters that were written in different fonts. After the priming, participants performed the DANVA 2-AF. During this emotion recognition task, eye tracking data were gathered. We computed the same measures for global (interfeatural saccade ratio) and local (fixations) information processing as in Study 2.

Results showed that Navon priming affected neither DANVA 2-AF performance nor global or local eye movements during the task. The interfeatural saccade ratio (global eye movements) correlated positively with DANVA 2-AF performance. The correlation coefficient for fixations (local eye movements) was negative but the correlation was not significant.

To sum up, Study 4 indicated that Navon global-local priming does not affect global and/or local eye movements and has no impact on emotion recognition accuracy. However, PONS performance was affected by Navon priming; local priming increased performance compared to global priming. This suggests that Navon priming affected information processing on a different, non perceptual level and that this level might play a more prominent role for the PONS compared to the DANVA 2-AF performance. This position will be further illustrated in section 4.

3. Summary

I defined a number of aims for my thesis, listed in the introduction section. In the following paragraphs I will go through these aims and will integrate my thesis' research.

My main goal was to get a better understanding of the mechanism underlying emotion recognition. In Study 1 we investigated the role of configural and featural processing on the recognition of four emotional expressions (happiness, sadness, fear, and anger). Results indicated that both types of information, configural and featural contribute to accuracy, because blurring and scrambling faces impeded the recognition of emotions compared to intact faces. Reaction times as well as the emerged face inversion effects emphasized the role of configural information in emotion recognition. The results of Study 2 went in the same vein. Study 2 examined the influence of global versus local processing on emotion recognition accuracy. Remember that the constructs of global and configural processing are related as well as the constructs of local and featural information. Study 2 showed that global information processing positively affected emotion recognition accuracy, whereas local information processing negatively affected emotion recognition accuracy. This was only found for participants in sad but not for participants in happy mood. In Study 4b there was no mood priming, and we found again that global processing was related to a better emotion recognition performance.

Another aim of my thesis was to explore gender effects on emotion recognition and to assess whether women use a different information processing style than men when recognizing emotions. Study 2 demonstrated that women and men indeed differed in their information processing: Women used a more global and less local information processing style when looking at the stimuli compared to men.

A further focus lied on how the perceiver's mood might affect emotion recognition. Study 2 and 3 addressed this question. Effects of mood on emotion recognition seemed to depend on the number of answer possibilities. When there were four emotions to recognize (Study 2: happiness, sadness, fear, and anger) we only found a tendency in men to recognize emotions better in happy compared to sad mood. Mood did not affect women's performance. In Study 3 there were only two emotions to recognize (happiness and sadness) and we found mood-congruity effects. In happy mood participants showed a decreased recognition of the sad, mood-incongruent emotion whereas the recognition of the happy, mood-congruent emotion did not differ from the control group in neutral mood. When sad, participants showed a hampered recognition of the happy, mood-incongruent emotion compared to the control group, but again, mood-congruent emotions were recognized equally well in both groups.

Study 3 included a stimulus set containing emotional expressions that differed in their intensities. A study comparing depressed patients with normal controls revealed that depressed patients differed in their emotion recognition ability from the control group when less intense but not when high intense emotions were presented (Surguladze, et al., 2004). In Study 3, we were interested, whether induced mood in healthy participants interacts with the recognition of emotional expressions of different intensities. We did not find such an interaction of mood with the intensity of the emotional expressions; this interaction might therefore be depression-specific and not mood-specific. However, the intensity of the emotional expressions affected the happy face advantage. It is a well-documented finding that happy expressions are in general recognized more reliably than other emotions (e.g., Leppänen, 2004). When the intensity of the emotional expression was low (25% of happiness resp. sadness) the happy face advantage disappeared, and sad faces were more easily recognized.

In Study 4a and 4b we wanted to figure out whether we can manipulate a person's information processing style and whether such a manipulation has consequences for emotion recognition accuracy. The manipulation was done by making the participants read either the big Navon letters (global priming) or the small Navon letters (local priming). In Study 4a, this priming affected accuracy on the PONS, a nonverbal decoding task in which complex social situations have to be interpreted. As a consequence of the Navon global-local priming, gender effects that are usually found in such tasks disappeared. In the control group women still performed better than men, but this was no longer the case in the global and local Navon priming groups. The Navon global-local priming did not affect accuracy on the emotion recognition task DANVA 2-AF. Study 4b replicated this zero finding and additionally showed that Navon priming had no effect on global and local eye movements during emotion recognition either.

Another aim of Study 4a was to investigate whether different nonverbal decoding tasks require the same information processing style or not. As mentioned before this was not the case. The Navon priming only affected PONS and not emotion recognition performance (measured with the DANVA 2-AF). PONS performance was boosted after a local information processing priming, whereas in Studies 2 and 4b evidence for a positive relation between global processing and emotion recognition accuracy was found. However, because Navon priming did not affect eye movements during emotion recognition, we think that Navon priming affects information processing on a different higher level that is not perceptual. As mentioned before, this point of view will be further discussed in the next chapter.

4. Integration: Toward a new two-level processing model

Previous models such as the Brunswik lens model, the FMLP and the configural model only take some of the aspects of information processing during emotion recognition into consideration. My thesis' research cannot be fully embedded in those models.

For instance, the Brunswik's lens model (Brunswik, 1956) does not focus on information processing per se, but describes that a perceiver has a limited number of more or less reliable cues available. The interpretation of these cues then results in an accurate or inaccurate judgment about a target person. In standardized test (such as the ones we used in my thesis), normally less information is available than in a natural environment (e.g., only the face) and information from the body or the voice etc. as well as situational factors cannot be taken into account. This is likely to bring accuracy down. In contrast, information in standardized tests might be more specific and less irrelevant information is presented. This might reduce ambiguity and increase accuracy. The lens model emphasizes that judgments are influenced by the amount and type of the available cues, but also if and how those cues are perceived and interpreted by the decoder. The model does not specify how different cues must be perceived and interpreted in order to form an accurate judgment. This has been addressed in the configural model and the FMLP.

The configural model (Calder, et al., 2000) and the FLMP (Massaro & Cohen, 1990, 1993) are especially relevant for embedding the findings of Study 1. The configural model stresses the role of configural information whereas the FLMP accentuates the role of featural information in emotion recognition. Overall, our data supported the configural model, although featural information also contributed to the correct recognition of emotions, and for some emotions (e.g., fear) to an even larger extent than configural information. The configural model is primary concerned with the visual information contained in the cues and distinguishes between featural and configural visual information. It remains unclear how the perceived cues are integrated and interpreted by the perceiver after the visual perception. The FLMP focuses more on further processing steps. The FLMP assumes that only featural information will be gathered on the perceptual level (but remember that we showed in Study 1 that configural information is more important). This visual featural information is further processed; the information is evaluated, and a comparison of the gained featural information with a prototype of emotion occurs. Finally, featural information is integrated. The FLMP does not provide alternative routes for processing information during emotion recognition and it is not possible to explain individual differences in emotion recognition accuracy with this model.

Taken together the models give evidence that information processing might occur on two different levels, a perceptual one (which is the focus of the configural model) and a higher processing level (which is the main focus of the FLMP). Although different models have been postulated in different research fields describing the process of social perception and judgments, none of them can be used to fully embed the findings of my thesis. Hence, I propose a new two-level processing model for nonverbal decoding that will borrow some ideas from the existing models. This new model describes the occurrence of global and local processing on a perceptual and a higher processing level. Results from Studies 2-4 will be embedded, as well as other studies that contribute to the understanding of information processing on the two levels.

The assumption that information processing occurs on two levels is supported by our findings in Study 4. Study 4a indicated that global and local information processing styles have different impacts on accuracy in different nonverbal decoding tests. Local Navon priming, compared to global Navon priming, boosted accuracy in the PONS. The priming failed to influence emotion recognition (DANVA 2-AF) performance, although we found in Study 2 that global information processing was positively and local information processing was negatively related to emotion recognition accuracy (measured with eye tracking). Study 4b replicated that Navon global-local priming did not affect emotion recognition accuracy. We further demonstrated that the Navon priming did also not influence global and local eye movements, but that global eye movements were positively correlated with DANVA 2-AF performance. This indicated that the priming did not manipulate global versus local information processing on a perceptual level (no influence on eye movements). This does not imply that the Navon priming had no modifying effect on global versus local processing. Remember that the priming had an effect on PONS performance (Study 4a). In order to explain this, I propose a further processing level which a) is not perceptual, b) is crucial for PONS accuracy, and c) might be influenced by the Navon priming.

But what exactly is this further processing level? Our data do not provide information with regard to the exact nature of the impact of the Navon priming on information processing. It is possible that Navon priming influenced what I call the higher processing level. This refers to a later processing state that determines how global versus local information is integrated. More arguments for this assumption will follow in the section 4.4.1.

To summarize, I suggest that global and local information processing might occur on (at least) two different levels. I call those processing levels the “perceptual processing level” and the “higher processing level”. The two levels will be described in the following sections.

4.1 The perceptual processing level

Global and local processing on the perceptual level refers to the type of visual information to which a perceiver pays attention when looking at a stimulus. Global visual information refers to the spatial relationships and to the interconnection of cues. Moreover, a holistic, Gestalt-like visual representation of a stimulus is formed. Local visual information lies in the cues itself; the detail information of those cues is of interest. Consequentially, a perceiver who looks at the global information would do a lot of eye movements between important cues in order to understand how this information is interconnected. Global visual processing would allow a person to form a more overall, Gestalt-like visual image of a stimulus. A perceiver who is engaged in local perceptual processing will gaze longer at detailed information in order to gain an exact and precise image of it. Interfeatural saccades will be less frequent. As a result his or her visual image of a stimulus will be more fragmented but it will also contain much more details compared to the global visual image.

4.1.1 Measuring information processing on the perceptual level

A way to assess a person's global versus local information processing on the perceptual level is by means of eye tracking (as was done in Studies 2 and 4b). By looking at eye movements we gain correlational data with nonverbal decoding measures. Study 2 showed that mood influences global eye movements (more global eye movements in happy compared to sad mood). This suggests that information processing on the perceptual level can be manipulated. Another way to influence eye movements might be the use of a dot-tracking paradigm: Participants would be instructed to focus their visual attention on a dot that moves on a face picture. This dot could simulate a global path by jumping from features to features, or a local path by staying for a longer time on the facial features. Participants would therefore learn to scan the picture in a specific global or local way. The dot-tracking might serve as a priming for global and local eye movements and participants might take on the same global or local scan path on the following emotion recognition task. Note that this is not yet an established manipulation, and research is needed in order to validate that procedure.

4.1.2 Perceptual information processing in my thesis' studies

Global versus local information processing on the perceptual level has been found to influence accuracy on emotion recognition (global processing is positively and local processing negatively related to accuracy, Studies 2 and 4b). I conclude that emotion recognition accuracy is sensitive to global versus local information processing on the perceptual level. The role of perceptual processing styles in other nonverbal decoding tasks remains unclear and needs to be investigated in further studies.

The perception is the first encounter with a stimulus. Information processing on the perceptual level occurs therefore first. The information collected during this first processing level determines which kind information will be available for further cognitive processing and elaboration. More precisely, it determines whether a more global or local image will serve as a basis for the further elaboration process which will then result in forming a judgment (the recognition of the emotion). This further elaboration process will occur on the higher processing level.

4.2 The higher processing level

In a next step, the visual image gained during the perceptual processing level is further processed in a global and local way on a higher processing level. Global higher level processing includes an integrative, holistic process which occurs in a more automatic, heuristic way, meaning that judgments (e.g., that a target person's face expresses a happy emotion) are based on an unspecific, overall impression. Local higher level processing refers to a more systematic and analytic way to process information. Details in the information will be constituently processed and resulting judgments will be deliberate. Note that global and local processing on the higher level is somewhat related to the central route (in case of global processing) and to the peripheral route (in case of local processing) defined in the ELM (Petty & Wegener, 1999). Remember that the aim of the ELM was to describe processing routes during attitude change (see section 2.3.1.).

4.2.1 Measuring information processing on the higher level

Higher level processing might also be manipulable by mood priming as it has been found that mood affected the choice of the processing route: Bless et al. (1990) showed that happy people tend to use the peripheral route (global higher processing) and sad people tend to use the central route (local higher processing). Another way to influence a person's higher level information processing style might be by adding cognitive load to a task. This cognitive load limits a person's cognitive resource and could prevent him or her from processing information in a deliberate, local manner. A further possibility to manipulate higher level global and local information processing is to give specific instructions to the participants. This method has been used in the domain of decision making. Halberstadt and Levine (1999) formulated explicit instructions for the field of decision making. Adapted to nonverbal decoding the following instruction could be given to the global group: "We are interested in the benefit of an overall impression for nonverbal judgments. Therefore we would not like you to think about and analyze your reason for making your judgments. Instead try to make your judgments based on your first instinct." To explicitly instruct participants to process information locally one could give the following instruction: "We are interested in the benefit of reasoning processes in nonverbal judgments. Therefore, we would like you to think about and analyze the reason why you make your judgment. Please list your reasons on a paper." In order to check the information processing manipulations one could analyze how fast the emotions were recognized. Global higher level processing is supposed to be faster than local higher level processing. This is because the former leads to a more automatic, heuristic, and therefore fast response and the latter evokes a well deliberated and time-consuming reaction (Horstmann, Hausmann, & Ryf, 2009).

Navon global-local priming might also affect information processing on a higher level. However, this still needs support from empirical data; so far we only have evidence that Navon global-local priming does not affect information processing on the perceptual level from Study 4b.

4.2.2 Higher level processing in my thesis' studies

There is evidence that global and local processing on the higher level has impacts on nonverbal decoding accuracy. Based on the assumption that the Navon global-local priming has effects on the higher processing level, one might conclude from Study 4a that the PONS is more affected by this higher processing level than the DANVA 2-AF. However, I do not belief that the DANVA 2-AF or emotion recognition accuracy is not at all affected by higher level global and local processing. In the section 4.4 research will be cited that provides information about factors that might influence information processing and accuracy in nonverbal decoding tasks. This will show that the impact of global versus local higher level processing on nonverbal decoding is highly dependent on a number of task characteristics.

Summarized, I postulate that information can be processed globally and locally on both levels, the perceptual and the higher processing level (see *Figure 15*). Both kinds of information are processed simultaneously. On the perceptual level, people perceive global and local visual information but will use relatively more global or local information. The same is true for the higher processing level: people differ in their degree of global and local higher level processing, but both can occur at the same time. Thus, it is a question of weighting and not of either or.

Although processing on the perceptual level precedes higher level processing, I assume that both levels can influence each other. From a bottom-up perspective, I suggest that information processing on the perceptual level influences higher level processing. Dependent on the relative amount of global and local visual information gathered on the perceptual processing level, different visual information is accessible for further elaboration. Although this still has to be investigated properly it seems logical that different visual information will be processed in different ways on the higher processing level. More global visual images would facilitate an integrative process, because the interconnections and relationships are already present in the visual image. A detailed analysis of features would be more difficult, because this information is less represented in the global visual image. In contrast, more local visual images would facilitate a further detailed analysis of single components. An integrative process would demand more cognitive effort, because a more holistic image is less available in a local visual image and still has to be created.

One could also adopt a top-down perspective: Gasper and Clore (2002) suggest that if someone adopts the mode of global processing on the higher processing level (e.g., because of happy mood) he or she might rely on the easier accessible type of information on the perceptual level. In some cases (for example in hierarchically structured figures) global information might be more easily accessible (Gasper & Clore, 2002; Navon, 1977), however, I think that when there is a typical local cue (such as a smiling mouth in the case of a happy facial expression) this local information might be more salient. Under other circumstances, a local higher level processing mode might also elicit a focus on more salient information. If a task is complex and demands a lot of cognitive effort, a person might have to engage in local higher level processing in order to master the task. However, cognitive resources might not be sufficient to process a big amount of visual information and the person might therefore choose to solely focus on the most salient cues (which might be the global from or specific cues, see above) and might then process a small number of salient visual cues deliberately on the higher processing level.

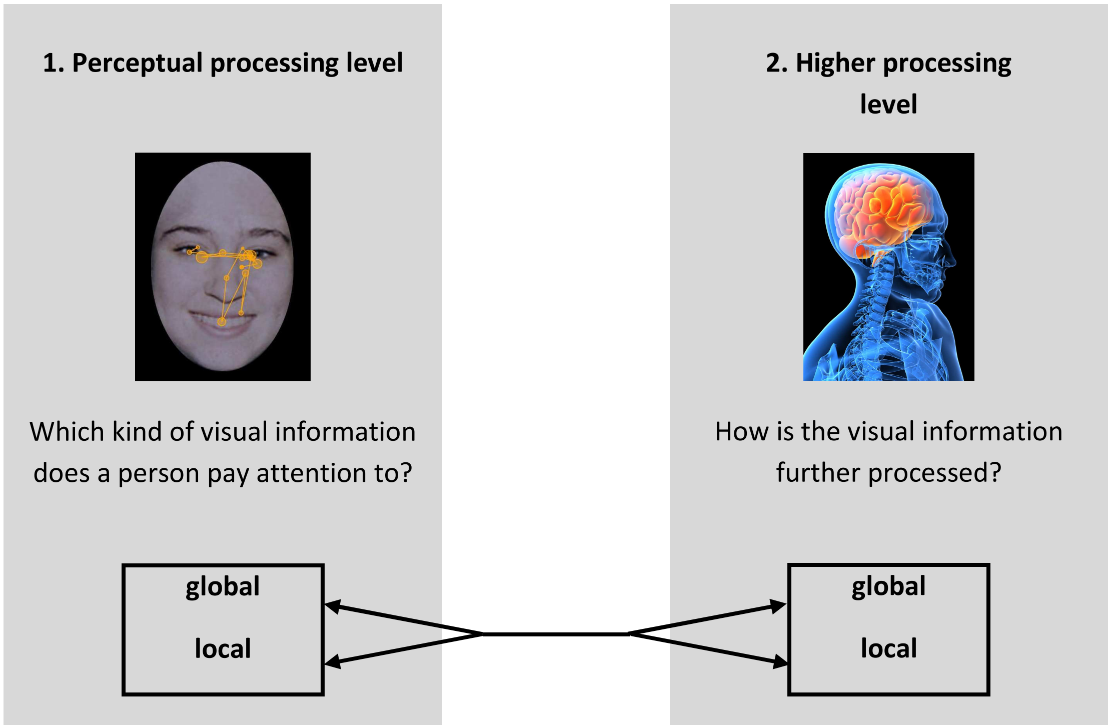

Figure 15. **A new two-level processing model for information processing in nonverbal decoding. Information processing occurs first on the perceptual then on the higher level. On both levels information can be simultaneously processed globally and locally with a weighting on one of the processing styles.**

4.3 Mood and gender effects on the two processing levels

Previous research showed that happy compared to sad participants adopted a more global view on the perceptual level (Gasper & Clore, 2002). This was found with regard to the perception of hierarchically structured figures (Kimchi & Palmer, 1982). Study 2 of my thesis revealed that this is also true for emotion recognition. Happy mood resulted in a more global information processing style compared to sad mood. As outlined before, mood might also influence higher level processing (e.g., Bless, et al., 1990; in the domain of persuasion). Concerning nonverbal decoding, there is also evidence for an influence of mood on higher level processing.

Ambady and Gray (2002) provided evidence that nonverbal decoding accuracy is influenced by the perceiver's mood and by the higher processing level. The authors were interested in information processing during a nonverbal decoding task in which the type of relationship between two people had to be assessed (romantic relationships, platonic friends, or strangers). They first showed that sad mood as well as high scores on a depression scale were related to a decreased ability in decoding relationship types. Secondly, according to the idea that sad mood is related to local, deliberate processing (e.g., Bless, et al., 1990) they assessed whether this deliberate processing style (in my terms local higher level processing) was responsible for the poorer nonverbal decoding accuracy in sad mood. Ambady and Gray assigned their participants to one of three conditions: Sad mood with cognitive load, sad mood without cognitive load, or a control condition. Cognitive load was supposed to hinder deliberate processing (or in my terms: local higher level processing). All three groups then judged the type of relationships between two people. In line with their hypothesis, sad mood only hindered nonverbal decoding accuracy in the no cognitive load condition. Sad participants with cognitive load (who were supposed to be prevented from deliberate processing) performed on the same level as the control group. We do not know whether and how cognitive load would affect participants' nonverbal decoding accuracy when in a neutral or positive mood. It might be possible that cognitive load affected participants' mood (e.g., by fading away their sadness) and they therefore performed on the same level as the control group. There is still a lack of studies examining mood effects on higher level processing during emotion recognition or nonverbal decoding in general.

Besides mood, also gender seems to influence how information is processed on both levels. When it comes to the perceptual level, we have evidence from Study 2 that men and women differ in the use of global and local processing during emotion recognition. Women processed information more globally and less locally compared to men. G. B. C. Hall and colleagues (2003) found that also brain activation differed between men and women during emotion recognition. The activation differences in the brain areas suggest that women process information more automatically and therefore more globally on a higher processing level (see section 2.3.2).

4.4 Task characteristics and their effects on information processing

The following sections present an overview over different variables and task characteristics that might influence global and local information processing on the perceptual and on the higher level. I will further outline how these variables are linked to decreased or increased nonverbal decoding accuracy.

4.4.1 Stimulus and answer option complexity

As discussed before, there are some preliminary hints that Navon global-local priming has an impact on higher level processing. Because Navon priming affected only PONS but not DANVA 2-AF performance, one could conclude that for the PONS higher level processing strongly matters (local is better than global) whereas higher level processing plays a less prominent role in emotion recognition. In order to interpret why one test was affected by the Navon priming and the other was not, one should take a closer look to the task characteristics. Remember that in the DANVA 2-AF emotions have to be recognized whereas in the PONS the task is to assess intentions. There are two further salient differences between the PONS and the DANVA 2-AF concerning the complexity of the stimuli and the answer options. Stimulus complexity differs because still pictures are used in the DANVA 2-AF, and more complex film scenes in the PONS. The answer options are always the same and easy to categorize in the DANVA 2-AF, in contrast, in the PONS the answer options change between items and contain complex social situations.

The role of stimulus complexity

The role of stimulus complexity in information processing can best be demonstrated by studies that used Navon global-local priming. Macrae and Lewis (2002) and Lawson (2007) both looked how Navon priming affected face identity recognition. Macrae and Lewis found an influence of Navon global-local priming on face recognition. In line with their hypothesis, global Navon priming boosted face identity recognition. Lawson could not replicate this finding; Navon priming did not affect face identity recognition in their studies. Taking a look at the methods reveals that Macrae and Lewis used more complex stimuli than Lawson. Macrae and Lewis presented a robbery film scene and participants had to identify the robber after the Navon priming, whereas Lawson exposed participants to still pictures, and then again, participants had to recognize the identity of a person after the Navon priming. Navon priming affected face identity recognition only when stimuli were complex.

Study 4 indicated as well that stimulus complexity may interact with Navon priming. We were the first to examine how Navon global-local priming affected emotion recognition and other nonverbal decoding. As shown in Study 4a, Navon priming only affected accuracy when stimuli were complex (film stimuli in the PONS) and not when they were simple (still pictures in the DANVA 2-AF). Because Navon priming probably affected higher level processing, one might conclude that stimulus complexity needs to be considered when examining global-local processing on the higher level.

The role of answer option complexity

The PONS has a complex answer system, because a) the answer options vary from item to item and b) the answers contain complex social situations. The DANVA 2-AF, in turn has a much simpler answer system including always the same four emotions. These differences between the two tasks could also explain why Navon priming differentially affected the PONS and the DANVA 2-AF. But how could the answer option complexity interfere with information processing?

The complex PONS answer system might require more cognitive resources during the test compared to the simpler answer systems usually found in emotion recognition tests. For the PONS test it is therefore of advantage to be in a local processing mode in which the detailed answer options can be taken into account. In the more automatic, global processing mode it would be difficult to handle a complex answer system, one would not be fully aware of all aspects of the possible answers. For the DANVA 2-AF less cognitive resources might be needed, and this test might be less dependent on the appropriate higher level processing style. If the reasoning is true that the PONS demands more cognitive resources than the DANVA 2-AF, the PONS would be more affected by additional cognitive load coming from other sources. Under cognitive load, participants can not solely focus on the main task (e.g., nonverbal decoding) but have to share their cognitive resources. As a result, deliberate, local processing would be hampered. So, cognitive load could therefore hinder local processing on a higher level which in turn should affect PONS performance negatively. There is indeed evidence that cognitive load and deliberation affect nonverbal decoding accuracy. The following sections will provide more direct evidence for that.

4.4.2 Cognitive load and deliberation

The role of cognitive resources during PONS performance has been investigated by Phillips, Tunstall, and Channon (2007b). The authors reported that cognitive load decreased PONS performance. In a following study Phillips and colleagues (Phillips, Channon, Tunstall, Hedenstrom, & Lyons, 2008) found that cognitive load hindered emotion recognition accuracy as well. More precisely, the more answer options were provided (two, four, or six categories of emotional expressions) the more the performance was affected by cognitive load. This shows that not only the complexity, but also the amount of the answer options is important. Or, one could say that adding answer options made the answer option system more complex. Summarized, Phillips and colleagues showed that the more complex the answer was the more performance was affected by cognitive load.

Tracy and Robins (2008) searched for effects of cognitive load and of deliberation on emotion recognition. Cognitive load hampered only the recognition of fear, sadness, and surprise but not the recognition of other emotions such as anger, contempt, disgust, happiness, and pride. In order to examine the influence of deliberation on emotion recognition, Tracy and Robins (2008) instructed participants either to deliberate about their decisions or to rely on their first impression when doing an emotion recognition task. For some emotions but not for all, deliberation boosted emotion recognition performance: Anger, fear, sadness, and pride were better recognized when participants were instructed to deliberate about their response compared to the condition were participants were instructed to form a first impression. The recognition of contempt, disgust, happiness, and surprise was not affected by the instructions.

Cognitive load decreased performance on the PONS and on emotion recognition and deliberation increased the recognition of certain emotions (Phillips, et al., 2008; Phillips, et al., 2007b; Tracy & Robins, 2008), which can be taken as evidence that both task performances are dependent on higher level processing and that local, deliberate processing seems to be the favorable higher level processing style. One could assume that higher level processing has more impact on the PONS than on the DANVA 2-AF, because in the latter not all but only a selection of emotions were affected by cognitive load and deliberation.

4.4.3 Motivation

The role of motivation on judgment accuracy has recently been debated. If motivation helped to decode other people's nonverbal behavior correctly, this would imply that people know which cues are relevant for judgments and how to interpret them. However, most studies found that motivation cannot boost nonverbal decoding accuracy. J. A. Hall, Blanch, Horgan, Murphy, Rosip, and Schmid Mast (2009) showed in 11 experiments that a person's motivation to form accurate judgments did not improve his or her scores on nonverbal decoding tasks. Accuracy motivation was manipulated using five different methods: (1) by the encouragement to try hard versus no instruction, (2) by monetary incentives, (3) by either announcing that accuracy would be assessed (motivation condition) or by exposing participants to the stimuli without forewarning (non motivation condition), (4) by an ego motive (manipulating the accuracy relevance for the participant, e.g., by saying that the test score is related to the participants' intelligence), and (5) by a reframing of the task instructions in a female-relevant or male-relevant way (which should motivate women or men, respectively, according to the test frame). Nonverbal decoding was measured by different tasks including the PONS, the Interpersonal Perception Task (IPT; Archer & Constanzo, 1987), and non published tasks in which the physical appearance of people had to be recalled, or in which the hierarchical status of people had to be assessed. Motivation did neither affect accuracy in the individual studies, nor on a meta-analysis of the 11 studies. A few studies showed that motivation can affect a person's judgment accuracy (e.g., Klein & Hodges, 2001; Neuberg, 1989), but this seems to be restricted to tasks including verbal information (J. A. Hall, 2009).

Whether and how motivation affects information processing is not clear. One might assume that a person who is highly motivated adopts a local processing mode on the perceptual and the higher level. A high motivated person may not want to miss any detail that might help him or her to make a correct judgment. He or she might therefore look for detailed local information in the stimuli and deliberately process this information on the higher level. Because motivation did not affect nonverbal decoding accuracy, there is also the possibility that motivation does not affect information processing systematically. More precisely, motivated participants use the cues that they suppose to be the most relevant for nonverbal decoding. Participants might differ in their beliefs about the most important cues and high motivation might therefore not result in a specific information processing style. Further research is needed to clarify the implications of being highly motivated on information processing during nonverbal decoding.

5. Future Directions

My thesis not only gave answers to some research questions but it evoked as well new questions that will have to be clarified in the future. For instance, further research is needed to test whether and how PONS performance is affected by information processing on the perceptual level, namely by global versus local eye movements. The role of stimulus and answer option complexity on information processing and accuracy also needs further examination. Furthermore, effects of the Navon global-local priming on the two processing levels have to be clarified. The following paragraphs give some rather rough ideas for possible future studies.

5.1 Investigating effects of stimulus complexity on the perceptual processing level

Studies 2 and 4b showed that performance in emotion recognition tasks was sensitive for changes in information processing on the perceptual level. It remains unclear whether and how processing on the perceptual level influences more complex tasks such as the PONS. A study could be conducted that retrieves a) the impact of global and local perceptual processing on the PONS and b) the influence of stimulus complexity on global-local perceptual processing.

Point a) could be examined by the use of an eye tracker during the PONS test. Point b) could be addressed by the use of different versions of the PONS test, the PONS film scenes test and the PONS picture test. The PONS picture test differs from the PONS film scenes test only with regard to how the stimuli are presented; the task itself remains the same. The PONS picture test consists of screen shots from the PONS film scenes test. The picture test is less complex than the film test because the dynamic information is absent. When comparing eye movements from the PONS film scenes with those from the PONS pictures, one could reveal whether the complexity of the stimulus material affects processing on the perceptual level.

I propose using a within-subjects design in which both tests would be presented to the participants. Half of the items would be presented in picture form the other half in film form. Film and picture items would be randomly exposed to the participants, both during 2 seconds for example.

If stimulus complexity does not play a role for perceptual processing, global and local eye movements would not differ between the two PONS tests. Note that it remains to define how global and local eye movements might look like on the PONS stimulus material, because it does not only contain face, but also body stimuli. Local features could be defined as the parts in the PONS where participants most often looked at. Similar to Studies 2 and 4b, global processing could refer to the amount of performed interfeatural saccades.

5.2 How does answer option complexity affect the perceptual processing level?

The complexity of the answer option system might have consequences for information processing on the higher processing level: A highly complex answer option system might demand cognitive resources which could elicit a more local processing mode on the higher level. This in turn might influence on the perceptual level processing. Because cognitive resources will be needed for a local higher level processing, one might expect that only the most salient information would be gathered.

In order to test how answer option systems affect information processing on the perceptual level participants could perform once the original DANVA 2-AF, and once the DANVA 2-AF stimuli presented together with the PONS answer system. The task would then be to indicate the target person's intentions and not to read his or her emotions. For example, a sad facial expression from a DANVA 2-AF picture would be presented with the two PONS answer options (e.g., "returning a faulty item to a store", and "trying to seduce someone"). I propose a within-subjects design in which half of the DANVA 2-AF items would be presented with the original answer system, half of them with the PONS answer system, the order of the items would be randomized. In order to look how global and local information is processed on the perceptual level, eye movement could be recorded. Eye movements on the original DANVA 2-AF (to recognize emotions having four answer possibilities: angry, fearful, sad, or happy) could then be compared to eye movements on the modulated DANVA 2-AF test (assessing a person's intentions).

If the complexity of the answer option system influences information processing on the perceptual level, eye movements would differ between the two tests. I hypothesize that when looking at the DANVA 2-AF in combination with the more complex PONS answer system, participants would use the more salient information in the faces, because they have restricted cognitive resources. Compared to the original DANVA 2-AF test, one might expect longer fixation on the eyes in the case of fearful faces (wide open eyes is a typical fear feature), in the case of happy faces the mouth (a smiling mouth is a typical happy feature) might be gazed for a longer time. Anger and sadness have less typical features, which makes it difficult to predict whether and how eye movements would differ between the two tests.

This experimental design would not allow looking at performance on the tests (at least not for the modulated DANVA 2-AF), but we would find out whether differences in the complexity of an answer option system affect perceptual information processing.

5.3 Exploring the effect of Navon global-local priming with fMRI

In order to better understand the effects of Navon global-local priming on the two processing levels one might conduct a fMRI study. When it comes to perceptual processing it has been found that the left hemisphere is more involved in local, part-based processing, whereas the right hemisphere is more active in global, whole-based processing (e.g., Rossion, et al., 2000). The limbic system seems to be involved in higher level processing: Limbic activation has been related to fast and automatic processing of emotional expressions, in my terms with global higher level processing (Damasio, 1994; Ledoux, 2000).

In order to investigate the effects of the Navon global-local priming on the two processing levels one might prime participants with either a global or a local processing style and let them perform an emotion recognition task. FMRI data would then show whether the Navon priming affected right and left hemispherical activity (the perceptual processing level), and / or limbic activity during emotion recognition (the higher processing level). In line with my assumption that Navon priming affects information processing on the higher but not on the perceptual level, I would expect that the priming affects the activity in the limbic system. Right and left hemispheric activity should not be influenced.

6. Significance

With this thesis I provide further information concerning the mechanism that underlies the accurate assessment of other people's emotions and the influence of mood on emotion recognition. This knowledge is significant and important for application.

Our findings clarify the role of global and local information processing on emotion recognition and therefore help to understand the underlying mechanism. This is a first step for towards the development of a training tool in emotion recognition accuracy. But why should we be interested in training people in accurate emotion recognition? Emotions have social functions. For instance, certain emotions facilitate interactive behavior and the bond of social contacts (e.g., love, desire, gratitude) whereas other emotions are more considered to help maintaining or restoring relationships as a result of facing a threat to the relationship (e.g., jealousy, anger, amusement) (see Keltner & Kring, 1998 for more details). However, if other people cannot recognize those emotions, the emotions lose their social function and the quality of relationships might decrease. There is indeed a correlation between emotion recognition accuracy and relationship well-being (Carton, et al., 1999). Because of the correlational nature of these findings we do not know whether training would increase the quality of a relationship. Research that investigates whether or not being accurate in recognizing other people's emotions *causes* relationships of better quality is therefore needed.

A further argument for the need of emotion recognition training comes from studies in the domain of work psychology. High scores on accuracy in emotion recognition tasks have been linked to higher annual salary increases in salespersons, also automobile salespersons with high emotion recognition abilities sold more cars compared to those who had low emotion recognition abilities (Byron, Terranova, & Nowicki, 2007). Moreover, Elfenbein, Foo, White, Tan, and Aik (2007) showed that better emotion recognition is linked to better and more effective negotiations.

Emotion recognition training might also be useful for people suffering from mental disorders. Mental disorders (e.g., depression, mania, schizophrenia, and autism) are linked with problems in social functioning and patients often show decreased emotion recognition accuracy (e.g., Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Heimberg, Gur, Erwin, Shtasel, & Gur, 1992; Lembke & Ketter, 2002; Surguladze, et al., 2004). Reduced emotion recognition ability can result in problematic social behavior such as inappropriate reactions to other people's emotions. This can elicit negative reaction in significant others. Family and friends might rebuff the patient and the patient might therefore lose the support of his or her social environment. Beyond that, depressed patients emotion recognition accuracy of negative emotions is an indicator for depression severity and depression persistence in the sense that the more pronounced the emotion recognition impairment is, the more severe is the depression and the less likely is fast regeneration (Hale, 1998). This might have crucial consequences, because the ability to recognize other person's nonverbal cues is important for a successful therapy: Geerts, Bouhuys, & Van den Hoofdakker (1996) showed that impaired communication on the nonverbal level between the patient and the psychiatrist might result in poor therapy outcome.

Good nonverbal decoding is therefore important for both, patients and therapists. And emotion recognition accuracy is linked to more success in relationships and jobs. Consequentially, there should indeed be an interest to develop a training tool in emotion recognition or in nonverbal decoding in general. But: is it possible to train nonverbal decoding?

For emotion recognition there are some indications that it is indeed possible; for instance, by going through an education as a FACS coder. This education was developed by Ekman and Friesen (1978). Learning FACS coding means that one learns to detect the facial action units and their meanings. However, this is rather time consuming and it is above all used for scientific purpose (e.g., by behavioral scientists or computer scientists). Recently another possibility to train emotion recognition accuracy has been developed, the Frankfurt Test and Training of Facial Affect Recognition (FEFA; Bölte, et al., 2002). The FEFA is a computer-based program in which emotions have to be recognized on the basis of photographs of either whole faces or eye regions. The computer program gives visual and acoustic feedback about the accuracy of a judgment. If an answer is incorrect the program provides an option to ask for a description of the characteristics of the emotional expression and further explains in which situation such an emotion might be experienced. This training method has been so far found to improve autistic people's ability to recognize emotions (Bölte, et al., 2006) and is (not yet) used to train healthy people or other clinical samples on emotion recognition. Using the results of Study 2, one could develop a training that is not based on giving feedback. Study 2 showed that a global eye scan path is favorable for emotion recognition. Emotion recognition might therefore be trained by teaching people how to process information best on the perceptual level. One could imagine the dot-tracking paradigm described in section 4.1 to realize such training.

It is rather promising that emotion recognition abilities can be improved with training. However, trials to train other nonverbal decoding provided more equivocal results. Zuckerman, Koestner, and Alton (1984) showed that training can help to detect lies, but only in the person that was used as target person during the training, it could not be applied to other people. For the PONS, no clear training advantages were found so far. The clinical staff of a mental health center was trained during 90 minutes on the PONS. However, overall performance did not improve (Rosenthal, et al., 1979). Up to now, most training has been done on the basis of performance feedback. Instead, one could provide an appropriate information processing strategy to the participants. Study 4a showed that for assessing a person's intentions, performance could be improved by the local Navon letter priming. This indicates that there is indeed possibility to train other nonverbal decoding skills through the manipulation of information processing. Remember that different nonverbal decoding tasks might require different information processing styles. This might be a challenge to solve when developing a training program and maybe several sub trainings have to be disposed in order to improve a person's general nonverbal decoding accuracy.

A further focus of my thesis was how mood affects information processing and emotion recognition accuracy. This research may have practical implications as well. For instance, for justice it is important to be aware of mood effects on judgments: A judge's mood could influence the final sentence. Positive mood could lead to more global judgments about the accused and less detailed information would therefore be considered. Furthermore, there might be a tendency to only see positive expressions in the accused's face. Negative mood, in contrast, could result in a more local and analytical processing of information and the judge might see more negative facial expressions in the accused. So, a judge would consider different information in positive versus negative mood and the judgment would therefore be biased. An example comes from Bright and Goodman-Delahunty (2006) who showed that emotions like anger and disgust might lead to a higher rate of sentencing. A similar biased judgment could occur in a job recruitment situation. A happy recruiter might use more global information and might see more positive expressions in an applicant, and in turn, a sad recruiter would rely on more local information and as a result see more negative expressions in the applicant. Here again, the recruiter's judgment and the hiring of the applicant might be dependent on the recruiters mood. The mood-as-information theory (Schwarz, 1990) emphasizes that being conscious about the own mood and that this mood could influence one's judgments can revoke mood effects. Therefore the knowledge about how mood affects emotion recognition is important in order to make people aware of it and, as a consequence, to give them the possibility to reduce mood evoked biases consciously.

To sum up, the studies of my thesis helped to get a better understanding of the processes involved in nonverbal decoding, especially in emotion recognition. These finding are of interest when it comes to the development of training in nonverbal decoding. My thesis additionally clarified the influence of the perceiver's mood on emotion recognition. The gained knowledge about mood biases is of significance in work domains, in which mood-biased judgments would have crucial implications (e.g., justice, human resources).

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7. Glossary

Configural information: Configural information include first-order relational properties that help to identify a form as a face (two eyes above a nose above a mouth) and second-order relational properties referring to the interrelationships between different feature positions (e.g., how far the distance between the two eyes is) and help to distinguish between different faces.

Emotion recognition accuracy: Emotion recognition accuracy in my thesis is the ability to correctly recognize emotions in others on the basis of their facial expressions. This ability is part of a larger construct called "nonverbal decoding accuracy".

Featural information: Featural information in a face refers to the information that lies in separate facial cues. The facial cues are the eyes, the nose, and the mouth.

Global information processing: Global information processing on the perceptual level refers to a focus on the interconnections between features; an overall, Gestalt-like visual impression is gained. Information can be processed globally on the higher level, it occurs automatic and fast. The judgments resulting from that process are based on an unspecific feeling.

Local information processing: Local information processing on the perceptual level occurs when local, detailed visual information is systematically gathered. On the higher level local information processing is characterized by a systematic and constituent processing of the visual information. A lot of cognitive effort is put in the information processing in order to form well deliberate judgments.

Mood-congruity effects: Mood-congruity theories suggest that mood makes mood-congruent information more accessible. As a consequence, people in sad mood show a negative bias and recall more easily sad, thus mood-congruent information than happy, mood-incongruent one, also they judge situations more negatively than people in happy mood. People in happy mood show a positive bias and remember happy information more easily and their judgments are more positive.

Navon global-local priming: Navon global-local priming is used in order to prime participants with global or local information processing styles. A series of hierarchical constructed figures (big letters that are composed of small letters) are presented to participants. In order to induce a global information processing style, the big letters have to be read out loud during 10 minutes. Reading out loud the small letters is supposed to induce a local information processing style.

Nonverbal decoding accuracy: Nonverbal decoding accuracy refers to the ability to understand and read other people's nonverbal behavior (e.g., gestures, mimic, tone of voice) in order to react appropriately to it.

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B) STUDY 1

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Emotion Recognition: The Role of Featural and Configural Processing of Facial Information

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Abstract

We studied the role of featural and configural processing on emotion expression recognition. Twenty-four participants identified emotion expressions (happy, sad, angry, and fearful) of 24 pictures of faces. Stimuli were presented in three different modalities (intact, blurred, and scrambled) and in two orientations (upright and inverted). Blurred faces contain configural and scrambled faces featural information, while inversion is known to selectively hinder configural processing. We found that the role of configural processing in expression recognition is more pronounced than featural processing, as suggested by both discriminability measure (A') and RTs. In fact, scrambled expressions showed slower RTs than intact and blurred faces and inversion dramatically reduced accuracy in emotion recognition. Interestingly, the importance of featural and configural information varied depending on the emotion for upright expressions.

Keywords: emotion recognition; facial expression; featural processing; configural processing.

Emotion Recognition: The Role of Featural and Configural Processing of Facial Information

Being accurate and fast in recognizing facial expressions is fundamental to efficiently communicate, interpret, and predict people's behavior (e.g., Keltner & Kring, 1998). Emotional expressions are commonly known to be processed efficiently and fast but still our knowledge about the mechanisms that underlie their recognition is not as profound as it is for related topics such as the recognition of facial identity.

For instance, the relative contribution of featural and configural processing in face identity recognition has been demonstrated in many behavioural (Cabeza & Kato, 2000; Leder & Bruce, 1998) and neuroimaging (Lobmaier et al., 2008; Rossion et al., 2000) studies. Features (or components) concern detailed information about face parts, such as the colour of the eyes or the shape of the nose. Configurations (or second-order relational information) are defined by the interrelationships between face parts, such as metric distances between the mouth and the eyes. To date, only few studies addressed the question whether featural and configural processing mechanisms are also involved in emotion recognition. On the one hand, studies by Bassili (1978, 1979) and Calder et al. (2000) show that configurations play a role in emotion recognition. Bassili (1978) found that an emotional expression could be identified above chance level by analyzing the movement of point-light faces (similar to point-light walkers created by Johansson, 1973), without seeing any facial features. Moreover, Calder et al. (2000) reported a composite face effect for emotion recognition, thus providing further support for the involvement of facial configurations. On the other hand, there are also approaches promoting the role of facial features. Ellison and Massaro (1997) and White (2000) proposed models which combine the independent analysis of the features with their subsequent integration.

One way to study the relative contribution of featural and configural processing is to use scrambled and blurred faces (Collishaw & Hole, 2000; Schwaninger, Lobmaier, & Collishaw, 2002; Lobmaier and Mast, 2007; Bombari, Mast, & Lobmaier, 2009). Scrambled faces contain detailed information about face parts but no cues about their spatial interrelationships. In blurred faces the detailed information about features is largely disrupted while saving configural information. Another way to study the contribution of featural and configural processing on face perception is to invert the face. Face inversion is known to hamper configural processing (Valentine & Bruce, 1988), whereas it has a smaller influence on featural processing (Leder & Bruce, 2000).

Prkachin (2003) found that inversion caused a general decrease in sensitivity to identify and detect facial expressions, but inversion did not equally affect different expressions. McKelvie (1995) showed that happiness was identified almost perfectly on upright and inverted faces, whereas recognition of other emotions was affected by inversion. This suggests the importance of both featural and configural processing, but that their contribution depends on the emotion being processed.

The goal of the present experiment was to clarify the role of featural and configural processing in facial emotion recognition. Other studies investigated the same issue by relying on rather indirect methods, such as composite faces (Calder et al., 2000) or face inversion alone (Prkachin, 2003). Indeed, both inverted and misaligned faces will reduce configural processing, but some simple configural judgements might still be possible (Butler & Harvey, 2005; Sekuler et al., 2004). In our study, we combined the use of scrambled (featural information) and blurred (configural information) expressions together with face inversion, thus providing a deeper and more direct analysis of the role of features and configurations in facial emotion recognition. In fact, combining both manipulations will inform us about robustness of mechanisms that underlie emotion recognition.

In an emotion recognition task we presented four emotion expressions (happiness, sadness, anger, and fear) in blurred, scrambled, and intact versions and we displayed them in the upright and the inverted orientation. If expression recognition is based on featural processing, we expect to find higher accuracy for scrambled faces compared to blurred faces. Conversely, if blurred expressions show higher accuracy than scrambled faces this will mean that configural processing plays a more prominent role in emotion recognition.

We hypothesized differences as to the relative importance of featural and configural processing for different emotions. For instance, a smile could be enough to recognize the expression of happiness, therefore we expect this expression to be processed in a more featural way and thus expect an advantage for scrambled faces over blurred faces. In expressions such as anger or sadness the emotion cannot be predicted simply by looking at one single feature. Hence we predict that angry and sad faces are treated in a more configural way which will be evident in an advantage for blurred expressions.

Method

Participants

Twenty-four participants (18 female, 6 male) ranging in age between 22 and 33 years (*M* = 25.12, *SD* = 2.89) took part in return for payment (20 CHF). All reported normal or corrected-to-normal vision and all provided informed consent. They were naive as regards to the purpose of the experiment and were treated according to the declaration of Helsinki.

Stimuli

The stimulus faces were modified versions of the Adult Facial Expressions set of the Diagnostic Analysis of Nonverbal Accuracy 2 (DANVA 2: S. Nowicki, Jr. & M. P. Duke, 1994). This set contains 24 intact faces expressing four different emotions (anger, fear, happiness, sadness) by different male and female individuals. The agreement ratings for these expressions are high (Nowicki & Duke, 1994). By modifying the original DANVA2 faces we obtained 24 intact, 24 blurred, and 24 scrambled faces (see Fig. 1). For intact stimuli all background information including hair and clothing was eliminated using the elliptic tool in Adobe Photoshop CS2. Blurred versions were created from the intact faces in two steps: we first discarded colour information as it does not contain any spatial information and in a second step we applied a Gaussian filter using a radius of 15 pixels, both of these manipulations left the spatial-related cues untouched. Scrambled faces were obtained from intact faces by cutting out four facial parts (right and left eye, nose and mouth) and by placing them on a black background in a non-natural position (e.g., the nose above the right eye and the mouth next to the left eye), but without changing their orientation. Finalized faces had a size of 14 x 21 cm, subtending a visual angle of approximately 16° x 24°, and were projected on a 17' monitor positioned at 60 cm from the participants.

Procedure and data analysis

Before the experiment proper we ran a pre-test (10 participants) to ensure that blurred and scrambled faces were matched for difficulty in an identity recognition task. Using a sequential same-different matching task, we presented 14 cue faces (7 scrambled and 7 blurred) from the DANVA2 set and each was followed by an intact test face which could be the same or a different identity as the cue face. Pre-test participants were asked to decide whether the identity of the test (intact) face matched the identity of the cue face. Results of the pre-test showed no difference in difficulty between blurred and scrambled faces ($t(9) = .514$, $p = .619$). Four keyboard keys (V, B, N, M) were labelled with the four emotional expressions (angry, fearful, happy, and sad). The labels of the four keys were counterbalanced across participants. The experiment proper started with a response-key learning phase in which the labels of the emotions were displayed on the screen and participants had to press the corresponding key without looking at the keyboard. They received feedback about their performance. After this learning phase of approximately 3 min all participants were perfectly familiar with the keys. The experiment proper began with a central fixation cross presented for 1 s which was replaced by a face displaying one of four emotional expressions and remaining until the participants responded. Each of the 24 original DANVA2 faces was presented six times, once in each possible combination of the factors orientation (upright and inverted) and information (blurred, scrambled, and intact) resulting in a total of 144 trials per session. No feedback was given to the participants about their performance at this time. All the stimuli were presented in three blocks in a pseudo-random order (blurred, scrambled, and intact versions of the same expression were presented in different blocks). Blocks order was counterbalanced across participants. We recorded and analyzed RTs for correct responses, accuracy (A') and a measure of strategy bias (B''_D) for each subject.

Results

Accuracy

A' is a non-parametric measure of discriminability which varies from 0 to 1, with a value of 0.5 indicating chance performance. A' was calculated with the formula suggested by Snodgrass, Levy-Berger, and Haydon (1985): $A' = 1/2 + [(pHit - pFA)*(1+pHit-pFA)]/[4pHit*(1-pFA)]$. We analysed A' in a 3 (Information: blurred, scrambled, intact) x 2 (Orientation: upright, inverted) x 4 (Emotion: happiness, sadness, anger, fear) ANOVA. Results showed a main effect for Information, $F(2, 46) = 18.39$, $MSE = .020$, $p < .001$, *partial* $\eta^2 = .44$, a main effect for Orientation, $F(1, 23) = 47.34$, $MSE = .033$, $p < .001$, *partial* $\eta^2 = .67$, and a main effect for Emotion, $F(3, 69) = 30.24$, $MSE = .016$, $p < .001$, *partial* $\eta^2 = .57$. Results are depicted in *Figure 2*. In all conditions emotions were recognized above chance level (all *p*'s < .001). Post-hoc pairwise-comparisons (Bonferroni corrected) revealed that intact expressions ($M = .87$) were recognized better ($p < .001$) than blurred ($M = .81$) and scrambled ($M = .78$) expressions. Blurred and scrambled expressions did not differ ($p = .47$). Overall, upright expressions were recognized more reliably than inverted expressions (*p*

< .001). Bonferroni-corrected pairwise comparisons revealed that angry and sad expressions were recognized less reliably than happy and fearful expressions (all *p*'s $< .01$).

The interaction Emotion x Orientation reached statistical significance: $F(3, 69) = 7.75$, $MSE = .013$, $p < .001$, *partial* $\eta^2 = .25$, while the other two-way interactions were not significant, all *p*'s $> .05$. The interaction between Orientation and Emotion is explained by the fact that inversion dramatically reduced recognition of all emotions except for fear. *Figure 2a* illustrates the Information x Emotion interaction in upright expressions and reveals that scrambling and blurring had a differential effect on different emotions, $F(4.43, 102.01)$[1] $= 2.91$, $MSE = .007$, $p < .05$, *partial* $\eta^2 = .11$. Happiness was recognized equally well when the stimuli were intact, scrambled, or blurred (all *p*'s $> .05$), whereas anger was recognized more reliably when the faces were intact compared to scrambled ($p < .01$) or blurred ($p < .05$). Likewise, fearful faces were recognized better when they were presented in their intact version compared to scrambled ($p < .05$) or blurred versions ($p < .01$). Sadness was recognized more reliably when the stimuli were intact than when scrambled ($p < .01$), but there was no difference between blurred and intact sad stimuli ($p = .348$).

Response Times

We analyzed RTs in a 4 (happiness, sadness, anger, fear) x 3 (blurred, scrambled, intact) x 2 (upright, inverted) ANOVA. The three main effects were significant: Emotion, $F(3, 27) = 8.92$, $MSE = 616256$, $p < .001$, *partial* $\eta^2 = .50$, Information, $F(2, 18) = 16.112$, $MSE = 747789$, $p < .01$, *partial* $\eta^2 = .64$, and Orientation, $F(1, 9) = 6.11$, $MSE = 1241670$, $p < .05$, *partial* $\eta^2 = .40$. Emotional expressions were identified faster when they were upright compared to inverted ($p < .05$) and scrambled stimuli were recognized slower than blurred and intact stimuli (both *p*'s $< .01$), which in turn did not differ between each other ($p = .99$).

[1] Huyn-Feldt correction for sphericity was applied.

Bonferroni corrected pairwise comparisons revealed that happiness (*M* = 1491 ms, *SE* = 174) was recognized faster than sadness (*M* = 2154 ms, *SE* = 240) ($p < .01$), while the mean RTs of anger (*M* = 2086 ms, *SE* = 291) and fear (*M* = 1801 ms, *SE* = 178) did not differ. The RTs from anger and fear did not differ from all other emotions. None of the interactions was significant.

Strategy bias

B''_D is a non-parametric measure of strategy bias and was calculated using a method suggested by Donaldson (1992): B''_D = [(1-pHit)*(1-pFA)-(pHit*pFA)]/[(1-pHit)*(1-pFA)+(pHit*pFA)]. Values above 0 indicate a conservative bias (less willing to guess a particular emotion) in participants' responses, while values below 0 indicate a liberal bias (more willing to guess a particular emotion). Mean B''_D values for each emotion were compared to 0, which corresponds to an unbiased criterion. We found that participants had a significantly conservative criterion for emotions of anger and fear in all conditions (all *p*'s < .01). Sadness showed a conservative bias for all conditions (all *p*'s < .05) except for intact expressions. Moreover, participants had a conservative criterion for inverted happy expressions when they were presented in their blurred ($p < .01$) and intact ($p < .05$) version. All other conditions were not significant (all *p*'s < .05).

Discussion

The aim of the present study was to investigate the role of features and configurations in facial emotion recognition. One of our major findings is that configural processing plays a more prominent role than featural processing in emotion recognition, which is supported by different lines of evidence. First, RTs were slower for scrambled expressions when compared to blurred and intact emotions, thus suggesting that the unavailability of configural information renders emotion recognition more difficult. Second, for all four emotions recognition of inverted expressions was more difficult than upright expressions, again suggesting that configural processing is important for reliable emotion recognition. Our results are in line with studies showing a role of configural processing (Calder et al., 2000; Bassili, 1978) and an effect of inversion (Prckachin, 2003; McKelvie, 1995) in emotion recognition. Despite the importance of configural information, some findings suggest to interpret its role with caution. First, we found that inverted blurred expressions were still recognized at above chance level, although configural information was hindered through face inversion and featural information through the blurring procedure. It is therefore possible that, although the few featural and configural information contained in inverted blurred stimuli is not enough to recognize the identity of a face (Collishaw & Hole, 2000), still it is sufficient to reliably identify emotional expressions. Second, the fact that overall intact expressions were identified more accurately than blurred and scrambled expressions may suggest that it is beneficial for the perceptual system to simultaneously process featural and configural information. When they are processed in isolation the perceptual system is less efficient. This could be explained by some kind of ‘holistic’ processing (Calder et al., 2000), in the sense that it needs both featural and configural information in order to be efficient.

Just as facial identity can be reliably recognized when faces are scrambled, blurred, inverted, or simultaneously scrambled and inverted (e.g., Collishaw & Hole, 2000), we showed that emotions were recognized well above chance level for all the manipulations we applied, suggesting that both the featural and the configural route can be used and are sufficient to recognize facial emotions. In contrast to studies on face identity recognition which show that orientation has relatively little influence on the processing of facial features (Leder & Bruce, 1998; Collishaw & Hole, 2000; Lobmaier & Mast, 2007), we found that scrambled emotions were indeed affected by inversion. This could be explained by the fact that some configural information is still available within the features, as the interrelationships between different parts within a face part. This local configural information could therefore become important for inverted scrambled stimuli and impair their recognition.

Comparing the different emotional expressions in the upright orientation, we found that featural and configural information have different roles depending on the emotional expression. Happiness was identified more easily and rapidly than the other emotions, regardless of whether featural, configural, or both kinds of information were provided. This happy face advantage has already been reported by other authors (e.g., Leppänen & Hietanen, 2004). Leppänen and Hietanen suggested that positive and neutral emotions differ to a greater extent than negative compared to neutral emotions do, because the configuration of facial features may change more significantly from neutral to happy expression than from neutral to negative emotions. A happy expression can be correctly identified either by looking at the global configuration of the facial expression or just by looking at the smiling mouth (Adolphs, 2002).

We found that recognition of sadness was more dependent on configural information and less on featural information: scrambled sad faces were more difficult to recognize than when they were intact or blurred. It can be argued that sad expressions have no highly distinctive features (e.g. compared to a smile in a happy expression), and thus we need to grasp the whole configuration in order to recognize the emotion of sadness.

Angry faces showed a different pattern altogether. With the overall lowest recognition accuracy, intact angry expressions were recognized more accurately than scrambled and blurred angry faces, suggesting that the concurrent presence of both featural and configural information is important for a correct identification of this emotion. This finding might be due to the fact that recognition of anger is very subtle, and as a consequence disrupting the available information severely reduces accuracy.

Finally, for fearful expressions there was a pronounced difference in accuracy between intact faces, which were recognized with high reliability, and scrambled and blurred expressions, which were difficult to recognize. Moreover, inversion affected fear recognition to a minor extent than other emotions. Robustness to inversion is in line with the evolutionary importance and the social relevance of fear (Adolphs et al., 2005). A possible explanation would be that expression of fear is mainly recognized by the openness of the eyes, and this does not change with inversion. Note that a study by Prkachin (2003) reported inversion to strongly reduce sensitivity to fearful faces. However her study differed from ours in that she presented emotional expressions only for 100 ms, while we presented them until the participants responded. Thus, different strategies and modalities of processing could have been used in the two studies.

For all the manipulations, participants had the tendency to choose anger and fear responses in a low number of cases. This conservative bias can be explained as an effect of less frequent exposure to these expressions in everyday life, as hypothesized by other studies (Gao & Maurer, 2008; de Haan et al., 2004).

In conclusion, we found that configural information plays a more important role than featural information when recognizing emotional expressions, even though the relative contribution of featural and configural processing changes depending on different emotions.

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Figure Caption

Figure 1. Example of happiness stimuli used in the present study: a) intact, b) blurred, c) scrambled and their inverted versions (d, e, and f).

Figure 2. Mean A’ values for scrambled, blurred, and intact emotions, presented either upright (a) or inverted (b). Error bars represent standard errors of the mean (SEM).

Figure 1

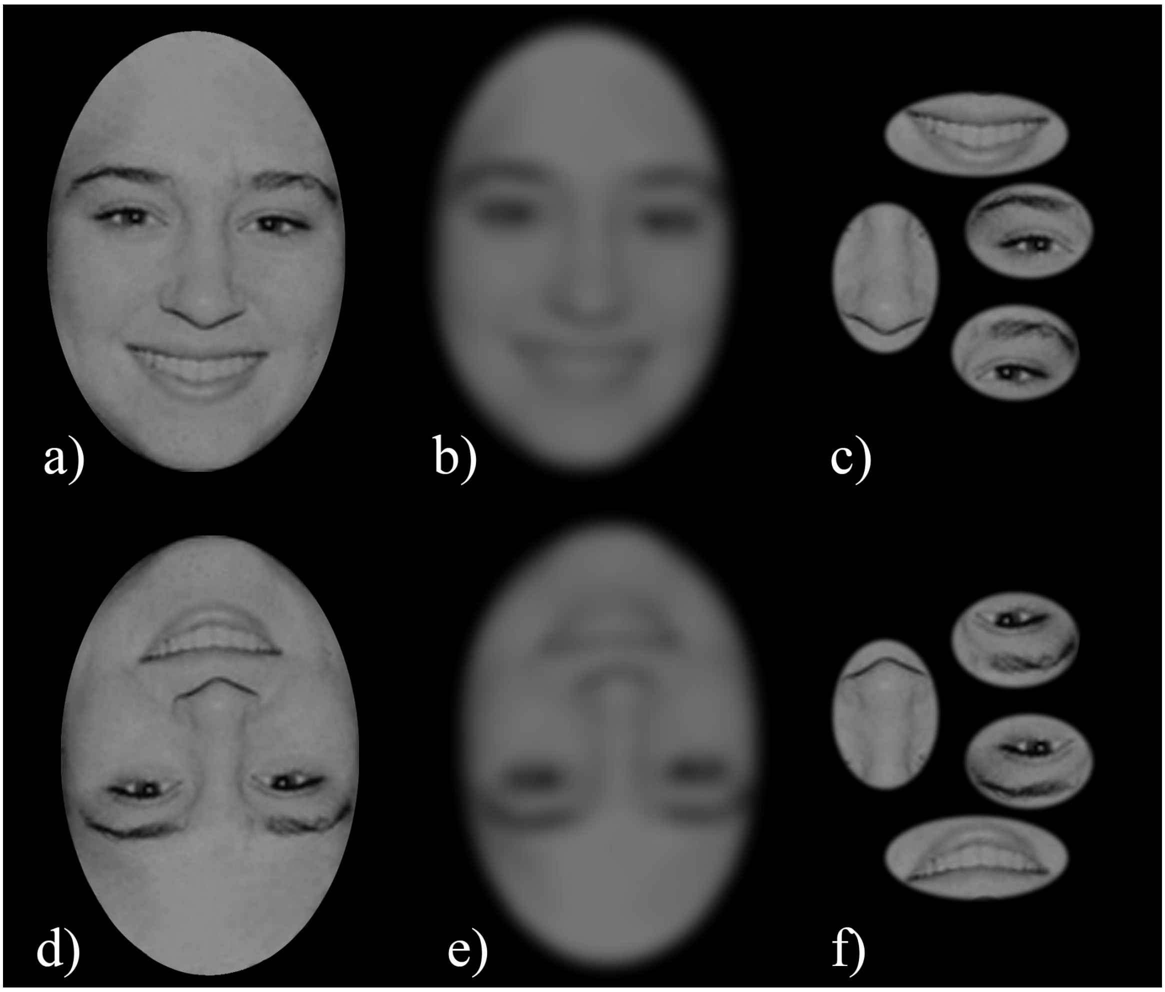
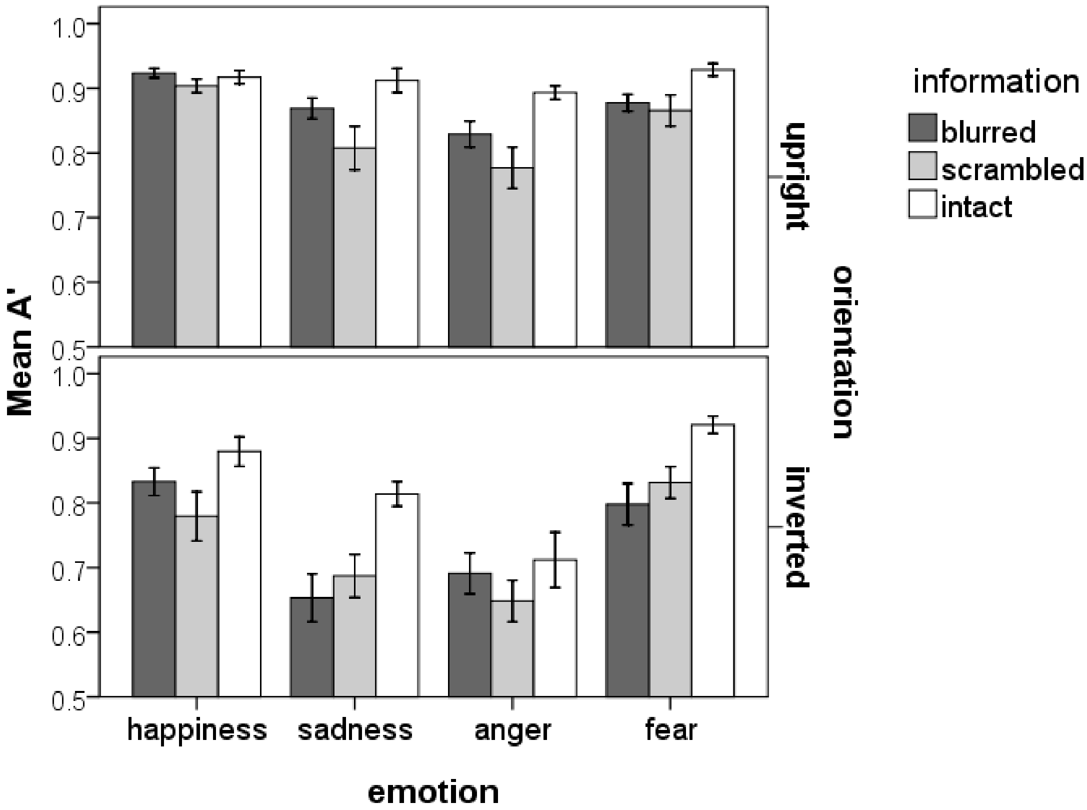


Figure 2


1.0
0.9
0.8
0.7
0.6
0.5
Mean A'
upright
inverted
orientation
happiness
sadness
anger
fear
emotion
information
blurred
scrambled
intact

C) STUDY 2

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How Mood and Gender Affect Information Processing During Facial Emotion Recognition: An Eye Tracking Study

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Abstract

Existing research shows that sad mood hinders emotion recognition and that mood affects information processing. Happy mood facilitates global processing, thus Gestalt-like impressions of integrating details, and sad mood is related to local processing, thus focusing on details. Also, women outperform men in emotion recognition tasks. The present study investigated how mood and gender affect information processing during an emotion recognition task. Thirty-three participants were induced with happy or sad mood in a within-subjects design. They performed an emotion recognition task during which eye movements were registered. Eye movements served to gain information about participants' global or local information processing style. When happy, participants processed information more globally than when sad. Global processing was positively and local processing negatively related to emotion recognition in sad but not in happy mood. Overall women performed better than men; but men unlike women recognized the emotions better in happy compared to sad mood.

How Mood and Gender Affect Information Processing During Facial Emotion Recognition: An Eye Tracking Study

Facial expressions of emotions are important cues in social communication. Emotional expressions coordinate social interactions by providing information about the sender's emotional and intentional states and/or the nature of the relationship between the two interaction partners. In general, people reliably recognize emotions from faces, however, there are huge individual differences due to age, general intelligence, attention, or task-specific motivation (Herba & Phillips, 2004; Moore, 2001). Although it is known that the ability to recognize other people's emotions is crucial to experience positive social interactions, the underlying mechanism of being accurate at emotion recognition is still unclear. In the present paper, we ask whether it is a rather global (used when a holistic, gestalt-like impression about others is formed) or local (deeper analysis of detailed information such as the eyes, the mouth, and the nose) information processing style that is beneficial for accurate emotion recognition and how mood affects the information processing style and emotion recognition.

How Information Processing Affects Emotion Recognition

There is reason to assume that global processing is favorable for emotion recognition. Evidence for this suggestion comes from a study that investigated the composite effect in emotion recognition: Calder, Young, Keane, and Dean (2000) cut faces expressing different emotions in an upper and a lower part and then presented an upper part together with a lower part each with a different emotional expression. The faces were either presented aligned, (= composite, forming a new face, the face can be perceived globally) or misaligned (= non composite, upper and lower part are misaligned on the horizontal axis, the global form is therefore not intact). Participants were instructed to recognize the emotion in either the upper or the lower part of the face. Participants recognized emotions slower when faces were aligned than when they were misaligned. This shows that participants have difficulties to ignore the global information in aligned faces, even when they were instructed to focus only on one half of the face. Global information therefore seems to play an important role in emotion recognition.

Further support for the suggestion that a global information processing style is important for emotion recognition comes from studies on face inversion. We know from face recognition that face inversion hampers configural processing (e.g., Yin, 1969). Configural information refers to the interrelationships between different facial features such as the eyes, the mouth, and the nose. This information is needed in order to form a gestalt-like, global impression, and therefore, the concepts of configural and global processing are somewhat related. Prkachin (2003a) showed that emotions in inverted faces were less well recognized than in upright faces, giving evidence that configural is important for emotion recognition. Because configural information contributes to global processing, this also stresses the role of global processing in the recognition of emotions.

There are several factors that might influence a person's way to process information. The following paragraphs will demonstrate how mood and gender can influence information processing and how mood and gender might affect emotion recognition accuracy.

How Mood Affects Information Processing

In the domain of persuasion it is well documented that mood affects information processing: People in sad mood process information more deliberately and search for detailed information before making a judgment. In contrast, people in happy mood use a more automatic, heuristic information processing style and judgments are made on the basis of an overall impression (e.g., Bless, et al., 1996). Gasper and Clore (2002) assumed that these two processing styles have consequences for global versus local perception, and asked happy and sad participants to perform the global-local focus test by Kimchi and Palmer (1982). This test contains hierarchical figures consisting of small triangles or squares (local attributes) forming a larger triangle or square (global attribute). Three of those figures were simultaneously presented, a standard figure with two other figures, one of them sharing the global attribute and the other sharing the local attribute with the standard figure. The task was to indicate which of the two figures was more similar to the standard figure. Results showed that sad people relied more often on the local attributes (and as a consequence less often on the global attributes) than happy people. This is evidence that happy mood triggers global information processing whereas sad mood triggers local information processing.

Mood Effects on Emotion Recognition

If people in sad mood use more local processing and if local processing hinders emotion recognition accuracy, one might expect that participants recognize emotions worse in sad mood compared to happy mood. There is empirical evidence suggesting that a person's mood can affect emotion recognition. Several studies showed that sad or depressed mood has detrimental effects on emotion recognition accuracy compared to a control group in neutral mood (Chepenik, et al., 2007; Surguladze, et al., 2004). Interestingly, almost no research to date has investigated how happy mood influences emotion recognition. We therefore do not know if happy mood increases emotion recognition accuracy because of they use the global information processing style. Schmid and Schmid Mast (2009), found that participants primed with happy and sad mood performed equally well, but they were less accurate than participants in neutral mood. The scarcity of existing findings focusing directly on the effect of positive mood on emotion recognition makes predictions tentative.

How Gender Affects Information Processing

Neuroimaging studies suggest gender differences in the processing of emotional information in a face. For instance, G. B. C. Hall, Witelson, Szechtman, and Nahmias (2003) exposed participants to different series of two pictures of faces expressing different emotions. Simultaneously they heard a voice speaking about emotional content. Participants had to choose which one of two presented faces expressed the same emotion as the voice. The authors found more limbic activity in women than in men and men showed more left hemispheric frontal cortical activation. Left hemispheric activation has been linked to analytic processing (Lobmaier, et al., 2008), which suggests that men adopt a more analytic and local processing style. A model described by Damasio (1994) supports the assumption that men rather use a local information processing style; women in turn, seem to use a global information processing style. The model states that the limbic system is involved when reacting to primary emotions such as fear or disgust where appropriate reactions might be crucial for surviving. These reactions ought to be faster, more automatic, and innate. The enhanced limbic activation in women compared to men might indicate that women process information more automatic and global than men.

Gender Effects on Emotion Recognition

One of the most widely studied factors influencing facial emotion recognition accuracy is gender. Meta-analyses show that females outperform males with respect to emotion recognition for most of the emotions (see McClure, 2000 for a meta-analysis).

Bringing together the existing literature on gender difference in emotion recognition and on how different mood states and different information processing styles affect emotion recognition, we tested the following predictions: Happy participants use a more global information processing style compared to sad participants (*Hypothesis 1a*) and sad people use a more local information processing style compared to happy people (*Hypothesis 1b*). Happy people outperform sad people in emotion recognition (*Hypothesis 2*). Women recognize emotions more accurately than men (*Hypothesis 3*). If the mechanism explaining the gender difference in emotion recognition indeed lies in different information processing styles of women and men, we predict that women process information more globally than men (*Hypothesis 4a*) and that men process information more locally than women (*Hypothesis 4b*). Moreover, we expect that the more a person processes information globally, the better the emotion recognition performance (*Hypothesis 5a*) and the more a person processes information locally, the worse he or she will perform on the emotion recognition task (*Hypothesis 5b*).

To assess whether a participant used a global or a local processing style, we measured the participants' eye movements during an emotion recognition task. From the eye scan paths we extracted a measure for local information processing and a measure for global information processing, both explained in more detail in the Method section.

Method

Participants

Participants were 33 university students (14 male / 19 female) majoring in different branches (*M* age = 23.18, *SD* = 3.43) who were remunerated with the equivalent of 30 US dollars. They all reported normal or corrected to normal vision and gave their informed consent to participating in the study.

Procedure

Participants came for two testing sessions on different days (1 to 2 days apart). At the beginning of the first session, they learned the four response keys (happy, sad, angry, and fearful) for the emotion recognition task by heart so that they would not have to look down at the keys during eye tracking. They were then randomly assigned to one of two mood primings, happy or sad. Both happy and sad mood inductions were achieved by showing the participants fragments of films. To check whether mood priming was successful we asked the participants "How do you feel at this moment?" (on a 6-point Likert scale of 1 = extremely sad to 6 = extremely happy) after they watched the films. They answered). Participants then performed part one of the emotion recognition task. Part two was presented to the participants in the second session (random allocation). In the second session, they were primed with sad if the priming in the first session was happy and vice versa. During the emotion recognition task, the eye movements were tracked.

Measures

Mood priming. Happy mood was induced with a film scene from “When Harry met Sally”. A film scene from “The Champ” was used to induce sad mood. The film scenes lasted between 2 and 3 minutes. They have been found to successfully induce happy and sad mood (Rottenberg, Ray, & Gross, 2007) and therefore have been used extensively as mood induction procedure in previous research.

Emotion Recognition Task. For the emotion recognition task, two different sets of stimuli were combined, the DANVA 2-AF (S. J. Nowicki & M. P. Duke, 1994) and the Ekman and Friesen (1976) series. The DANVA consists of 24 pictures of people expressing emotions on their face: happiness, fear, anger, or sadness. Further, 40 stimuli from the Ekman and Friesen series of basic emotions showing the same emotions expressed were used. The stimuli sets were divided in two parts (one for each of the two sessions). Each part consisted of 12 stimuli from the DANVA and of 20 stimuli from the Ekman and Friesen series. The size of the pictures was 14 x 21 cm, the visual angle about 13° x 20°. Stimuli were presented during four seconds and were followed by a 5s mask (blank screen). Participants could respond during stimulus exposure or during the mask period (time frame of 9 s). Because we were only interested in eye movements in the face, we discarded irrelevant information such as hair and clothing information of the target persons. The adapted pictures consisted of an oval containing only the face, standardized for shape and size (see *Figure 1*). Each participant’s score on the emotion recognition task was calculated as the percentage of correct answers over the two test sets.

Eye tracking

To register eye movements we used a Hi-Speed 1250 tracking system, SMI-SensoMotoric Instruments (Teltow, Germany). We solely analysed eye movements that were performed before the answer to the emotion recognition task was given.

Interfeatural Saccade Ratio. We calculated a ratio comparing the amount of saccades that were performed between two different features with the amount of all performed saccades (in order to correct for the varying exposure times that result from the different reaction times). Features included the left eye, the right eye, the mouth and the nose. A high score on this ratio indicates a global information processing style (i.e., integrating information and forming an overall impression).

Gaze duration. Gaze duration was measured in a similar way as in the Bombari, Mast, and Lobmaier (in press) study. Gaze duration refers to the mean time spent inside a feature before leaving it. Consecutive fixations that were performed within the same feature were first summed up. Fixations that were shorter than 100 ms were not taken into account. Longer gaze duration indicates local processing, information is analyzed in detail.

Results

Manipulation check showed that after happy mood priming, participants felt significantly happier than after sad mood priming $t(30) = 7.97$, $p < .001$ ($M = 3.06$ after sad mood priming, $M = 4.35$ after happy mood priming).

To test whether happy participants processed more globally than sad participants (*Hypothesis 1a*), and whether women adopt a more global processing style than men (*Hypothesis 4a*), we calculated a mixed model ANOVA with gender as between-subjects factor and mood priming (happy vs. sad mood) as the within-subjects factor, with interfeatural saccade ratio as the dependent variable[1]. Order of mood priming and order of the test parts were entered as covariates in the analyses[2]. There was a significant mood priming main effect, $F(1, 25) = 6.41$, $p = .018$, indicating that induced happy mood resulted in a higher interfeatural saccade ratio ($M = .40$) than induced sad mood ($M = .39$) which confirmed *Hypothesis 1a*.

Also a marginally significant gender main effect emerged (significant when one-tailed), $F(1, 25) = 3.09$, $p = .091$, showing that females had a higher interfeatural saccade ratio ($M = .45$)

than males (*M* = .34) as predicted in *Hypothesis 4a*. The interaction effect was not significant, *F*(1, 25) = 0.02, *p* = .888.

To test *Hypothesis 1b* predicting that sad mood priming results in more local processing than happy mood priming and *Hypothesis 4b* that men use a rather local processing style compared to women we calculated the same ANOVA described above for local processing (gaze duration) as the dependent variable). Contrary to expectation in *Hypothesis 1b*, the ANOVA revealed no significant mood priming main effect, *F*(1, 25) = 0.02, *p* = .893. *Hypothesis 4b* concerning the mood main effect was confirmed, males fixated longer (*M* = 657.20) than females (*M* = 320.40), *F*(1,25) = 7.99, *p* = .009. The mood priming by gender interaction effect did not reach statistical significance, *F*(1, 25) = 0.11, *p* = .743.

To look at emotion recognition accuracy, we calculated a mixed model ANOVA with gender as between-subjects factor and mood priming (happy vs. sad mood) as the within-subjects factor and mean proportion of correct responses in the emotion recognition task as the dependent variable. Contrary to *Hypothesis 2*, there was no significant main effect of mood priming, *F*(1, 29) =1.26, *p* = .272, however, a marginally significant mood priming by gender interaction effect emerged, *F*(1, 29) = 3.17, *p* = .085. Men tended to recognize emotions better in happy mood (*M* = .83) than in sad mood (*M* = .79), in line with our initial prediction. However, no such mood priming difference emerged for women (*M* = .85 in happy mood and *M* = .86 in sad mood). As predicted in *Hypothesis 3*, there was a significant main effect of gender indicating that females performed better than males (*M* = 0.85 for females and *M* = 0.81 for males; *F*(1, 29) = 4.63, *p* = .040.

To test *Hypothesis 5a* predicting a positive relation between global processing and emotion recognition, we correlated the interfeatural saccade ratio with emotion recognition accuracy (partialling out gender). All reported correlations were tested are one-tailed. Results showed that for sad mood there was the predicted positive relation between global processing style and emotion recognition, *pr*(26) = .39, *p* = .021, whereas for happy mood it was not, *pr*(26) = -.06, *p* = .376. The difference between the two correlations was marginally significant (*p* = .089). To test the *Hypothesis 5b* predicting that local processing is related to a decrease in emotion recognition, we calculated a partial correlation between gaze duration and emotion recognition. Correlations (partialling out gender) confirmed *Hypothesis 5b* for sad mood where we found that longer gaze duration was related to decreased emotion recognition, *rp*(26) = -.31, *p* = .050, however, the predicted negative relation was not found for happy mood, *rp*(26) = .17, *p* = .192. The difference between the two correlations was marginally significant (*p* = .075).

Note that there was a negative correlation between interfeatural saccade ratio and gaze duration for happy mood, *r*(29) = -.50, *p* = .006, as well as for sad mood, *r*(29) = -.57, *p* = .001.

Discussion

This study focused on the influences of gender, mood, and information processing on emotion recognition. As expected, happy mood resulted in more global information processing than sad mood (*Hypothesis 1a*). However, happy mood did not entail less local processing than sad mood (*Hypothesis 1b*). We predicted that happy participants would perform better on a facial emotion recognition task than sad participants (*Hypothesis 2*) and found that men but not women showed a tendency to recognize emotions better in happy mood compared to sad mood. In line with our hypotheses, we found that women outperformed men on the emotion recognition task (*Hypothesis 3*) and we also confirmed that women process information more globally and less locally than men (*Hypotheses 4a and 4b*). The hypothesized positive correlation between global information processing and emotion recognition and the negative correlation between local processing and emotion recognition could only be confirmed for sad but not for happy mood (*Hypotheses 5a and 5b*).

Research on persuasion suggested that information processing depends on a person's mood; happy mood is supposed to boost global processing, and sad mood is supposed to boost local processing (Gasper & Clore, 2002). We showed that the link between mood and information processing also appears for emotion recognition: Participants in happy mood had a larger interfeatural saccade ratio (indicator for global processing) compared to participants in sad mood. That is, we showed that mood affects the way we process information.

We found further evidence that the global information processing style is more favorable for emotion recognition than the local information processing style. Global information processing was positively and local information processing was negatively related to emotion recognition accuracy – however, this link could only be found for participants in sad mood but not for participants in happy mood. The fact that happy primed people engage in more global processing than sad primed people (according to our results) might be the reason why we did not find an association between information processing and emotion recognition accuracy for happy participants. Participants in the happy group already use the more favorable global information processing style and were thus less affected by other factors such as mood when they identify emotions in others.

We failed to show a direct link between mood and emotion recognition. Remember that previous studies found that sad mood decreased emotion recognition compared to a neutral mood condition (e.g., Chepenik, et al., 2007). A reason why this emotion recognition accuracy decrement in sad mood did not come out in our study might be the lack of a control group in neutral mood. It is possible that happy and sad mood both affected performance negatively, and therefore no mood priming main effect was found. But why did participants in happy mood who used more of the "better" global information processing style not outperform sad participants? It is possible that both happy and sad mood resulted in cognitive load, because participants had to handle their mood state. Cognitive load might then have affected higher level processing. More precisely, happy participants might perform more global eye movements and gained therefore more reliable information than participants in sad mod, but if then cognitive load is high (because participants have to handle their mood) they might not being able to take profit of their reliable information and therefore happy participants' performance might be on the same level as sad participants' performance. Support for this argumentation comes from Phillips, Channon, Tunstall, Hedenstrom, and Lyons (2008) who showed that cognitive load had detrimental effects on emotion recognition accuracy.

A limitation of our study is the lack of a control group in neutral mood. Such a control group could clarify if both happy and sad mood decrease emotion recognition performance, or if accuracy is just not dependent on a person's mood. Also, further research is needed to investigate the possible mood by gender interaction effect (that was marginal significant in our study) by including a control group in neutral mood.

Besides the effects of mood on information processing we also predicted that gender would affect information processing. In line with the literature (McClure, 2000), women outperformed men. Our hypotheses concerning gender effects on information processing could be confirmed as well; women processed information less locally than men, and when tested one-tailed (which is acceptable when there is a directed hypothesis as it is in this case) we also found that women process information more globally than men. G. B. C. Hall et al. (2003) already found evidence in brain data that women and men process emotional information differently. The present study showed that this gender difference in information processing during emotion recognition does not only appear in brain data but also on a behavioral level when scanning the faces. Women do not only recognize emotions better than men, they are also more expressive than men (J. A. Hall, 1984). Further, mothers express more emotions and emphasize more often the emotional content of social interactions to their daughters than to their sons (Fivush, 1991). This suggests that women may have a special interest and expertise concerning emotions which appears at an early age already due to a different treatment of boys and girls by their mothers. Zangemeister, Sherman, and Stark (1995) showed that expertise might lead to more global processing. The authors compared eye movements of professional art viewers to unprofessional novices and reported a more global scanpath for professionals compared to novices. Note that men are not novices in emotion recognition; they perform clearly at above chance level and are as well exposed to other people's emotions. However, compared to men, women seem to be more experienced in reading and expressing emotions and might therefore adopt relatively more of the expert's processing style which is the global processing style than men.

The aim of this study was to provide further insights to the scarce research on the effects of mood and gender on emotion recognition. Existing literature on depression and the few studies that examined mood effects on the ability to decode nonverbal cues often argued that effects of sad or depressed mood were due to the different information processing styles adopted by sad / depressed and happy people (e.g., Ambady & Gray, 2002). Although there is literature showing that there is actually a link between mood and information processing, this had never been examined for emotion recognition. Also, a lot of studies reported gender differences in emotion recognition accuracy (McClure, 2000), however, in order to understand why we need to know what men and women do differently when recognizing emotions. The present study showed that men and women rely on different kind of information during emotion recognition. The present study helps therefore to better understand the mechanism underlying accurate emotion recognition. Because the ability to correctly recognize other people's emotions is important to experience positive interactions (Keltner & Kring, 1998) there should be an interest in improving this capability.

Understanding how correct emotion recognition works is a first step in order to search for possibilities to ameliorate emotion recognition accuracy.

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Footnotes

[1] Because of calibration problems we had to suppress four participants resulting in N = 29.

[2] We were not interested in whether order affected our results which is why we do not report any effects of order. There was only one main effect of mood priming order and one interaction effect of mood priming order by mood priming.

Figure Caption

Figure 1. A selection of the modified stimuli of the emotion recognition task

D) STUDY 3

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Mood Effects on Emotion Recognition

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Abstract

Mood affects memory and social judgments. Although mood-congruity effects have been reported for memory, it remains unclear, if they also occur on emotion recognition. Moreover, findings are not consistent with regard to how mood affects emotion recognition: Some studies find negative bias for sad mood (in line with mood-congruity theories) while other studies find general performance decrements in emotion recognition for sad mood. The influence of happy mood on emotion recognition is even less examined. Most studies have been conducted with clinical samples (depression or mania) and not with healthy individuals and especially data for happy mood effects is missing. We induced 93 participants with happy, sad, or neutral mood and had them perform an emotion recognition task. Results showed that happy emotion recognition was reduced in sad participants (negative bias), and sad emotion recognition was decreased in happy participants (positive bias) compared to a control group in neutral mood.

Key words: mood, emotion recognition, positive and negative biases

Mood Effects on Emotion Recognition

Mood can affect social judgment. For instance, mood has been found to influence justice judgments in that anger and disgust evoked through juridical evidence lead to a higher rate of sentencing (Bright & Goodman-Delahunty, 2006). Ambady and Gray (2002) showed that sad mood reduced accuracy in judgments of teacher effectiveness as well as in judgments of type of relationship. Also, there is evidence that mood affects the ability to recognize other people's emotions. However, researchers disagree on how exactly mood influences emotion recognition. Negative mood compared to neutral mood seems to decrease emotion recognition accuracy (Asthana, et al., 1998; Chepenik, et al., 2007; Surguladze, et al., 2004; Zuroff & Colussy, 1986), but not all studies found this effect (e.g., Loeb, Feshbach, Beck, & Wolf, 1964). Moreover, in some studies a negative bias emerged, meaning that sad mood makes it easier to correctly recognize sad as opposed to happy faces (Bouhuys, et al., 1995; Gray, et al., 2006; Gur, et al., 1992; Hale, 1997; Niedenthal, et al., 2000). Much less research has been conducted on happy mood. Mood-congruity theories (Bower, 1981; Schwarz, 1990) would suggest that happy mood makes it easier to correctly recognize happy as opposed to sad faces (positive bias) and there is some empirical evidence supporting this view (Lembke & Ketter, 2002). However, also overall performance decrements were reported for patients with mania (who experience happy mood) (e.g., Getz, Shear, & Strakowski, 2003) and some authors argue in favor of an overall performance enhancement (Bless, et al., 1990).

Happy and sad people differ in their way to process information. When sad, people are more detail-oriented and more deliberate in their judgments and when happy, people process information more automatically and holistically (Bless, et al., 1990). There is evidence that for correct social judgments, the automatic and holistic processing style is more favorable and that deliberation might hinder accuracy (e.g., Ambady & Gray, 2002). The following paragraphs provide more information about mood-congruity effects and performance decrement in emotion recognition due to different mood states.

Mood-Congruity Effects in Emotion Recognition

Mood-congruity theories predict that a person's mood exerts a mood-congruent effect on memory and social judgments. Being in a positive mood makes an individual better in remembering positive stimuli and facilitates positive judgments about other people (positive bias). Being in a negative mood entails better performance in recalling negative stimuli and makes an individual prone to judge others in a negative way (negative bias). Several theories describe why mood-congruity effects occur. The two most important theories are Bower's network theory of affect (Bower, 1981) and mood-as-information theory (Schwarz, 1990). In Bower's network theory of affect, emotion or mood is described as an affective node. Affective nodes are connected with other nodes reflecting similar affects. For example, nodes that reflect depressive experiences would be connected with nodes reflecting low self-esteem and the feeling of loneliness. Thus, when a person is in a specific mood state, information and cognitions of the same emotional valence will be automatically activated and will thus be more easily accessible. Conversely, mood-incongruent information will be less well accessible in the network. Thus, mood functions as an affect priming.

The affect-as-information theory by Schwarz (1990) explains mood-congruity effects in the following way: Mood can affect judgments when people inadvertently attribute irrelevant affects (their own current mood state) to something or somebody. People tend to think that it was the object or the person that provoked their mood state.

Mood-congruity research has focused almost exclusively on memory effects. Matt, Vàsquez, and Campbell (1992) showed in a meta-analytic review that clinically depressed, induced depressed, and induced elated individuals showed mood-congruent recall. In other words, clinically and induced depressed individuals recalled more negative stimuli than positive stimuli (e.g., words or stories) and induced elated subjects recalled more positive than negative stimuli.

With respect to emotion recognition, much less research has been done. Mood-congruity theories would predict that sad mood leads to a negative bias, thus to better emotion recognition of sad compared to happy faces, whereas happy mood should lead to a positive bias: happy faces should be better recognized than sad faces. Empirical support for a mood-congruity effect in emotion recognition is equivocal. In a study by Gur et al. (1992), participants had to indicate on a scale whether the emotional expression of a face was happy, sad, or neutral. Depressives showed a negative bias by misinterpreting neutral faces as sad and happy faces as neutral. Hale (1997) used schematic facial expressions to test if depressives differ in their emotion recognition ability compared to controls. Some of the facial expressions were ambiguous – they contained equal amounts of positive and negative emotions (features of different emotional expressions such as a smiling mouth and eyebrows forming a tent were combined). Depressives saw more sadness in the faces in comparison to the control group. This negative bias has also been found in non clinical populations: Bouhuys, Bloem, and Groothuis (1995) used the same schematic faces as Hale and found that participants in induced sad mood perceived more rejection and sadness in ambiguous faces (expressing a similar amount of positive and negative emotions) as well as less invitation and happiness in unambiguous faces (expressing a preponderate amount of either positive or negative emotions) compared to induced happy participants. However, as will be discussed below, not all studies found the negative bias in sad people when it comes to emotion recognition but a general emotion recognition decrement instead (e.g., Chepenik, et al., 2007; Surguladze, et al., 2004; Zuroff & Colussy, 1986).

Mood-congruity theories not only predict a negative bias for individuals in sad mood, but also a positive bias for individuals in happy mood. There is only scarce research on the positive bias. Niedenthal, Halberstadt, Margolin, and Innes-Ker (2000) provide evidence for both a negative and positive bias in emotion recognition: They induced happy, sad, or neutral mood and exposed participants to stimuli that consisted of happy expressions that changed into neutral expression through a morphing procedure, as well as sad expressions that changed into neutral expressions. Expressions changed according to the position of a sliding bar. Participants had to drag the bar to the frame at which they perceived no longer the initial emotional expression (sadness, or happiness). Results indicated that after a happy mood induction, participants fixed the threshold of the happy emotional expression at a later frame, thus closer to the neutral expression than for the sad emotional expression. The opposite was found for participants with induced sad mood: when emotional expressions (happy or sad) became neutral, participants saw the sad emotion for a longer time in the face than the happy emotion and therefore set the threshold of the sad emotional expression at a later frame than the threshold for the happy emotions. Participants in neutral mood perceived the threshold of the happy and sad emotional expressions at around the same threshold. Therefore, when happy, participants saw more happiness than sadness in faces and when sad, the opposite effect emerged. In the same vein, Lembke and Ketter (2002) showed that manic individuals' performance was impaired when recognizing several negative emotions (e.g., fear, disgust) but not when recognizing happy emotions.

However, also positive bias in emotion recognition is not a consistent finding: Gray et al. (2006) examined emotion recognition in bipolar patients and compared patients in depressed state (who experience sad mood) to patients in manic state (who experience happy mood) and reported mood-congruity effects during depressed episodes (negative bias) but no mood-congruity effect for manic patients, thus no positive bias.

Mood and Performance Decrement in Emotion Recognition

As mentioned earlier not only mood-congruent biases had been found for happy and sad people when recognizing emotions. Another line of research suggests that individuals in sad mood show an overall performance decrement in emotion recognition compared to a control group instead of specific deficits such as the negative bias. The same overall decrement has been reported for manic individuals who experience happy mood (e.g., Getz, et al., 2003), even though there is theory that would predict increased emotion recognition ability in happy people due to a more favorable information processing style (Bless, et al., 1990).

Concerning the performance decrement in depression, an explanation may come from Beck's cognitive view of depression (1976). His theory says that depressed individuals have incorrect perceptions of situations and events. Applied on the ability to recognize other people's emotions one could conclude that depressives might have incorrect perceptions of other people's emotions.

Empirical evidence for a performance decrement in sad mood comes from Zuroff and Colussy (1986): depressed patients were in general less accurate on Izard's (1971) test of emotion (a test including eight different emotions: sadness, shame, anger, fear, disgust, joy, interest, and surprise) but they did not find evidence for a negative bias. Also, Surguladze, Young, Senior, Brébion, Travis, and Phillips (2004) reported that people with major depressive disorders were less accurate than controls in an emotion recognition task. The authors presented standardized photographs with happy, sad, and neutral expressions. Results showed that depressed participants were significantly more impaired in recognizing emotion of both, happy and sad faces than non-depressed participants, and even more impaired in recognizing sad expressions than in recognizing happy expressions which contradicts mood-congruity theories. Also, Asthana, Mandal, Khurana, and Haque-Nizamie (1998) reported a general emotion recognition performance decrement in depressed individuals using photographs of faces expressing happy, sad, fearful, angry or neutral expression. Chepenik, Cornew and Farah (2007) looked at a healthy sample and compared induced participants with sad or neutral mood before testing them on their emotion recognition ability by using the Ekman photographs containing people displaying happiness, sadness, anger, fear, or a neutral expression. Sad mood participants showed an emotion recognition deficit, but no negative bias as mood-congruity theory would predict.

The few studies focusing on the influence of happy mood on emotion recognition have been done with a clinical sample (manic patients). Getz, Shear, and Strakowski (2003) reported that individual with bipolar disorder that experience a manic episode show overall deficits on the Ekman and Friesen (1976) emotion recognition test. Lembke and Ketter (2002) found that manic patients, exhibit overall decreases in emotion recognition accuracy on the Ekman and Friesen (1976) series. Having a closer look at the different affective stimuli, one can see that this is due to negative emotional expressions such as fear and disgust, and not due to positive emotional expressions. If healthy individual s in happy mood show the same biases as manic patients remains an open question. As mentioned earlier there is also theory that would expect happy people to have an enhanced ability to recognize emotions because they use a more favorable information processing style (Bless, et al., 1990).

The Present Study

To summarize, both mood-congruity effects and overall performance decrements have been found for individuals in sad and happy mood. It would be possible that both effects occur simultaneously; however, previous studies either focused on just one effect, or found just either mood-congruity effects or general performance decrement but not both. All in all, there is no clear picture on how positive and negative mood affects emotion recognition. One of the reasons why the results in the existing literature are ambiguous might be that existing studies are very heterogeneous with respect to the participants examined (e.g., clinically depressed or manic patients, induced sad or happy participants), the methods used (e.g., line-drawn faces, schematic faces, still pictures of real persons expressing emotions), or the amount and type of emotions examined (e.g., happiness, sadness, anger, surprise). Most studies have been conducted with individuals suffering from affective disorders that experience happy (in case of mania) or sad (in case of depression) mood, but who might also have additional cognitive impairments which could explain the results obtained. Moreover, there is much more research on the influence of sadness than of happiness on emotion recognition. The aim of the present study is to gain a better understanding of how positive and negative mood affect emotion recognition in healthy individuals. We expect that manipulation of mood will lead to mood-congruent biases. More specifically, we predict a positive bias for participants in happy mood (better recognition of happy faces compared to sad faces) and a negative bias for participants in sad mood (better recognition of sad compared to happy faces). We will further examine if mood boosts the recognition of mood-congruent or hinders the recognition of mood-incongruent faces. We expect that sad mood will decrease overall emotion recognition performance compared to neutral mood. Additionally, we explore whether happy mood leads to overall performance decrement or improvement.

Because it is well documented that women are better at forming correct impressions of others in general and at correctly reading others emotions (for meta-analyses: J. A. Hall, 1978, 1984) we test how participant gender influences emotion recognition and/or bias. McClure (2000) showed in a meta-analysis that women outperform men on the recognition of most emotions (anger is an exception). Because women are more expressive than men (J. A. Hall, 1984) and score higher on tests measuring Emotional Intelligence (Brackett, Rivers, Shiffman, Lerner, & Salovey, 2006) one could conclude that women have special interest and expertise with regards to emotions (Hall & Schmid Mast, 2008). This expertise might be the reason why women outperform men on emotion recognition tasks. We thus expect that women will outperform men on the emotion recognition task. To the best of the authors' knowledge, to date, no research examined gender differences concerning mood-congruity effects or emotion recognition performance decrement due to influences of mood.

Method

Participants

Participants were 93 students, 51 women, 42 men. Their average age was 23.45 (*SD* = 3.27). Participants were not paid but had the possibility to win one of four i-pods shuffle.

Procedure

Participants were welcomed, signed an informed consent form, and were then randomly assigned to one of three mood priming conditions: happy, sad, or neutral. Mood priming was performed by short film scenes (described in more detail later). To check whether the priming took effect, we asked participants right after having watched the movie scenes how they felt using a 7-point Likert scale (1 = extremely sad, 7 = extremely happy, 4 = neutral). Participants then performed an emotion recognition task (described in more detail below). In order to keep participants in the initially induced mood state, participants listened to happy, sad, or neutral induced mood-congruent music during the emotion recognition task.

Material

Mood priming. Mood was induced by using one of three different 2-3 min film scenes that have been validated to induce positive, negative, or neutral mood (Rottenberg, et al., 2007). A film scene from "When Harry Met Sally" was used in order to induce happy mood. A scene from "The Champ" was used for sad mood induction. For the neutral mood condition, a screen-saver animation was presented, showing sticks in different colors. During the emotion recognition task emotionally valenced music (same valence as in the film priming) was audible for participants via a headset. The music was selected based on previous research (Gerrards-Hesse, Spies, & Hesse, 1994 for an overview). Participants in the positive mood condition listened to “Mazurka” from Coppelia by Léo Delibes, “Divertimento in D Major #136” and “Eine kleine Nachtmusik” (Serenade 13 in G Major) by Wolfgang Amadeus Mozart. For the negative mood condition we used “Adagio in G Minor” by Tomaso Albinoni, “Adagio for Strings” by Samuel Barber, and “Preludes” (Opus 28#6) by Frédéric Chopin. To put participants in neutral mood, the following music has been chosen “Common Tones in Simple Time” by John Adams, “Neptune – The Mystic” out of The Planets by Gustav Holst, and “Aerial Boundaries” by Michael Hedges.

Emotion Recognition Task. For the emotion recognition task, we used 60 different stimuli from the Facial Expressions of Emotion: Stimuli and Tests (FEEST: Young, et al., 2002). Stimuli contained 30 happy and 30 sad facial expressions of emotions and were displayed by 10 different male and female targets. Facial expressions of emotions were morphed in order to change the intensity of the happy and sad emotional expression. The morphed faces expressed 25%, 50%, or 75% of happiness resp. sadness. Stimuli were presented during 2000 ms, because this exposure time is used in standardized emotion recognition tests using photographs such as the Diagnostic Analysis of Nonverbal Accuracy (S. J. Nowicki & M. P. Duke, 1994). Also, Surguladze et al. (2004) used this exposure time for the FEEST. Participants could answer as soon as the stimuli disappeared; there was no fixed time frame for the answers.

Manipulation Check

An ANOVA with mood priming as independent variable and participants’ reported mood as the dependent variable was conducted in order to check if mood priming worked. The mood priming main effect was significant, $F(2,90) = 10.53$, $p < .001$. Contrast analyses showed that participants felt significantly happier after happy mood priming (*M* = 5.44) than after neutral mood priming (*M* = 4.90), *p* = .029, and participants felt significantly less happy after sad mood priming (*M* = 4.34) than after neutral mood priming, *p* = .026.

Results

A mixed model ANOVA was calculated in order to examine mood effects on emotion recognition. The within-subjects factors were the facial expressions (happy vs. sad) and the intensity of the facial expression (25%, 50%, or 75%). The between-subjects factors were mood priming (happy, neutral, sad) and gender. Results showed the predicted mood-congruity effect represented in the interaction of facial expressions by mood priming, $F(2,87) = 4.41$, $p = .015$ (Figure 1): *t*-tests showed that people in sad mood recognize sad faces (*M* = 27.31) relatively better than they recognized happy faces (*M* = 25.50), $t(31) = 2.99$, $p = .005$, therefore confirming the expected negative bias for sad mood. The opposite pattern was found for happy mood: Means for participants primed with happy mood went in the direction of a happy bias (*M* = 26.59 for happy faces, and *M* = 25.72 for sad faces). However, the difference was not significant, $t(31) = 1.26$, $p = .216$. Participants primed with neutral mood showed no difference in recognizing happy (*M* = 26.79) as compared to sad faces (*M* = 27.21), $t(28) = 0.68$, $p = .501$.

But did mood-congruity effects emerge due to a better recognition of mood-congruent emotions or due to an impaired recognition of mood-incongruent emotions? To test whether the negative bias was due to sad mood increasing emotion recognition of mood-congruent, sad faces compared to participants judging sad faces in neutral mood, we calculated a simple main effect and found no significant difference (sad mood: *M* = 27.31; neutral mood: *M* = 27.21), $t(59) = 0.23$, $p = .817$. Negative bias in sad mood must therefore have occurred due to an impaired recognition of mood-incongruent happy faces. Indeed, participants in sad mood recognized the happy emotions marginally less well than participants in neutral mood (for sad mood: *M* = 25.50; for neutral mood: *M* = 26.79), $t(59) = 1.87$, $p = .067$.

When comparing the recognition of happy and sad emotions of participants in happy and in neutral mood, we found a corresponding pattern. Happy emotions were recognized equally well in happy mood (*M* = 26.59) as they were recognized in neutral mood (*M* = 26.79), $t(59) = 0.34$, $p = .738$. However, the mood-incongruent sad emotions were less well recognized in happy mood (*M* = 25.72) compared to when in neutral mood (*M* = 27.21), $t(59) = 2.68$, $p = .010$. Therefore mood did not facilitate the recognition of mood-congruent facial expressions but hindered the recognition of mood-incongruent facial expressions (see Figure 1).

The mixed model ANOVA further revealed a marginally significant mood priming main effect $F(2,87) = 2.58$, $p = .082$. Contrast analyses confirmed the hypothesis that in neutral mood (*M* = 8.99), participants performed better than in happy (*M* = 8.71), $p = .015$, and than in sad mood (*M* = 8.78) $p = .05$ (both one-tailed). No significant difference between happy and sad participants emerged, $p = .557$.

The mixed model ANOVA further revealed a significant facial expressions by facial expression intensity interaction $F(1.20,104.15) = 20.81$, $p < .001$ (Huynh-Feldt corrected values) showing that when emotions were expressed with an intensity of 25%, sad faces (*M* = 8.05) were better recognized than happy faces (*M* = 6.99) $t(92) = 3.60$, $p = .001$, whereas the contrary was found when emotions were expressed with 50% or 75% intensities (for 50% intensity: *M* = 9.46 for happy faces, *M* = 9.14 for sad faces, $t(92) = 2.84$, $p = .006$; for 75% intensity: *M* = 9.83 for happy faces, *M* = 9.54 for sad faces, $t(92) = 3.28$, $p = .001$).

A main effect of facial expression intensity showed that low intense emotions (25% of happiness or sadness) were recognized worse than faces expressing 50% or 75% of happiness or sadness, $F(1.58,137.81) = 291.19$, $p < .001$ (Huynh-Feldt corrected values), indicating that low intense displayed emotions are more difficult to recognize than high intense displayed emotions.

As predicted, a gender main effect emerged, showing than women (*M* = 9.00) outperformed men (*M* = 8.65), $F(1,87) = 10.93$, $p = .001$. No interactions with mood priming ($F(1,87) = 2.76$, $p = .260$), facial expressions ($F(1,87) = 1.28$, $p = .260$) and facial expression intensity ($F(1.58,173.81) = 0.17$, $p = .797$ [Huynh-Feldt corrected values]) were found.

Discussion

The goal of this study was to investigate how different mood states (happy, sad, neutral) affect the ability to correctly recognize other people's emotions. More specifically, we hypothesized and found mood-congruity effects. In sad mood a negative bias emerged showing that sad participants better recognized sad facial expressions than happy facial expressions. In happy mood, participants did not recognize happy facial expressions better than sad facial expressions, although means went in this direction. However, we demonstrated that induced happy mood as compared to participant in a neutral mood lead to a decrease in sad facial expression recognition which indicates that the happy mood priming hampers the recognition of the mood-incongruent, sad emotions. In analogy, sad mood priming had detrimental effects on the recognition of mood-incongruent emotions (happy emotions in this case): the recognition of happy facial expression was reduced in sad mood compared to the performance of participants in neutral mood.

When looking at the overall performance there is evidence that both happy and sad mood decrease emotion recognition performance compared to the control group in neutral mood. However, as mentioned above this is due to a specific decrement in the recognition of mood-incongruent facial expressions, the recognition of mood-congruent facial expressions was not impaired. We replicated therefore findings that suggested mood-congruity effects in emotion recognition (e.g., Bouhuys, et al., 1995; Gur, et al., 1992), and could additionally show, that for a non-clinical sample decreased accuracy in sad mood and happy is not due to an overall impairment in emotion recognition, but to a specific problem in recognizing mood-incongruent emotions. Studies reporting a general performance decrement (concerning the recognition of all, not only mood-incongruent emotions) have been mostly conducted with patients. Asthana et al. (1998) argue that clinical depressed individuals might have additional cognitive impairments that have consequences on emotion recognition performance such as problems on visuospatial tasks. They suppose that the lack of mood-congruent bias might be due to samples including individuals suffering from neurotic depression that exhibit further cognitive impairments. After the authors, depressives without these cognitive impairments may also show a negative bias.

In general, there is a lack of research comparing individuals suffering from affective disorders (depression, mania) to healthy participants experiencing normal variations of mood. Both, clinical samples and healthy subjects in happy and sad mood show mood-congruent biases; however, concerning performance decrement in emotion recognition, there might be a difference between the clinical group and the healthy group in different mood states. Future research should therefore systematically examine and compare healthy participants in different mood states with patients suffering from affective disorders on emotion recognition.

Our study is the first one that systematically examined how positive and negative mood priming affect emotion recognition in terms of mood-congruity effects and reduced or boosted overall emotion recognition accuracy. Previous research often had a focus on either mood-congruity effects or overall performance effects and rarely on both effects simultaneously. In our study, we concentrated on the recognition of happy and sad faces, therefore mood-congruent or mood-incongruent emotions, whereas other researches who found overall performance decrement often used a stimuli set including a wider array of positively or negatively valenced emotions such as anger and fear (Asthana, et al., 1998; Chepenik, et al., 2007; Zuroff & Colussy, 1986). It is not yet clear if in sad mood negative emotions like anger and fear would be recognized on the same level as sad emotions because they share the emotional valence or if in sad mood individuals only perform well when faces express sad emotion but not other negative emotions. Future research may investigate whether the negative bias equally concerns different emotions of the same valence.

We tested whether the intensity of the displayed emotion affected emotion recognition and found that the intensity influenced the so-called happy face advantage. The happy face advantage refers to the findings that happy expressions are easier to recognize than sad expressions. This effect has already been widely reported in the literature (e.g., Kirita & Endo, 1995; Leppänen, 2004). The results of the present study confirmed this happy face advantage when using facial expression with higher intensities (50% and 75% of happiness, resp. sadness). However, this advantage disappeared when the emotional expression was less intense (25% of happiness, resp. sadness) and it became easier to recognize the sad facial expressions than the happy ones. When expressions only contain 25% of the emotion, this is close to a neutral expression. It had been demonstrated that when identifying neutral facial expressions there were more misidentification in the direction of a sad than happy faces (Leppänen, et al., 2004). So when no or, like in the present study, only a small amount (25%) of emotion is displayed in a face, it seems to be judged more likely as being sad than happy.

Concerning gender effects, we confirmed previous findings. As described in McClure's (2000) meta-analysis, women outperformed men on the emotion recognition task. This was independent of their mood state, meaning that mood-congruity effects or mood effects on performance were not moderated by gender.

The findings are important for application as well. The ability to recognize emotions is crucial for the experience of positive social interactions: It has been found that there is a relation between emotion recognition performance and relationship well-being and social competence (Carton, et al., 1999). Because for social functioning it is so important to read other people's emotion accurately, it is important to be aware of how the ability to recognize emotions might be biased. As an example, individuals whose work success is affected by their ability to correctly read other's emotions such as therapists or counselors might be affected by mood-congruity effects without them noticing it. A therapist who is feeling happy and thus particularly inaccurate at recognizing sad mood in his or her client might fail to correctly assess the client's problem and might react inappropriately. It is therefore important to include such findings in the training of therapists and counselors.

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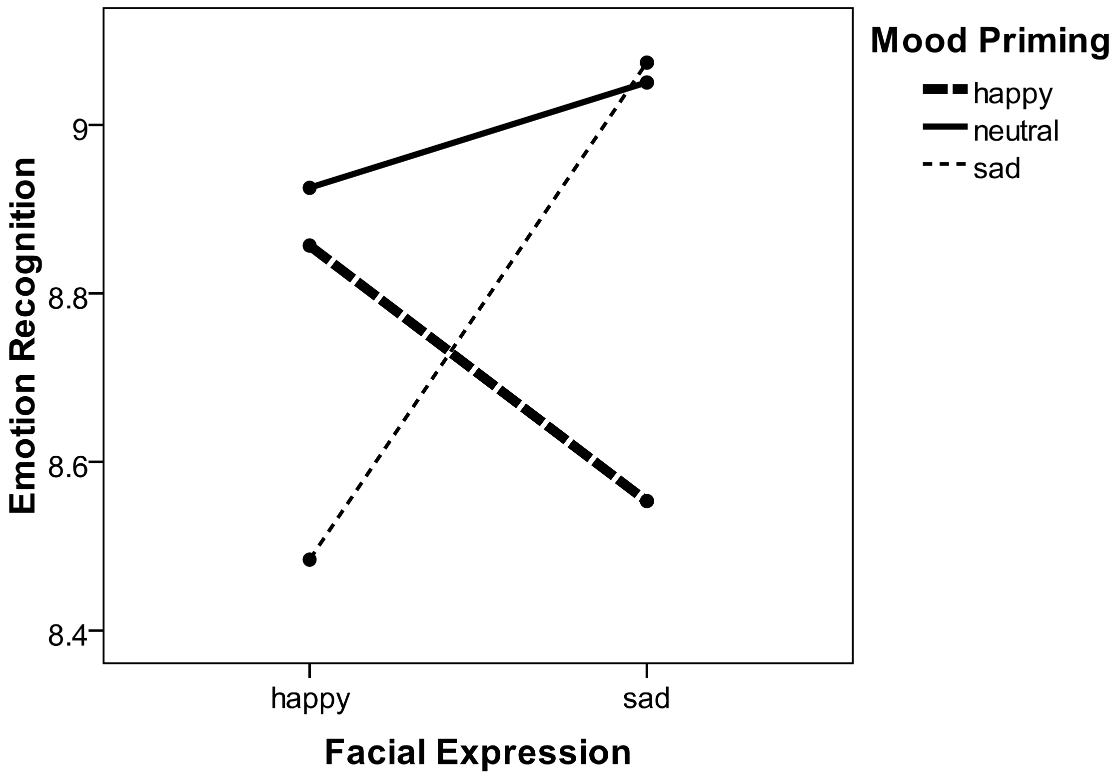
Figure Caption

Figure 1. Amount of correctly recognized happy and sad facial expression in happy, neutral, and sad mood.


Mood Priming
happy
neutral
sad
Emotion Recognition
9
8.8
8.6
8.4
happy
sad
Facial Expression

E) STUDY 4

Schmid, P. C., Schmid Mast, M., Bombari, D., Mast, F. W. (under review). How global versus local priming affects nonverbal decoding accuracy. *Journal of Nonverbal Behavior*.

How Global Versus Local Priming Affects Nonverbal Decoding Accuracy

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Abstract

Women typically outperform men on nonverbal decoding which might be due to the use of a more favorable processing style. Study 1 aims to find out if this gender difference is due to different processing styles of women and men and if the gender effect still emerges when women and men are primed with specific processing styles (global versus local). Looking at accuracy on the Profile of Nonverbal Accuracy (PONS) we found that local priming did not affect women's but improved men's performance so that the performance difference between men and women vanished. After global priming, the gender difference disappeared as well, but due to slightly increased nonverbal decoding accuracy in men and a decreased performance in women. Priming did not affect accuracy on the Diagnostic Analysis of Nonverbal Accuracy 2 (DANVA 2-AF) even though it had been found in other studies that global processing (eye movements) boosted performance on the DANVA 2. Study 2 showed that the priming does not affect eye movements on the DANVA 2. It was concluded that different nonverbal decoding test require different processing styles.

Key words: nonverbal decoding, information processing, global versus local priming, gender

How Global Versus Local Priming Affects Nonverbal Decoding Accuracy

Being able to interpret other people's nonverbal behavior correctly is important for positive interpersonal interactions (J. A. Hall & Bernieri, 2001). It enables us to respond appropriately to the displayed behaviors of a social interaction partner and it can help prevent social faux-pas. Previous research shows that in general, people are able to form correct social judgments based on observed nonverbal behavior. People are able to correctly assess others' emotional expressions (J. A. Hall & Bernieri, 2001), thoughts (Ickes, 1993, 2001), personality characteristics (Ambady, et al., 1995; Borkenau & Liebler, 1992; Funder & Sneed, 1993; Gifford, 1994; Watson, 1989), intelligence (Murphy, Hall, & Colvin, 2003; Zebrowitz, Hall, Murphy, & Rhodes, 2002b), and the nature of their social relationships (Barnes & Stemberg, 1989; Bernieri , Gillis, Davis, & Grahe, 1996; Schmid Mast & Hall, 2004).

However, people differ in their ability to decode nonverbal cues. For example, women typically do a better job than men in correctly assessing others (J. A. Hall, 1978; 1984 for meta-analyses). A possible explanation for this gender difference is that females use a more effective strategy to decode others' nonverbal behavior. For emotion recognition, there is evidence that women rely more on global information and less on local information than men (Schmid, Schmid Mast, Bombari, Mast, & Lobmaier, 2009). By global information processing we understand the formation of an overall, gestalt-like impression of others by integrating different pieces of information whereas local information processing is understood as focusing on details and looking at the pieces separately. In the Schmid et al. study, global processing was measured with eye tracking and operationalized as the interfeatural saccade ratio, calculated by dividing the amount of interfeatural saccades (saccades that were performed between the mouth, the nose, and the eyes) by the amount of all performed saccades. Local processing was operationalized as the total duration of fixating features (mouth, nose, and eyes). Women had a higher interfeatural saccade ratio (= more global processing) and shorter fixations (= less local processing) than men which we interpreted as women using more of a global and less of a local processing style than men. Additionally, global processing was positively and local processing negatively related to emotion recognition performance; however this was only true for people in sad mood but not for happy participants.

More evidence to suggest that cognitive information processing styles affect nonverbal decoding accuracy comes from Ambady and Gray (2002). They found that sad participants are impaired in assessing relationship type from short film scenes (2002; Study 2) and examined whether the deliberate, local information processing style that sad people usually adopt (e.g., Bless, et al., 1990; Gasper & Clore, 2002) is responsible for sad people's decreased performance (Ambady & Gray, 2002, Study 4). Induced sad participants were compared to sad participants who were exposed to an additional cognitive load (that should prevent them from doing deliberate, local processing), and to a control group in neutral mood. Results showed that sad participants under cognitive load performed equally well as participants in a neutral mood and significantly better than sad participants without cognitive load. In other words: sad people who supposedly processed information locally performed worse on the nonverbal decoding task than sad people who were prevented from local processing by an additional cognitive load and than people in neutral mood. This is thus further evidence that local processing is detrimental to nonverbal decoding accuracy. However, the authors did not look at gender effects in this study.

These findings suggest that a more global information processing style is beneficial and a more local processing style is detrimental for nonverbal decoding. However, Fiske, Lin, and Neuberg (1999) posit in their continuum model that paying attention to individuating details (thus local processing) is related to better interpersonal judgments and that a more global or heuristic processing style is at the other end of the continuum and characterizes stereotyping. Due to the lack of empirical evidence for this position, it is fair to state that to date, the state of affairs concerning which cognitive information processing style to use for accurate nonverbal decoding is unclear. Moreover, it is possible that the type of decoding task used might necessitate a different processing style. In the present studies, we measured nonverbal decoding accuracy with two of the most frequently used nonverbal decoding tests: the Profile of Nonverbal Sensitivity (PONS; Rosenthal, et al., 1979; included in Study 1) and the Diagnostic Analysis of Nonverbal Accuracy 2 – Adult Faces (DANVA 2-AF; S. J. Nowicki & M. P. Duke, 1994; included in Studies 1 and 2). The DANVA 2-AF measures the ability to correctly recognize other people's emotions in faces on the basis of still pictures. Emotions can be anger, fear, happiness, or sadness. The PONS measures accuracy in the assessment of the intentions of a woman through her nonverbal behavior in the face or body displayed in a series of different 2s short film scenes. The content of the displayed nonverbal behavior either expresses something positive (e.g., expressing motherly love) or something negative (e.g., talking about one's divorce). Therefore, emotion recognition also plays a role in the PONS. Note, however, that the PONS does not only include the aspect of emotion recognition, because participants further have to assess the intention of the woman in various social situations.

Study 1

The goal of the Study 1 was to investigate how gender and information processing style influence nonverbal decoding accuracy. More precisely, we aimed to find out whether the female advantage in nonverbal decoding accuracy disappears when participants are forced to process information globally or locally. Because women are better nonverbal decoders (J. A. Hall, 1984) and seem to use more global information processing (Schmid, et al., 2009), we expect to boost men's nonverbal decoding accuracy by priming them with a global information processing style. Under the assumption that global processing is beneficial for nonverbal decoding and that women use this strategy by default, we also expect local priming to have detrimental effects on women's nonverbal decoding accuracy, because they would be forced to use a less effective strategy.

Method

Participants

Participants were 137 college students from different areas of study, 68 of them were males, and 69 were females. Their average age was 19.90 years (*SD* = 3.19). Small gifts (pens, chocolates, etc.) were given to thank the students for their participation. All participants filled in an informed consent form.

Procedure

Participants were randomly assigned to either the global or local processing condition or to the control group and were then primed with the corresponding information processing style by using the NAVON figures (explained in more detail below). We then measured the participants' nonverbal decoding accuracy with two tests: One test was the PONS (Rosenthal, et al., 1979) and the other one was the DANVA 2-AF (S. J. Nowicki & M. P. Duke, 1994).

Measures

Information processing style priming. Participants in the global and the local processing condition completed the NAVON task (Navon, 1977) in which a series of 100 big letters composed of small letters were presented (for example, a big "W" is built of several small sized "A"s). In the global processing condition, participants had to read aloud as fast as possible what the big letter was. Participants in the local condition had to read aloud as fast as possible what the small letter was. This task was used as priming of the global cognitive processing (read aloud the big letters) or of local cognitive processing (read aloud the small letters) for the subsequent nonverbal decoding task. The control group had to read aloud 100 letters that were written in different fonts (which were not made up of many smaller letters). Participants were naïve with regards to the aim of the Navon priming and reported that they thought that this was an independent task measuring their ability to concentrate and to stay focused.

Nonverbal decoding accuracy

DANVA 2-AF. To measure nonverbal decoding accuracy, we used a subtest of the DANVA 2 (S. J. Nowicki & M. P. Duke, 1994). The subtest was the DANVA 2 Adult Faces, consisting of 24 still pictures with adults' faces expressing one of four different emotions. Emotions were happiness, sadness, fear, and anger. Faces were presented for 2s on a computer screen. The task was to judge the facial expression of emotion by having always the four answer possibilities.

PONS. The short version of the PONS (Rosenthal, et al., 1979) consisting of 40 2s film scenes without sound was used. This version of the PONS measures the accuracy of identifying the meaning of nonverbal cues through face and body expressions displayed by a woman. The participants choose between two options describing which intentions the woman was expressing in each film scene (e.g., returning faulty item to a store, or trying to seduce someone).

Results

PONS. We computed the same a 2 (participant sex) x 3 (priming condition: global, local, or control) ANOVA with the amount of correct answers on the PONS as the dependent variable. We found a significant main effect of participant gender, $F(1,131) = 11.65$, $p = .001$, showing that women performed better ($M = 28.93$) than men ($M = 27.52$). Also, there was a priming condition main effect, $F(2,131) = 4.46$, $p = .013$. Participants primed with local processing performed significantly better ($M = 29.09$) than participants primed with global processing ($M = 27.84$), $p = .015$, and than the control group ($M = 27.75$), $p = .009$. However, the main effects have to be qualified by a significant participant gender by priming condition interaction, $F(2,131) = 4.01$, $p = .020$, (*Figure 1*).

To clarify the gender by priming interaction effect, planned comparison *t*-tests were calculated. The gender difference was mainly due to the women's better performance in the control group compared to men $t(43) = 4.18$, $p < .001$. The gender difference mostly disappeared when participants were primed with local information processing, $t(46) = 1.80$, $p = .078$; and was absent when they were primed with global information processing $t(42) = 0.15$, $p = .881$.

For women, global priming entailed a decrement in performance compared to the control group, contrast-$t(44) = 1.12$, $p = .039$, but in men, the global priming marginally significantly boosted performance on the PONS, contrast-$t(41) = 1.72$, $p = .094$. Local priming only affected men's performance: After a local priming men gave more correct answers on the PONS than the control group, contrast-$t(43) = 2.90$, $p = .006$. No significant difference was found in women, contrast-$t(46) = 0.74$, $p = .462$.

DANVA 2. First we calculated a 2 (participant sex) x 3 (priming condition: global, local, or control) ANOVA with the amount of correct answers in the DANVA 2 as the dependent variable. No significant effects were found (priming condition: $F(2,131) = 1.65$, $p = .197$; gender: $F(1,131) = 0.74$, $p = .390$; gender x priming condition $F(2,131) = 0.165$, $p = .848$.

Discussion

The goal of our study was to investigate whether gender differences in nonverbal decoding accuracy can be explained by different information processing styles of women and men. Women outperformed men in the PONS in the control group; however, no gender effect emerged for the DANVA 2-AF. Note that information processing style priming was unobtrusive, meaning that participants did not have to try to consciously change their natural cognitive strategy. So the possibility that participants would be hurt by consciously trying to change their style is not very likely. Also, because participants were not conscious about the aim of the Navon priming, we can exclude that gender effects emerged due to gender differences in task motivation. In the PONS gender interacted with the information processing style participants used: We predicted that global priming would boost men's nonverbal decoding accuracy whereas it had no effect on women. Further, we expected that local priming would decrease women's nonverbal decoding abilities and that it would not affect men's performance. Against predictions, we found that *local* priming increased men's performance whereas it had no effects on women, whereas *global* priming had detrimental effects on women's nonverbal decoding ability, and slightly positive effects on men's accuracy. Local processing resulted in better performance on the PONS compared to global processing. So, if local processing is what makes people accurate in this task, women might already use a local processing style that helps them to perform well so that local priming does not increase women's performance any further (ceiling effect). However, the situation for men is different; they profit greatly from a local processing style. Their performance increases and becomes comparable to that of women (no significant gender difference in nonverbal decoding accuracy in the local priming condition). Global priming brought the performance of women down and that of men marginally significantly up when compared to the control condition. So if women already use the correct information processing strategy by default (local), they are hurt when they are "forced" to use a global strategy. For men, however, the global strategy seems to be better than nothing. Whether men are made to process globally or locally does not matter for their decoding accuracy but it increases their performance compared to the control condition. One could argue that on the basis of global information processing, people are able to perform reasonably well on the PONS; however, when relying on local information, performance is even better.

Note, this is not in line with our hypothesis and previous research on emotion recognition showing that global information processing is favorable for nonverbal decoding accuracy (Schmid, et al., 2009). The impact of strategy might therefore be quite task-specific.

The PONS is a more complex task than emotion recognition tests. The PONS covers video material of emotions and intentions in different social situations and not only emotion recognition on still pictures. Local processing might be the better strategy in the PONS, because the scenes on the PONS are very specific (ordering food in a restaurant, etc.) and people's responses are probably not very automatic. Participants probably have to analyze and think. Furthermore, each pair of response alternatives is different—this could be very important because they have to be really alert cognitively. With standard emotion recognition tasks the alternatives are the same every time so this requires no or less cognitive effort. Rosip and Hall (2004) pointed out that "…because the items on the PONS require the test-taker to consider various ways one might act in different situations, it is more likely to require more deliberate processing than does the DANVA 2-AF" (p. 272).

There is empirical evidence that the PONS is maybe a more complex task than other nonverbal decoding tasks: Phillips, Tunstall, and Channon (2007a) showed that the PONS required a lot of working memory resources whereas the Interpersonal Perception Task (IPT) did not (or participants simply chose to trade-off attention to the IPT against attention to the load task). The authors conclude that for the IPT, the decoding of the cues was more automatic than for the PONS.

The fact that women usually outperform men on most nonverbal decoding tasks suggests that women automatically rely on the most useful processing style, that might be the local one in case of the PONS, or the global one in case of emotion recognition tasks. Men's lower performance might be due to an ignorance of which cues they have to pay attention to and can be compensated by giving them the appropriate strategy.

But if the PONS requires local processing and emotion recognition tests global processing, why did global Navon priming not boost emotion recognition performance in the present study? A possibility is that the global-local Navon priming does not affect participants' eye movements (which are known to be related to emotion recognition performance) but it might affect information processing on a higher processing level. To the extent that the PONS features complex social situations and thus might necessitate a certain – as we have seen rather local – high level processing style and that the DANVA 2-AF consist of identifying emotions and relies thus on less complex social information, the argument that the Navon priming affects only higher cognitive processing could explain the discrepant results between the PONS and the DANVA in the present research. Maybe after having seen the PONS clips, participants had to further deliberate about the responses and maybe had to activate autobiographical memories and semantic knowledge about scripts in order to find the correct answer. This is an example for higher local information processing (which might have been affected by the Navon priming) that is not in relation with eye movements. Also, because answer possibilities change between the trials in the PONS, whereas they remain the same in the DANVA 2-AF, one might conclude that the PONS demands much more deliberate, local information processing after the perception of the clips. This might have been facilitated by the local Navon priming and hindered by the global Navon priming (the latter at least for women). The DANVA 2-AF most likely requires less deliberation maybe also because of the simpler response options, it might very well be more important to what kind of information a person pays attention to on the perceptional level. If the Navon priming affected information processing on a higher processing level, this might explain why it had neither positive nor negative effects on accuracy on the DANVA 2-AF. But effects of the Navon priming on the DANVA 2-AF still have to be clarified.

Study 2

Study 2 aimed to clarify why the global-local Navon priming had an effect on nonverbal decoding accuracy measured by the PONS, but not when using the DANVA 2-AF. Because other studies showed that global information processing is favorable for emotion recognition compared to local information processing measured by registering participants' eye movement (Schmid, et al., 2009), we conducted a second study in order to look if and how the Navon priming affect eye movements during the DANVA 2-AF. We postulate that the Navon priming of global and local as we used it in Study 1 does not affect the way stimuli are perceived but how perceived stimuli are further treated in the brain. In line with this reasoning, we expect that the Navon priming does not influence eye movements (whether a participant shows more global or more local eye movements), and also does not affect emotion recognition accuracy. However, we expect to replicate the Schmid et al. findings and posit therefore a positive correlation between the global eye movements and a negative correlation between local eye movements and emotion recognition accuracy.

Method

Participants

We recruited 48 students (24 women and 24 men) at the University of Lausanne in Switzerland. Participants filled in an informed consent form and were paid for their participation with the equivalent of 10 dollars. The experiment lasted about 30 minutes.

Procedure

Participants were randomly assigned to one of three priming conditions: global, local, or neutral. As in Study 1, priming was realized by using the Navon figures, however, in order to potentially make the priming effect more powerful we increased its duration and let the participants read the 100 during ten minutes (the 100 Navon letters appeared randomized during ten minutes on the screen). After the priming they performed the DANVA 2-AF. During this task, participants' eye movements were registered in order to assess whether the Navon priming influenced the scan pattern or not, and to see whether the correlations between information processing and emotion recognition accuracy found in Schmid et al. (2009) could be replicated. Similar to the Schmid et al. study, we created a global processing and a local processing style measure on the basis of the eye tracking data (explained in more details below). Eye movements were tracked by using a Hi-Speed 1250 tracking system from SMI-SensoMotoric Instruments (Teltow, Germany).

Measures

Global Information Processing. Global information processing was assessed by computing an interfeatural saccade ratio: the amount of all interfeatural saccades (saccades that were performed between feature fixations on left eye, right eye, nose, and mouth) was divided by the amount of all performed saccades. We only considered saccades that have been performed before the response was given.

Local Information Processing. Local information processing refers to the mean time that participants spent on the features (left eye, right eye, mouth, and nose). Only fixations that lasted longer than 100 ms were considered. Consecutive fixations within the same features were first summed up. Again, we focused solely on fixations that were made before the participants gave the answer.

Results

A 2 (gender) x 3 (priming: local, global, control) ANOVA was computed with emotion recognition as the dependent variable. As in Study 1, no effects reached significance (gender: $F(1,42) = 1.44$, $p = .237$; priming condition: $F(2,42) = 0.73$, $p = .488$, gender by priming condition: $F(2,42) = 0.09$, $p = .914$). Replacing the dependent variable with the interfeatural saccade ratio, again, no significant results emerged, as we predicted (gender: $F(1,42) = .88$, $p = .352$; priming condition: $F(2,42) = 0.94$, $p = .398$, gender by priming condition: $F(2,42) = 0.08$, $p = .927$). Also according to prediction, no significant results were found for the fixations (gender: $F(1,42) = 0.06$, $p = .809$; priming condition: $F(2,42) = 2.27$, $p = .116$, gender by priming condition: $F(2,42) = 0.86$, $p = .432$).

We then correlated the interfeatural saccade ratio and the fixations with emotion recognition and replicated the finding from Schmid et al. (2009): a positive correlation between the interfeatural saccade ratio (global processing) and emotion recognition, $r = .29$, $p = .048$. Also, the correlation between the fixations (local processing) and emotion recognition was negative as reported in the Schmid et al. study, however, it did not reach significance ($r = -.21$, $p = .162$). Partialling out priming condition, the correlation between the interfeatural saccade ratio and emotion recognition ($pr = .27$, $p = .066$) was not significantly different from the correlation without controlling for priming condition ($p = .343$). Partialling out the priming condition ($pr = -.25$, p = .096), did also not affect the correlation between the fixations and emotion recognition ($p = .161$).

Discussion

As in Study 1, Study 2 showed that the Navon global-local priming did not affect emotion recognition accuracy measured by the DANVA 2-AF and it did neither had an effect on eye movement during the task. Also, correlations between eye movements and emotion recognition accuracy were not affected by the Navon priming. Global eye movements were related to better performance on emotion recognition. One could conclude that Navon priming does not affect information processing on the perception or eye movement level. However, the scan path determines how well a job a person does in emotion recognition. For emotion recognition it seems thus crucial which information (global or local) a person pays attention to in order to make accurate judgments.

General Discussion

In sum, results from Studies 1 and 2 show that different nonverbal decoding tasks seem to require different processing styles. Study 1 showed that for the PONS, local information processing is beneficial which is also in line with the findings from the Phillips et al. (2007a) study that showed that cognitive load (supposed to hinder local processing) hurt PONS performance. Gender effects on the PONS emerged only in the control group and vanished when participants were primed with global or local information processing. The

DANVA 2-AF was not affected by the Navon global-local priming in Study 1, but Study 2 showed that global eye movements are related to better accuracy which is a replication of the Schmid et al. (2009) results.

Because for the PONS results appeared when participants' information processing style was manipulated by used the Navon global-local priming, which in turn did not affect performance on the emotion recognition test DANVA 2-AF, we conclude that Navon priming does not influence information processing on the perceptual level, but probably on a higher processing level. The DANVA 2-AF performance is sensitive with regard to the perceived information, global eye movements are related to better performance. Further processing seems to be more automatic, probably because of simply organized answer categories and therefore, the Navon priming does not influence performance on the DANVA 2-AF. This is different for the PONS where stimuli and answer categories are much more complex. The PONS requires higher deliberate processing and was therefore positively affected by the local Navon priming, but negatively affected by the global Navon priming. It remains unclear which processing (global or local) is best on the perceptual level for the PONS.

Further research should (1) clarify the effects of the Navon global-local priming on different information processing levels and its consequences for nonverbal decoding accuracy and (2) investigate how global and local eye movements affect performance on the PONS.

On the basis of our results we suggest that the Navon priming affects higher level information processing, however, it remains unclear what exactly is affected by the Navon priming. There is research showing that global versus local Navon figures activate different brain areas, global figures activated the right lingual gyrus, and local figures the left inferior occipital cortex (Fink, Halligan, Marshall, Frith, Frackowiak, & Dolan, 1997). Macrae and Lewis (2002) showed a 30s video showing a robbery scene before participants were primed with the Navon letters. Participants then had to identify the robber among seven unfamiliar faces. Global processing is known to boost face recognition (e.g., Leder & Bruce, 2000a; Tanaka & Farah, 1993; A. W. Young, D. J. Hellawell, & D. C. Hay, 1987b), and in line with this, Macrae and Lewis found that after a global Navon priming participants more easily recognized the robber compared to the local Navon priming. However, these findings could not be replicated by Lawson (2007) who had a setting that was more similar to the DANVA 2-AF test: They exposed participants to still pictures of faces and objects, or words and primed then participants using the Navon letters. Then during the face recognition task, participants were again exposed to still face pictures and had to say whether or not a face, object or word was novel or not. Navon priming did not affect recognition performance. This suggests that the effects of the Navon priming highly depend on test characteristics. Again, the difference in stimulus complexity between the task where effects of the Navon priming were found (films, therefore more complex stimulus) compared to the task where no effects were found (still pictures, less complex) are salient. However, further research is still needed to explore the effects of the Navon figures on different tasks varying in stimulus complexity and answer options.

Because we found evidence that different nonverbal decoding tasks require different information processing styles further research should try to identify which task characteristics demand which processing style: Is it the difference in the type of stimuli (still pictures, short or longer film scenes, real interactions) that requires different processing styles, is it the type and amount of answer possibilities (two or more different answer possibilities, are there always the same answer possibilities for each item or not, etc.), or is it the type of interpersonal judgment (emotion recognition, assessment of intentions, etc.)?

So far there is evidence that the number of possible responses can influences cognitive resources: Phillips, Channon, Tunstall, Hedenstrom, and Lyons (2008) showed that the more answer possibilities were given in an emotion recognition task the more cognitive resources were needed. But also type of stimuli might be an important factor which might explain why cognitive load had different effects on the PONS compared to the IPT in the Phillips et al. (2007a) study. Both, the PONS and the IPT contain film material, however, scenes in the PONS last 2s, film scenes in the IPT around 30s. Phillips et al. pointed out that during the IPT task participants might have generated brief snapshots of information across the 30s clips, whereas this was not possible for the 2s lasting short clips in the PONS, and therefore the PONS might have needed more cognitive resources. When comparing the PONS with the DANVA 2-AF the most salient differences are two: (1) The DANVA 2-AF consists of still pictures and the PONS of film clips and (2) answer possibilities in the DANVA 2-AF are four, in the PONS two, however, in the DANVA 2-AF those answer possibilities are less complex and remain the same over all trials, whereas in the PONS answer possibilities contain complex social situation and change over the trials.

Performance on the PONS has been linked to the experience of healthier and better adjusted personalities. Further, when having a high score on the PONS, people were judged as being more interpersonally sensitive, more democratic (in case of teachers), and better performing in their job (in the case of clinicians and teachers) by others (Rosenthal, et al., 1979). High scores on the DANVA 2-AF have been brought in relation to less feelings of depression and more relationship well-being (Carton, et al., 1999).Therefore, it seems to be important for everyday life to have the interpersonal skills that are measured in the PONS and the DANVA 2-AF and there should be an interest to improve or train nonverbal decoding accuracy skills. Such training can only be developed when there is knowledge about the mechanism underlying nonverbal decoding accuracy. The present study provides such information and is therefore important for application as well.

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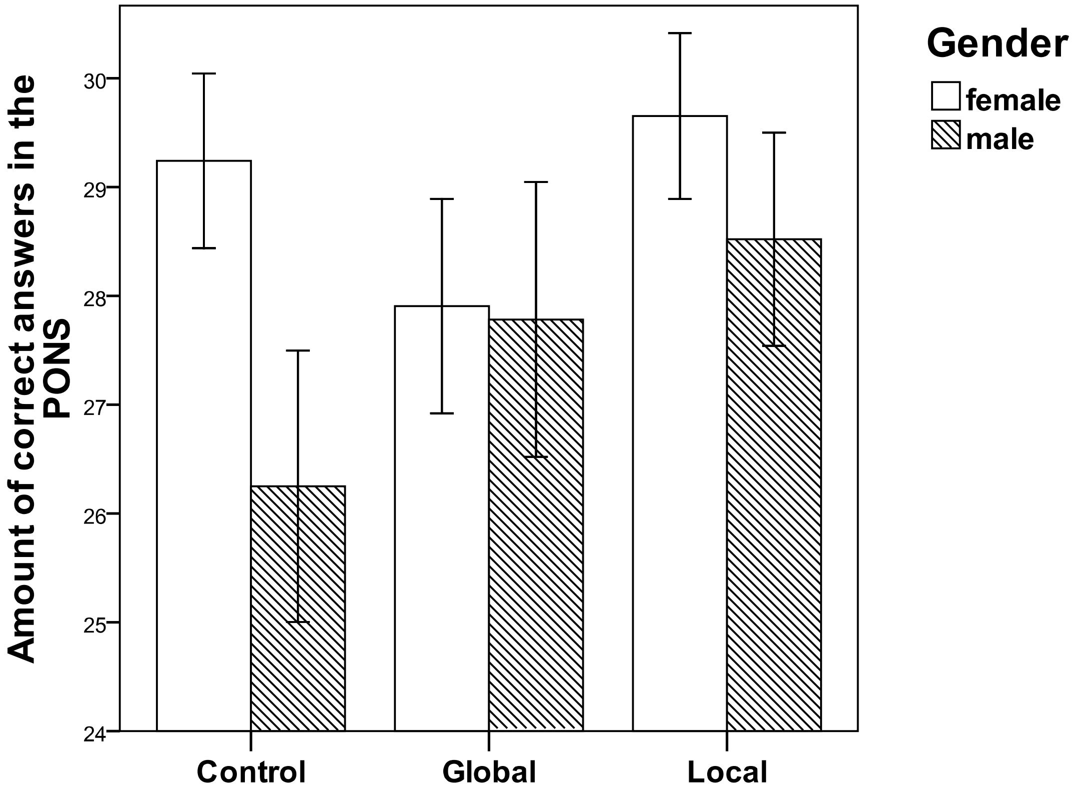
Figure Caption

Figure 1. Men and women's amount of correct answers in the PONS after global or local information processing priming and control group.



Error Bars: +/- 2 SE