Between Ourselves

Automatic mimicry reactions as related to empathic ability and patterns of attachment

Sonnby-Borgström, Marianne

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Abstract

The studies included in this thesis investigated emotional communication in experimentally created face-to-face interaction situations. The hypotheses were based on the conception of a process which leads to emotional empathy, assuming that automatic mimicking tendencies are involved in an early, automatic part of the process. Subjects were categorised as high- or low-empathic according to results on the Questionnaire Measure Of Emotional Empathy (QMEE). The compared parameters were facial mimicry reactions, represented by electromyographic (EMG) activity, when subjects were exposed to pictures of angry or happy faces. Comparisons were made at different stimulus exposure times in order to elicit reactions at different levels of information processing: preattentive (from 17 ms), automatic (17-56 ms), and controlled (100-2350 ms) levels. High-empathy subjects showed mimicking reactions already at the automatic level. In contrast, the low-empathy group reacted with inverted reactions and showed higher zygomaticus activity ("smiling") when exposed to angry faces. Thus, the result supported the hypothesis that mimicry is an early, automatic element involved in emotional empathy.

Since patterns of attachment have been assumed to be involved in emotion regulation, the Relationship Scales Questionnaire (RSQ) was introduced to measure patterns of attachment and to relate this parameter to mimicry and empathy. Negative model-of-self subjects (corresponding to preoccupied and fearful-avoidant attachment patterns) showed a significantly stronger corrugator response (negative emotions) and reported more negative feelings than subjects with a positive model-of-self (corresponding to secure and dismissing-avoidant patterns of attachment) at the controlled level, representing emotionally regulated responses. These results supported the hypothesis that subjects with a negative model-of-self would show difficulties in self-regulation of negative emotions. The dismissing-avoidant subjects displayed "normal" corrugator reactions to angry faces at the automatic level of information processing (56 ms), whereas they showed inverted zygomatic reactions (“smiling”) and decreased their corrugator response, to the angry face, at the controlled level (2350 ms), a reaction that may be may be interpreted as a repression of their preceeding negative emotional reaction.

The dismissing-avoidant subjects scored significantly lower on QMEE than non-avoidant subjects, a result that may be explained as a repression of apprehensive reactions to others' negative emotional expression. Negative model-of-self subjects scored significantly higher on QMEE than positive model-of-self subjects and showed a mimicry reaction at the controlled level, which may be interpreted as a tendency for negative model-of-self subjects to be easily distressed by others showing negative emotional reactions.

Key words: Facial mimicry, emotional contagion, EMG, empathy, attachment pattern, emotion regulation

List of studies

This thesis is based upon the following papers, which will be referred to by their Roman numerals:

I. Sonnby-Borgström, M. (2002) Automatic Mimicry Reactions as Related to Differences in Emotional Empathy. *Accepted for publication in Scandinavian Journal of Psychology.*

II. Sonnby-Borgström, M. & Jönsson, P. (2002) Models-of-Self and Others as Related to Facial Muscle Reactions at Different Levels of Cognitive Control. *Accepted for publication in Scandinavian Journal of Psychology.*

III. Sonnby-Borgström, M. & Jönsson, P. (2002) Dismissing-avoidant Pattern of Attachment and Mimicry Reaction at Different Levels of Information Processing. *Submitted for publication.*

IV. Sonnby-Borgström, M. & Jönsson, P. (2002) Emotional Empathy as Related to Mimicry Reactions at Different Levels of Information Processing. *Submitted for publication.*

To Lars, Sara and Erik

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Contents

Abbreviations

BAS	Behavioural activation system
BIS	Behavioural inhibition system
EMG	Electromyography
DET	Differential Emotions Theory
ms	milliseconds
μV	microvolt
QMEE	Questionnaire Measure Of Emotional Empathy
RSQ	Relationship Scales Questionnaire
STAI –T	State and Trait Anxiety Inventory (trait-anxiety)

Sammanfattning på svenska

Denna avhandling inspirerades av utvecklingspsykologiska teoretiker som Bowlby, Stern och Winnicott, vilka alla anser att den tidiga emotionella kommunikation mellan barn och vårdare är betydelsefull för utvecklingen av barnets självvärdering och värdering av andra och hur barnet kommer att relatera till andra senare i livet. Frågeställningarna i de olika studierna berör de processer som äger rum i den emotionella kommunikationen mellan människor. Vilka är mekanismerna bakom den emotionella process, som sker primärt intraindividuellt hos en sändare, och sedan kommuniceras till en mottagare, hos vilken de resulterar i en känslomässig upplevelse för att sedan kommuniceras tillbaka till "sändaren"? Avhandlingen bygger på en systemteoretisk syn på individens bearbetning av information, som antas utgå från biologiskt grundade emotionella processer, som avspeglas i våra spontana ansiktsuttryck. Dessa emotionella processer interagerar på en mera avancerad bearbetningsnivå med flexibla kognitiva processer. Avhandlingen studerar emotionell kommunikation via ansiktsuttryck i experimentellt skapade interaktionssituationer. Imitativa reaktioner i olika stadier av informationsbearbetningsprocessen relateras till individuella skillnader i emotionell empati samt till skillnader i anknytningsmönster.

I studie I och IV studerades emotionell empati i relation till styrkan i de imitativa reaktionerna på andras ansiktsuttryck. En hypotes formulerades med utgångspunkt från Baschs teori om den process som leder till empati. I denna antas en tidig, primitiv del av processen utgöras av automatisk imitation av andras ansiktsuttryck, som via somatisk och fysiologisk feedback, resulterar i att mottagaren upplever samma emotion som sändaren. Detta kallas emotionell smitta. Personer med hög empati antogs i ett tidigt skede av processen uppvisa högre grad av imitativa reaktioner än lågempatiska personer. Försökspersonerna kunde delas in i hög- och låg-empatiska på grundval av resultatet på ett självskattningsformulär (Ouestionnaire Measurement of Emotional Empathy, QMEE), som mäter emotionell empati. Arga och glada ansikten visades på olika långa exponeringstider för att kunna fånga den emotionella processens olika bearbetningsstadier. Den första nivån, som aktiveras med en 17 millisekunder (ms) lång exponeringstid, är preattentiv, dvs perceptuellt omedveten. Den andra nivån (17-56 ms) kallades automatisk och antogs uppväcka automatiska, emotionellt icke reglerade reaktioner. Den tredje nivån (100-2350 ms) kallades kontrollerad och antogs uppväcka kognitivt mera reglerade emotionella reaktioner. Försökspersonernas imitativa ansiktsreaktioner registrerades med hjälp av elektroder, (elektromyografi, EMG), som mäter den elektriska aktiviteten i musklerna. Reaktionerna i zygomaticus-muskulaturen ("leende") speglar positiva emotioner, medan corrugator-muskulaturen ("rynka pannan") speglar negativa emotioner. EMG är en känslig metod, som kan mäta även mycket små muskelrörelser, som är osynliga för ögat. Efter varje ansiktsvisning fick försökspersonerna dessutom verbalt skatta sin egen emotionella upplevelse.

Resultatet av Studie I och IV bekräftade Baschs idé om imitativa reaktioner som en tidig komponent i den empatiska processen. Redan på automatisk nivå (17-56 ms) uppträdde imitativa reaktioner hos de högempatiska, medan de lågempatiska inte visade imitativa reaktioner utan tvärtom "log" mot det arga ansiktet ($p<0.05$). Dessa skillnader kunde inte påvisas på emotionellt mera reglerad nivå. De högempatiska visade i Studie I också ett större samband mellan muskelaktivitet och sin egen skattning av upplevd emotion än de lågempatiska ($p<0.05$). De hög- och låg-empatiska individerna skilde sig däremot inte åt, när det gällde hur de själva verbalt skattade sina reaktioner inför det glada och det arga ansiktet. Resultaten tyder på att det framförallt är i de tidiga automatiska muskelreaktionerna som de hög- och låg-empatiska individerna skiljer sig och inte i de emotionellt mera reglerade reaktionerna (kontrollerad nivå) och i de verbala skattningarna av sina känsloreaktioner.

I studie II och III introducerades ett självskattningsformulär (Relationalship Scales Questionnaire, RSQ), för att mäta försökspersonernas anknytningsmönster, som baserar sig på

deras inre modell av självet och av andra. Dessa inre modeller (självbilden och ”den generaliserade andre”) kan antas inverka på en persons emotionella ansiktsreaktioner i interaktionssituationer och även på förmågan till emotionell empati. Skillnader i inre modeller av sig själv och andra antas också vara avgörande för skillnader i regleringen av negativa emotioner. Framförallt självbilden anses vara affektivt laddad, och personer med en negativ självbild antas ha problem med att kunna reglera negativa affekter. Personer som har en avvisande-undvikande (s.k. dismissing-avoidant) anknytningsstil utmärks av en positiv självbild och en negativ bild av andra. De karakteriseras av att de undviker, eller tränger bort, negativa emotioner på det medvetna planet, men på ett omedvetet plan antas personer med detta anknytningsmönster ha en självbild som är mera ångestfylld (mera negativa emotioner).
Resultaten i studie II gav stöd åt hypotesen att personer med en negativ självbild utmärktes av sämre reglering av negativa emotioner. De hade högre poäng på ett självskattningsformulär, som mäter ångestnivå än personer med positiv självbild ($p<0.05$) och visade starkare corrugator reaktioner på ett argt ansikte (negativa emotioner) på emotionellt reglerad nivå (2350 ms) än personer med positiv självbild ($p<0.01$). De visade starkare corrugator aktivitet i förhållande till zygomaticus aktivitet oberoende av exponeringstid och stimuli i jämförelse med personer med positiv självbild ($p<0.05$), ett resultat som också tyder på ett negativt stämningsläge för personer med negativ självbild.
Resultaten i studie III gav stöd åt antagandet att personer med avvisande-undvikande anknytningsstil undviker eller tränger bort negativa emotioner. På den automatiska nivån visade de "normala" corrugatorreaktioner (negativa emotioner). På den emotionellt reglerade nivån uppvisade de inga corrugatorreaktioner och tendens till omvända zygomaticusreaktioner vid visning av det arga ansiktet till skillnad från de övriga försökspersonerna, som visade en imitativ reaktion ($p<0.05$). Detta skulle kunna tolkas så att de omvända zygomaticusreaktionerna, via somatisk feed back, kan vara ett sätt att reglera eller borttränga de negativa emotionerna. Individer med avvisande-udvikande anknytningsstil skulle på så sätt kunna behålla sin positiva självbild och sin attityd av oberoende. De avvisande-undvikande försökspersonerna hade, i enlighet med förväntningarna, lägre poäng på empatitestet ($p<0.05$) än de övriga försökspersonerna. Något oväntat uppvisade försökspersonerna med negativ självbild en högre grad av empati än personer med positiv självbild ($p<0.05$). Detta skulle kunna förklaras av att QMEE-testet visat sig korrelera med Neuroticism faktorn i den s.k. Fem Faktors Modellen för personlighets-beskrivning. Kanske mäter detta test huvudsakligen en persons känslighet för negativ emotionell känslosmitta.
I enlighet med Wallers och Fraleys modell och Baschs syn på den empatiska processen skulle vårt sätt att relatera till andra kunna beskrivas som en process, som utgår från mera primitiva former av känslosmitta och interagerar på ett högre plan med kognitivt styrda processer. Fraley och Waller menar att den affektivt laddade självbilden, som i faktoranalytiska studier visat negativt samband med faktorn Neuroticism, påverkar en tidig del av processen. Bilden av andra, som visat sig korrelera med faktorn Extraversion, antas vara en senare kognitivt bestämd del i den process, som antas leda fram till empati och anknytningsmönster. Skillnaderna mellan empatigrupperna i de redovisade studierna uppkom redan på den automatiska nivån, något som kan vara ett resultat av skillnader i deras tendens till primitiv negativ emotionell smitta (ångest) på en icke reglerad nivå. Nästa steg i processen kan beskrivas som vårt sätt att reglera dessa emotioner kopplade till självet. Kanske är förutsättningen för närhet och empati att de negativa emotionerna (ångesten) inte bortträngs från medvetandet, som hos den lågempatiska, avvisande-undvikande gruppen i denna studie. Det sista ledet antas vara en mera intentionell process, relaterad till vår bild av andra, som kan resultera antingen i ett närmande till eller i ett avståndstagande från andra. I de redovisade studierna visade bilden av andra inget samband med de emotionella ansiktsreaktionerna.

Synopsis

This thesis investigated emotional communication in experimentally created face-to-face interaction situations. The hypotheses in Studies I and IV were based on the conception that empathy is a result of a process. A fundamental assumption of this is that biologically prewired automatic mimicking tendencies and emotional contagion are involved in an early, automatic part of the process. Forty-two students participated in Experiment I, resulting in Study I, and sixty-one students in the second experiment, resulting in Studies II, III and IV. Subjects were categorised as high- or low-empathy subjects according to results on the Questionnaire Measure of Emotional Empathy (QMEE). The compared parameters were facial mimicry reactions, represented by electromyographic (EMG) activity, when subjects were exposed to pictures of angry or happy faces, and the degree of correspondence between subjects' facial EMG and their self-reported feelings. Corrugator muscle reactions indicated negative emotions and zygomaticus muscle reactions indicated positive emotions. Comparisons were made at different stimulus exposure times in order to elicit reactions at different levels of information processing. These were in Study I denoted preattentive (from 17 ms), automatic (17-40 ms), medium (45-75 ms) and controlled (100-1000 ms) levels of information processing. In Studies II, III and IV the different levels were termed preattentiv (17 ms), automatic (56 ms) and controlled (2350 ms) levels. A repeated measures ANOVA (Faces x Muscles x Emotional empathy) with Emotional empathy as between group factor resulted in studies I and IV in a significant interaction ($p<0.05$) at the automatic level of information processing. High-empathy subjects showed mimicking reactions already at automatic level in Studies I ($p = 0.06$) and IV ($p<0.05$). In contrast, the low-empathy group reacted with increased zygomaticus activity ("smiling") when exposed to the angry face as shown in Studies I and IV. In Study I high-empathy subjects also reported feelings that were reflected in their muscle reactions in contrast to low-empathy subjects that showed "smiling" reactions, when they reported negative feelings. Thus, the result supported the hypothesis that automatic mimicry is an early, automatic element involved in emotional empathy. A tentative interpretation of the low-empathy subjects' inverted "smiling reactions" is that these reactions through facial feedback may function as a means to regulate, or repress, negative emotions.

The differences between high and low-empathy subjects in mimicking were hypothesised to be partly explained by differences between individuals in their manner of relating to other people, associated with their internal working model-of-self and others.

In Studies II and III, based on a similar experimental design as used in Experiment I, the Relationship Scales Questionnaire (RSQ) was introduced to measure patterns of attachment and to relate this parameter to mimicry behaviour. Patterns of attachment have been assumed to be involved in emotion regulation. Insecure attachment, especially attachment patterns associated with a negative model-of-self, are hypothesised to be related to difficulties in regulating negative emotions. Dismissing-avoidant pattern of attachment is supposed to be related to repression of negative emotions. In Study II negative model-of-self subjects showed a significantly stronger corrugator response ($p<0.01$) and reported more negative feelings than subjects with a positive model-of-self at the longest exposure time (2350 ms), representing emotionally regulated or cognitively controlled responses. These results supported the hypothesis that subjects with a negative model-of-self would show difficulties in self-regulation of negative emotions. Negative model-of-self subjects scored significantly higher on a trait-anxiety test ($p<0.05$) and showed an overall higher corrugator than zygomatic activity compared to positive model-of-self subjects ($p<0.05$), further evidence of a negative tonic affective state.

The dismissing-avoidant subject displayed "normal" corrugator reactions to angry faces at the automatic level of information processing (56 ms), representing conditioned emotional

reactions. At the controlled level of information processing (2350 ms), representing an emotionally regulated level, a repeated measures ANOVA (Faces x Muscles x Attachment pattern) with Attachment pattern (dismissing-avoidant versus non-avoidant pattern) as between group factor resulted in $p<0.05$. At this level the dismissng-avoidant subjects showed inverted zygomatic reactions (smiled) to the angry face, whereas the non-avoidant subjects reacted with a significant mimicking reaction. The dismissing-avoidant subjects' decreased corrugator response (negative) and increased zygomatic response (positive) at the controlled level, when exposed to the angry face may be interpreted as a repression of their preceding negative emotional reaction.
The dismissing-avoidant subjects scored significantly lower on the QMEE than non-avoidant subjects ($p< 0.05$), a result that may be explained as a repression of apprehensive reactions to others' negative emotional expressions. Negative model-of-self subjects scored significantlly higher on QMEE than positive model-of-self subjects and showed a mimicry reaction ($p < 0.05$) at the controlled level of processing, whereas the positive model-of-self subjects did not display any mimicry reaction. The negative model-of-self subjects' higher level of emotional empathy may be interpreted as a tendency to be easily distressed by others showing negative emotional reactions.
In line with Fraleys and Waller's model of attachment and Basch's view on the empathy process, our way of relating to others may be described as a result of a process starting with a primitive form of emotional contagion, which at more elaborated processing levels interacts with more cognitively controlled operations. Fraley and Waller propose that the affect-laden model-of-self, that has been found to correlate with the Neuroticism factor, influences the first part of the process. Model-of-others, that has been found to correlate with the Extraversion factor, is hypothesised to be of a more cognitive character, that operates at later stages of the process. The differences between the empathy groups in the present studies emerged already at the automatic level, a result that may be interpreted as influenced by differences in their tendencies to primitive negative emotional contagion (anxiety). The next step may be described as a result of differences in their emotion regulation strategies, related to their model-of-self. A prerequisite for empathy may be that apprehensive reactions to others' distress are not made inaccessible to consciousness, an emotion regulation strategy characteristic of the low-empathic dismissing- avoidant subjects in the present studies. The final step could be described as an intentional process, related to model-of-others, that may result in either approach or avoidance of other persons. In the present studies no relation was found between the emotional facial reactions and model-of-others.
The designs used in the present studies with a process perspective on personality and emotional communication has less often been applied in psychophysiological research. The results may be regarded as a base for fruitful future research rather than confirmations of the hypotheses.

INTRODUCTION

Theoretical frame and issue of the thesis

Emotional nonverbal communication is a significant theme in psychoanalytical theory, in attachment theory, and in Stern's theory about the development of the infant's interpersonal world. These theories consider the emotional communication or mutual mirroring processes between the caretaker and the infant to be crucial for later development (Bowlby, 1969; Holmes, 1993; Stern, 1985; Winnicott, 1974). Reflections concerning these kinds of emotional communication processes between individuals inspired this thesis. Which are the mechanisms that are involved in the emotional processes that take place intraindividually in the sender, as an interindividual process between the sender and the receiver, which may influence the receiver’s emotional state, and finally be reflected back as an emotional message to the “sender”?

In the present thesis a bio-psycho-social approach to man was applied to study these questions. The thesis aimed at analysing emotional reactions in experimentally created face-to-face interaction situations and to relate these reactions to individual differences in empathic ability and to patterns of attachment.

Processing of social emotional information, studied in an evolutionary perspective, can be described as a hierarchically organised process, starting with basic innate emotional special-purpose mechanisms. The processing is assumed to evolve through consecutively more cognitively elaborated stages, involving both special- and general-purpose mechanisms in interaction. Special-purpose mechanisms can be viewed as distinct command systems that activate various types of innate motivational-emotional systems, serving adaptive survival purposes. General-purpose mechanisms are considered to be flexible cognitive processes open to learning. Our basic emotions described in Differential Emotional Theory (DET) (Dougherty, Abe, & Izard, 1996; Izard, 1971; Tomkins, 1962; Tomkins, 1963; Tomkins, 1981; Tomkins, 1984) are assumed to be an important part of the special-purpose mechanisms. Man’s enlarged cortices make us less constrained than animals by the dictates of these basic systems, since they are modified through social learning in interaction with general-purpose mechanisms. Each emotional system is assumed to interact with specific physiological and motor outputs at more primitive levels, and with more evolved cortical structures at more elaborated levels of information processing. Thus, emotions can be described as processes that originate from both stereotypical motivational-emotional tendencies as well as from more cognitively controlled and flexible processes. These processes are at higher levels assumed to interact in a dynamic way and may finally result in conscious and voluntary behaviour. Our basic motivational-emotional reaction tendencies can be reduced to internalised emotional experiences that serve as guides to more flexible interpretative strategies to adaptive behaviour (Buck, 1985; Buck, 1999; Panksepp, 1994; Panksepp, 1998).

Our genetically prepared potential for basic emotions is supposed to be linked to special sensory-perceptual input of exteroceptive or interoceptive character, that leads to special patterns of motivational-emotional reactions (Buck, 1999; Gibson, 1979; Panksepp, 1998). Facial expressions are by many researchers considered to be one of these genetically based sensory-perceptual signals that are linked to basic emotional reactions. In this approach man is assumed to have a biologically based system for spontaneous emotional communication (Buck, 1984; Buck, 1999; Buck & Ginsberg, 1991; Dimberg, 1989; Ekman, Friesen, & Ellsworth, 1972; Izard, 1994a; Sackett, 1966; Tomkins, 1962; Tomkins, 1963; Tomkins, 1981; Tomkins, 1984). Mirror neurons are proposed to be involved as a special-purpose anatomical system that links the sender and the receiver (Rizzolatti, Gallese, & Fongassi, 1995; Williams, Whiten, Suddendorf, & Perrett, 2001; Wolf, Gales, Shane, & Shane, 2001). The present thesis analyses emotional reactions to facial expressions both at more spontaneous emotional reaction levels and at more flexible, cognitively controlled levels of information processing. Facial mimicry reactions, assumed to be indicators of emotional reactions, were studied at different levels of cognitive control in relation both to individual differences in empathic ability and to different patterns of attachment.

Instructions for the reader

In the following sections, I will initially expand on different theoretical aspects of emotions and on the hierarchical view of information processing. Following these sections, emotional communication via facial expressions and attachment are discussed, and an attempt to integrate these perspectives with the hierarchical view is done. Finally, the different aspects on emotional communication and attachment, as involved in emotional empathy, are combined. In the end of each section the implications of the discussed topic for the present studies are summarised.

Affects, emotions and feelings: A theoretical introduction

What is an emotion?

No consensus exists of the term emotion and its use is often unclear. It is thus important to clarify: (a) what different components that may be involved in emotions; (b) how emotions can be operationalised ; (c) what the different labels affect, emotion and feeling may refer to; and (d) what different functions emotions are assumed to serve.

Mood and emotional reactions must be differentiated from each other. Moods, in contrast to emotional reactions, may last for long periods of time. Mood can be seen as a baseline or tonic affective state of an organism, in which emotional reactions to emotional stimuli, in congruence with the tonic affective state, may easily be provoked (Surraka, 1998).

Different components involved in emotions

Most emotion theories list certain factors as being relevant in the characterisation of emotions, but the theories differ in the relative importance they attribute to the factors involved: (a) an eliciting stimulus that might be exogenous (events in the world) or endogenous (thoughts or images); (b) conscious or unconscious appraisal of the emotional stimulus or the context as being either positive or negative; (c) physiological correlates, that might include both central and autonomic nervous-system activity as well as automatic somatic responding (e.g. facial expressions); (d) distinctive types of subjective experiences of internal mental states; and (e) emotions are finally assumed to have motivational properties (Kagan, 1994; Oately & Johnsson-Laird, 1996; Reber, 1995).

In the following definition of emotions all these features have been included: “Emotions are organised, meaningful, general adaptive action systems….They are complex functional wholes including appraisal or appreciation, patterend physiological processes, action tendencies, subjective feelings, expressions, and instrumental behaviour ”. But as Fischer and collaborators also propose “ None of these features are necessary for a particular instance of emotion" (Fisher, Shaver, & Carnochan, 1990 pp. 84-85).

Different ways of operationalising emotions

Lang postulated three separate emotional response systems whith different functions and which are not always closely tied together: the bodily-physiological, the behavioural-expressive, and the cognitive-verbal emotional systems (Lang, 1995). In line with Lang's postulation most experimental emotion researchers agree that three different components can be used as measures of emotional responses: the physiological/autonomic, the behavioural/expressive, and the experience component (Dimberg, 1989; Kolb & Whishaw, 1990; Lang, 1995). Modern neurological research has made it possible to include also neurological correlates of emotional responses as one of the physiological components involved in the measurement of emotion (LeDoux, 1994; Panksepp, 1998).

Labelling of emotions

The labels of emotions used by investigators of emotion differ depending on the level of analysis and theoretical approach. Today's neurological research usually deals with basic emotional levels for scientific inquiries, so as to understand the biologically prepared emotion systems on which higher level aspects of emotions are based. Researchers often label these emotions basic affects or basic emotions.

Subtle social emotions, such as for example guilt, embarrassment, empathy or curiosity are assumed to be based on innate affects or basic emotions interacting both with each other and with open general-purpose systems operating at higher levels of processing in the brain (Panksepp, 1994; Panksepp, 1998). These forms of emotions are often called secondary emotions and their various labels seem to be endless. Specifically, Tomkins distinguished between three different aspects of the emotion system. He used the term “affect” to denote the biologically innate affective reactions and the term “emotion” to denote multiple affects and episodic memories in interaction, assumed to develop during a person’s course of life. The term “feeling” has, by Tomkins as well as by many other emotion researchers, been reserved to the subjective experience of emotions (Nilsson, 1995; Tomkins, 1984).

Different functions of emotions

Different functions of emotions have been proposed. Primarily, emotions can “inform” the organism about urgencies of survival value (Buck, 1999; Edelman, 1989; Tomkins, 1991). The elicitation of autonomic responses and endocrine responses are of clear survival value to prepare the body for action (Buck, 1999; Panksepp, 1998; Rolls, 1999). Secondarily, in contrast to behaviour based on reflexes or instincts, emotions make it possible for the organism to make flexible responses. Emotions allow a two-stage process of learning to take place, the first stage at a classical conditioning level and the second at an instrumental and more flexible learning level (Rolls, 1999). Thirdly, emotions are proposed to motivate the organism (Izard, 1991; Rolls, 1999; Tomkins, 1962; Tomkins, 1963; Tomkins, 1991). A forth function, suggested for emotions, is that of making it possible to communicate internal motivational states between group members (Buck, 1984; Buck, 1999; Panksepp, 1998). Finally, emotions are suggested to promote social bonding related to attachment between parents and their children (Buck, 1999; Izard, 1993; Lang, 1995; Panksepp, 1998; Rolls, 1999).

Different theoretical approaches to emotion

Many controversies exist in emotion research. One is the nature of the process that intervenes between the occurrence of an emotion-arousing stimulus and the conscious feeling it elicits. Another controversy is whether emotions are best characterised by a typological/categorical approach or a dimensional approach. Another discussion contrasts the top-down versus the bottom-up approach. This discussion is related to the question of the existence of basic universal emotions. As outlined below, different theoretical approaches to emotions have come up with different answers to these issues.

Cognitive approaches to emotion

The social constructivist, or cognitive, approach to emotion denies basic biologically prepared emotions and assumes that our various emotions are acquired through learning. This approach focuses on the way we label our bodily sensations and interpret our environments. Concepts and words are socially learned and human emotional experience is thus assumed to be constructed by social learning (Averill, 1985; Mandler, 1984). In Lazarus' cognitive appraisal theory of emotion the link between cognitive appraisal and physiological arousal is stressed. All forms of emotional responses are, according to Lazarus, preceded by cognitive appraisal (Lazarus, 1991). Schachter and Singer have formulated a two-factor emotion theory, emphasising the role of a cognitive interpretation of the cause of undifferentiated physiological arousal states (Schachter & Singer, 1962). According to this view of emotion, cognitive appraisal of the contextual influence and of the internal state fills the gap between the eliciting stimulus, associated with non-specific bodily arousal, and the subjective experience. Conscious interpretation of the eliciting stimulus and the context plays an important role and could be considered a top-down approach to emotion in contrast to the biologically based theories suggesting basic innate emotions.

Dimensional approaches to emotion

The dimensional view of emotion is closely connected to behaviouristic theory in psychology. In this approach emotion may be defined as states elicited by rewards and punishments, including changes in these (Lang, 1995; Rolls, 1999). A reward is anything for which an organism will work. Punishment is anything that an organism will try to escape or avoid. Some of these rewards and punishers are unlearned (primary), while others may become rewarding or punishing by classical conditioning. Behaviouristic approaches to emotion are often associated with a two-dimensional view on emotion: One dimension of emotion is the affective valence (rewards or positive valence versus punishment or negative valence) and the other dimension indicates the level of arousal. Accordingly, only these two factors are assumed to differentiate between emotions (Lang, 1995; Rolls, 1999).

Tomkins' typological affect theory

Central to Tomkins' affect theory is the notion that emotions are based on biological systems structured by evolution, rather than stemming from higher order cognitive-appraisal processes (Demos, 1995; Tomkins, 1962; Tomkins, 1984; Tomkins, 1991). The primary affects, associated with different facial expressions, are considered to be controlled by innate affect programs, inherited as subcortical structures that automatically instruct the muscles and glands to respond with unique patterns characteristic of a given affect. The affects are hypothesised to be comprised of correlated sets of responses involving the facial muscles, the viscera, neurochemicals, the respiratory system, the skeleton, blood flow changes, and vocalisation, all acting together (Demos, 1995; Tomkins, 1984; Tomkins, 1991). A biologically based emotional response to certain external or internal "scenes" is by Tomkins called an innate script. The scene and the relationships between scenes are assumed to be the basic unit of analysis for understanding persons. One of these innate scripts is the excitement-interest driven visual tracking of the mother's face and another example is the rage script driven by hunger or other excessive stimulation (Demos, 1995; Tomkins, 1984; Tomkins, 1991). These innate patterns, or scripts, are assumed to be transformed in interaction with the social environment throughout the ontogenetic development. The affect is a separate assembly that, according to Tomkins, functions along with the homeostatic system, the drive system, the cognitive, and the motor systems and can, thus, occur independently of both drive and cognition. Tomkins considers affects to be the primary sources of motivation and argues that affects function as analogue amplifiers that create an experience of urgency within the organism. This amplification causes the organism to care about what is happening and makes good things feel better and bad things worse. As Tomkins puts it "the drive must be assisted by affect as an amplifier if it is to work at all… The affect is, therefore, the primary motivational system because without its amplification, nothing else matters, and with its amplification anything else can matter. It thus combines urgency and generality. It lends power to memory, to perception, to thought, and to action no less than to drives." (Tomkins, 1984, pp. 355-356).

Tomkins distinguishes nine primary affects, each characterised by separate facial responses: interest-excitement, enjoyment-joy, surprise-startle, fear-terror, distress-anguish, shame-humiliation, anger-rage, contempt-disgust, and dissmell (Demos, 1995; Nilsson, 1995; Nilsson, 1998; Tomkins, 1991). This approach, in which different categories of emotions are assumed to be biologically prepared, has been referred to as the typological approach or Differential Emotions Theory (DET) in contrast to the dimensional approach of emotion (Dougherty et al., 1996; Izard, 1971). Tomkins conceives of emotional experiences (feelings) as being mainly the result of facial proprioceptive feed back (Demos, 1995; Tomkins, 1984; Tomkins, 1991). Thus, in Tomkins' theory the facial expression is, via proprioceptive perceptual feed back, the "cause" of the subjective feelings, a conception that can be regarded as a special instance of the James-Lange theory of emotions. According to this theory the arousing stimulus elicits a bodily change and the subjective feeling is assumed to be the perception of the corresponding bodily responses (LeDoux, 1996).

A developmental-interactionist theory of emotion

Buck's theory of emotion has many features in common with Tomkins' theory, since it conceives of different biologically based affects associated with motivational properties. Buck, however, proposes that emotions can not be separated from motivation and cognition and that each system is involved in both of the others (Buck, 1999). Motivation is in this approach defined as the potential for behaviour built into a system of behaviour control. Emotion is considered to be the readouts of the motivational potential when activated by a challenging stimulus. The different biologically prepared emotional special-purpose systems (motivational-emotional systems) are supposed to interact at further elaborated levels with general-purpose system (cognitive interpretative systems) so as to allow intentional and flexible reactions. According to Buck, emotions serve both selfish, adaptive purposes, important for the organism's survival, and social communicative purposes important for social co-ordination and thus, for the survival of the members in a group (Buck & Ginsberg, 1991). Buck's approach to emotion integrates both the dimensional and the typological view of emotion, as he conceives of emotions as hierarchically organised with arousal and punishment-reward systems involved at lower brainstem based levels of emotional responding. The reward and punishment systems are at higher levels interacting with affective neural circuits in the limbic area that are associated with the emotions happiness and sadness, with the prosocial family related system for attachment and submission, and the affect system associated with the agonistic affects fear, anger and disgust (Buck, 1999). These prosocial and agonistic affects are basic and biologically prepared, as well as the phylogentically older systems for reward-punishment and arousal. Basic emotions may at higher levels interact with cognitive interpretative systems and result in more complex feelings as for example pride, shame, jealousy, and guilt.

Buck distinguishes between three different forms of emotional readouts: (a) adaptive-homeostatic arousal responses (Emotion I); (b) expressive behaviours such as facial expressions (Emotion II), and; (c) subjective experience of emotion (Emotion III) (Buck, 1984; Buck, 1993; Buck, 1999). Each form of readout serves its own function. Buck conceives of Emotion I as serving basic adaptive purposes for maintenance of homeostasis. Emotion II has evolved to serve communicative purposes. Emotion III, the subjective experience, fulfils the organism's need to be aware of certain internal states. Subjective emotional experience informs the organism about its internal emotional state and can thus guide self-regulative behaviour in a flexible way. Emotion III is by Buck considered to be a form of cognition or knowledge about the individual's internal emotional state. This knowledge can be of syncretic or analytical character. Syncretic knowledge, or knowledge-by-acquaintance, can be described as based on special-purpose processing systems, being a "warm", immediate, self-evident raw knowledge and is assumed to always be present in the organism, even if usually as an unnoticed whisper. Buck assumes emotional raw knowledge to be associated with specific neurochemicals, constituting a kind of interoceptive information. In contrast to Tomkins, he does not believe that facial feedback is a prerequisite for emotional experience. Analytic cognition, or knowledge-by-description, is described as a "cold", sequential, and serial way of information processing based on general-purpose systems and has been labelled knowledge-by-description (Buck, 1984; Buck, 1999; Buck & Ginsberg, 1997). Emotional education and language are considered to be involved in this form of emotional knowledge.

One important feature of Buck's theory is that man is supposed to be biologically prepared for emotional communication through innate displays on part of the sender and preattunements to these displays on part of the receiver. Individuals in spontaneous communication are by Buck considered to constitute a biological unit (Buck & Ginsberg, 1991). Thus, his theory proposes different intraindividually hierarchially organised levels of emotional response and further biologically prepared interactions between individuals.

The present approach: Man as a bio-psycho-social being

Tomkins' and Buck's emotion theories have been important sources of inspiration for the studies involved in this thesis. Their theories view man as a bio-psycho-social creature evolved through the specie's phylogenetic and the individual's ontogenetic history in communication with a social environment. Buck's and Tomkins' theories are bottom-up approaches to emotions based on the assumption that biologically prepared motivational-emotional tendencies or basic emotions – special-purpose systems - operate as the base of our emotional responding, which at higher levels of processing interact with, and can be controlled by, conscious, flexible, general-purpose systems. Spontaneous or basic emotions are by Buck and Tomkins regarded as a kind of raw knowledge about the survival significance of our internal or external environment, which may guide adaptive behaviour in a flexible way (Buck, 1999; Tomkins, 1981). The present studies were based on the assumption that spontaneous facial expressions can be conceived of as being efferents of basic innate affect programs in interaction with primary memory systems (Ekman & Friesen, 1975; Izard, 1991; Tomkins, 1962; Tomkins, 1963) Thus, spontaneous emotional expressions are here assumed to be closely linked to emotions.

Labels of emotional phenomena used in the present thesis

The labels used in this thesis to denote emotional phenomena distinguish between different aspects of emotions. "Basic emotions" or "basic affects" are used to refer to basic innate motivational-emotional tendencies. The term "feeling" is restricted to conscious subjective emotional experiences, knowledge-by-description according to Buck. "Emotional or affective reactions" include reactions, which may be accompanied by either emotional raw knowledge outside awareness or by conscious emotional experience (feelings). In addition the term "emotion" is used at an abstract principal level, and may include all subordinate meanings of the concept.

The terms emotion regulation or affect regulation are described as consisting of "the extrinsic and intrinsic processes responsible for monitoring, evaluating and modifying emotional reactions, especially their intrinsic features to achieve one's goals" (Thompson, 1994, pp. 53-54). Such regulatory processes may be automatic or controlled, and may be conscious or unconscious (Gross, 1999).

Moods, in contrast to emotional reactions, may last for long periods of times and may be seen as a baseline emotional state of an organism. This internal emotional state of an individual is in the present thesis denoted tonic affective state.

The term cognition is in the present thesis often used in contrast to spontaneous affects or emotions and refers to flexible general-purpose systems, working at a secondary memory level.

Information processing as hierarchically organised

One further important assumption in the present thesis was that emotional information processing can be conceived of as hierarchically organised, and that the cognitive product is the result of a microprocess in time.

Leventhal's and Öhman's emotional information processing theories

Leventhal has formulated "the perceptual-motor-model-of-emotion", implying the existence of three different hierarchically organised levels of emotional response (Leventhal, 1984). His theory is in line with Buck's and Panksepp's ideas of different neurological stages of emotional information processing. Öhman has proposed a similar conception of different stages in the information processing of emotional stimuli (Öhman, 1993). Öhman's model, however, is primarily concerned with evolutionarily relevant stimuli that evoke fear and anxiety.

A first and most basic level of the affect program is assumed to be inherited and thus biologically prepared. The response at this level is either physiological or automatic motor in character and automatically evoked by specific stimuli, without previous learning (Leventhal, 1984; Öhman, 1993). This first level is by Öhman termed the feature detector system and is assumed to be directly connected to the arousal system (ARAS) in the brainstem and operates on physical input and not in interaction with memory systems (Öhman, 1993).

The second level is conceived of as involving a separate memory system (first memory system), which is automatically evoked. It constitutes a schematic, prototypical level of emotional processing, representing a conditioned emotional response (Leventhal, 1984; Öhman, 1993). This level is by Öhman labelled "the significance evaluator" and is considered to be schema driven, involving first level memories. It requires cognitive resources but is still considered to operate without access to conscious awareness (Leventhal, 1984; Öhman, 1993).

The significance evaluator may as the third step in the emotional processing activate the conscious perception channels. At this level the input from the significance evaluator system and the arousal system is interpreted in interaction with the expectancy system and its associated memory system at a conscious reportable level, labelled second memory systems. It involves controlled or regulated reactions rather than spontaneous emotional reactions (Leventhal, 1984; Öhman, 1993).

Microgenetic theory of information processing

The experimental method used in the present studies was based on microgenetic theory, that assumes that mental phenomena, including ideas, perceptions, words, actions, and affects evolve through qualitatively different stages of processing, which ultimately may emerge in consciousness. This process involves a progressive unfolding in time, spanning from microseconds to seconds (Hanlon, 1991), and is supposed to recapitulate the organism's phylogenetic and ontogenetic development. A model called percept-genesis, (Kragh & Smith, 1970), is built on the same assumption of perception as a microprocess in time recapitulating phylogenetic and ontogenetic development.

Neural correlates of emotional hierarchical processing

Panksepp defines emotions from a neuropsychological perspective: "Emotions are the psychoneural processes that are especially influential in controlling the vigour and pattering of actions in the dynamic flow of intense behavioural interchanges between animals, as well as with certain objects during circumstances that are especially important for survival " (Panksepp, 1998, p.48). Thus, emotions are by Panksepp defined as psychoneural processes that guide the organism to promote behaviour important for survival.

The anatomy of the emotional network hierarchy

The brain is by many recent neuroscientists viewed as a hierarchical system, in which higher functions operate on the basis of lower functions. Higher functions are generally more open, while lower functions are more reflexive, stereotyped, and closed. The anatomical hierarchy involved in the processing of emotional information is connected by neuronal networks that integrate different functional levels (Buck, 1999; Panksepp, 1994; Panksepp, 1998). The neocortex is assumed to be responsible for further elaboration and interpretation of the earlier stages of information already processed in older brain structures (LeDoux, 1996; LeDoux & Phelps, 2000).

MacLean has described the cerebral evolution of emotions in his conception of "the triune brain", suggesting three levels in the hierarchical organisation: the reptilian brain or basal ganglia, the old mammalian or limbic structure, and finally the neomammalian brain consisting of the neocortex (MacLean, 1993; Panksepp, 1998).

The reptilian brain plays, according to MacLean, a fundamental role in performing instinctual motor habitual routines, as well as instinctual displays used in social communications and is also suggested to be associated with a raw form of sex and aggression (MacLean, 1993; Panksepp, 1998). These primitive forms of sex and aggression can be regarded as antecedents of prosocial and selfish emotions. Performance at this level is assumed to occur automatically, without any accompanying emotional experiences (Buck, 1999). This first level in the motivational-emotional process is, according to Buck (1999), located at the brainstem and medial forebrain level and is also by Buck supposed to be a level of simple reflexes. The arousal system (ARAS) as well as the medial fore brain bundle (MFB) and the periventricular bundle (PVS) are at this level responsible for primitive approach and avoidance reflexes. These primitive affective special-purpose systems are supposed to interact with other higher brain areas such as the hypothalamus, the limbic system and the prefrontal cortex and constitute the positive, activating (BAS) and negative, inhibitory expectancy (BIS) systems. These systems are considered to be important in the basic positive (activating, approaching, rewarding) and the negative (inhibitory, avoidant, punishing) dimensions of emotion (Buck, 1999; Lang, 1995; Panksepp, 1994; Panksepp, 1998; Rolls, 1999).

The second level of the anatomical hierarchy consists of the limbic structures. In the evolutionary transition from reptiles to early mammals, the limbic system evolved with new capabilities necessary for survival of mammals. The thalmocingulate circuit, involved in the limbic structure, is assumed to be responsible for nursing in conjunction with parental care. The family related behaviours include separation vocalisations and play behaviour. Another sub-division of the limbic system is the amygdala-circuit important for self-preservation connected with areas responsible for searching (approaching) and defensive (avoiding) behaviour. It is also involved in selfish emotions such as aggression, competition and fear involved in active flight behaviour (Buck, 1999; MacLean, 1993; Panksepp, 1998). The septal network in the limbic area is of importance for sexual functioning. The limbic system is considered to be associated with emotional experience, sometimes an experience of a free-floating nature, being completely unattached to any particular thing, situation or idea (Buck, 1999; MacLean, 1993).

The third level in MacLean's anatomical hierarchy consists of the neocortical structures. The processing of emotional information, carried out by these structures, is more dominated by general-purpose mechanisms than by special-purpose emotional networks. The orbitofrontal part of neocortex is strongly linked to the thalamocingulate circuit implicated in the family-related network essential for attachment processes (Schore, 1994; Steklis & Kling, 1985). "Through such culminating developments, it might be that a sense of parental responsibility generalises to other members of the species, becoming what we varying qualify as conscience, empathic concern, and altruism" (MacLean, 1993, p. 81). Thus, even sophisticated social emotions, such as the empathic concern for others, which is in focus in the present thesis, seem to be based on special-purpose-systems in interaction with higher levels of cognitive interpretation.

Neural correlates of different stages in emotional processing

Contemporary research supports the idea that much of our primary processing of external emotional stimuli is unconscious and automatic, involving the amygdala, before it proceeds to cortical sensory areas for further elaboration. LeDoux has traced a subcortical pathway, from the primary auditory cortex over the thalamus and to the amygdala, that automatically activates autonomic responses and muscle reactions without participation of the cortex. The short-cut to the amygdala is several synapses shorter and faster than the processing by neocortex (LeDoux, 1996). Other, slower, routes involve the visual cortex and the hippocampus and operate at a more conscious level. The features of the stimuli can be further processed at the cortical level and finally associated with knowledge-by-description (Kagan, 1994; LeDoux, 1996; Pally, 1998b). The result of the cortical analysis is relayed back to the hippocampus and the amygdala about 50 milliseconds later than the primary information processing to support the first level of processing (Kagan, 1994). These experimental findings in neurological research are in accordance with Leventhal’s and Öhman’s theories of an unconscious/automatic level in the emotional process. The different types of responses to an emotional stimulus are assumed to be associated with separate memory systems. The amygdala dependent system is associated with the first memory system (knowledge-by-acquaintance), and can be assumed to operate at Öhman's and Leventhal's second, automatic level in the emotional process.

The other memory system is termed the secondary or declarative memory system (knowledge-by-description). The hippocampus is considered to be involved in this memory system and to play an important role in the setting of the emotional context of the stimulus (LeDoux, 1996; LeDoux, 1994; Pally, 1998b). This system can be conceived of as operating at the third level of Leventhal's and Öhmans models of emotional information processing.

The frontal lobes are important for the planning of behaviour and for control of both emotions and behaviour. The frontal regions in the human brain may achieve their executive functions through vertical integration, combining the representative capacities of the neocortex with the motivational and regulatory influences of the orbitofrontal cortex and the subcortical motivation-emotional system (Tucker & Derrberry, 1992). The orbitofrontal cortex is supposed to be an area of interaction with subcortical reward and punishment networks, and its capacity to anticipate and plan may either be concerned with prospects that induce anxiety or induce joyful planning (MacLean, 1993; Schore, 1994). The reward system (BAS), is associated with activity in the sympathetic energy-expending autonomic system, while BIS is associated with the parasympathetic energy-conserving system, which is considered to have a special role in emotional regulation. The orbitofrontal region is further innervated from the prefrontal regions of the right hemisphere, supposed to be involved in emotion regulation and cognitive control at a secondary memory level (Rothbarth, Taylor, & Tucker, 1989). The orbitofrontally modulated response may through descending neurons modify the spontaneous autonomic activity and the spontaneous emotional response, a feedback mechanism that may be regarded as a top-down mechanism involved in the emotional regulation process (Schore, 1994). In the more elaborated stages of information processing the posterior right hemisphere is assumed to be specialised for processing of nonverbal emotional information (knowledge-by-acquaintance), while the left hemisphere is assumed to be involved in processing of symbolic, analytical information (knowledge-by-description). This final step in information processing might be necessary for the ability to cope with the emotional reactions in an adaptive manner (Banich, 1997; Buck, 1993; Buck, 1994; Buck, 1999; Gainotti, Caltagirone, & Zoccolotti, 1993; Pally, 1998a; Tucker, 1981; Tucker, 1992).

The observations in neuropsychological research described above are in accordance with Leventhal's and Öhman's theories of both an automatic stage outside awareness and a more conscious/more controlled level in the perceptual-emotional process and can further be considered as supporting the theory of microgenesis.

The present approach: Levels of emotional information processing

The designs of the present studies aimed at analysing emotional reactions at different levels of information processing and were inspired by Öhman's and Leventhal's theories of emotional processing as hierarchically organised (Leventhal, 1984; Öhman, 1993), the microgenetic theory (Dixon, 1981; Hanlon, 1991), the theory of perceptgenesis (Kragh & Smith, 1970), and modern neurological research (Kagan, 1994; LeDoux, 1996; LeDoux, 1994; MacLean, 1993; Pally, 1998b; Tucker & Derrberry, 1992). Different levels of information processing were induced by successively prolonged exposure times of facial expressive stimuli, starting with very short exposure times at preattentive level (17 ms), continuing on to longer exposure times representing conscious information processing (Dimberg, Thunberg, & Elmehed, 2000; Dixon, 1981; Hanlon, 1991; Kragh & Smith, 1970; Öhman, 1993). A masking picture was presented immediately after presentation the facial stimulus to interrupt information processing (Esteves & Öhman, 1993).

The preattentive level was operationalised as exposure times at which subjects were perceptually unaware of the facial expressive stimulus. At this exposure time (17 ms) the processing of the stimuli is assumed to take place at a subcortical level inaccessible to awareness since the time from stimulus onset until the processing take place in neocortex takes about 24 ms as supported by findings in brain research on animals (LeDoux, 1996). The second level, here called automatic, was operationalised as the exposure time at which subjects hardly recognised the facial expression. The label automatic can be questioned and perhaps "border-line attentional level" would have been more adequate, since the term automatic is usually used to represent the reaction side of the process. The controlled level of processing was operationalised as exposure times long enough for subjects to clearly identify the facial expressions.

Facial reactions at the shortest exposure times (the preattentive and the automatic levels) were conceived of as being a result of biologically prepared emotional reaction tendencies and first memory systems in interaction, representing automatic, conditional emotional responses (Leventhal's and Öhman's second level). The result of the cortical analysis (24 ms after stimulus onset) is relayed back to the hippocampus and the amygdala about 50 milliseconds later to support the first primitive level of processing (Kagan, 1994; LeDoux, 1996). Thus, the short exposure times (from 17 to 56 ms), with an interrupting masking picture, presumably are not long enough to activate processing levels at which emotion regulation at a secondary memory level operates to modulate automatically evoked spontaneous emotions. Reactions at the longest exposure times (the controlled level, 1000-2350 ms) were here assumed to represent emotionally regulated responses, in which the hippocampus and secondary memory processes are supposed to be involved (Leventhal's and Öhman's third level).

A further measure of emotional responses in the present thesis were the subjects' verbal label of their internal emotional experience (self-reported feelings). In the present studies, subjects reported their feelings immediately after they were exposed to the emotional stimuli. This level of measurement can be considered as an operationalisation of subjective feelings corresponding to Buck's knowledge-by-description (Buck, 1984; Buck, 1993; Buck, 1999).

Man as biologically prepared for facial communication

The present studies were further built on the assumptions that communication of emotions via facial expressions is a biologically prepared capability and that the communication of emotions takes place both at a spontaneous, biologically prepared level and at more consciously controlled levels of information processing.

Spontaneous and symbolic communication

Symbolic communication is defined as communicative behaviour, which has an arbitrary relationship with its referents, is socially defined and occurs intentionally. Language can be considered to be our most important means of symbolic communication, but certain nonverbal behaviour, such as sign language and intentionally posed facial expressions can as well be classified as symbolic (Buck, 1984; Buck, 1995; Buck & Ginsberg, 1991). In contrast to symbolic communication, spontaneous communication is viewed as being based on a biologically shared signal system, which is not arbitrary in relation to its referents. On the contrary it is a biologically prepared and universal system for communication, that occurs automatically outside awareness. Facial expressions, the prosody of the voice, and body gestures are involved in this spontaneous, automatic communication process (Buck, 1984; Buck, 1992; Buck, 1995; Buck & Ginsberg, 1991).

Communication in authentic life situations

The relationship between symbolic and spontaneous communication in real life situations can be very complex with a continuous interaction between them. A parallel, biologically based stream of communication, that connects organisms directly with one another, is assumed to occur simultaneously with the verbal communication. In such interaction situations, one individual's subcortical affective signals are assumed to directly influence the other individual’s subcortical emotional reactions (Buck & Ginsberg, 1991; Hofer, 1984; Schore, 1994; Trevarthen, 2001t). The direct involvement in other individuals’ internal emotional processes in spontaneous communication may satisfy deep emotional needs of attachment. In conjunction with other motives these social motives may serve an essential prerequisites for communication (Buck, 1984; Buck, 1992; Buck, 1993).

It is important to note that nonverbal communication is viewed both as based on prewired biologically prepared communication skills and as modified and controlled by implicit or explicit social rules learned in the individual's socialisation process (Ekman & Friesen, 1969). These socially learned modifications of nonverbal expressions can however be ”built in” and automated in the spontaneous communication process and constitute modulated facial expressions (Buck, 1994; Matsumoto & Lee, 1991).

Communication via facial expressions as biologically prepared

Contemporary research on facial expressions can be traced back to Tomkins' theory of facial expressions as markers of biologically based emotions and his idea that facial expressions through a feedback mechanism are involved in the experience of emotion (Tomkins, 1962). His proposal that nine basic discrete affect programs include automatic neural messages to the facial musculature, has been referred to as the facial efference hypothesis. These affect programs are assumed to correspond to discrete facial expressions for happiness, interest, surprise, sadness, fear, anger, disgust, dissmell, and shame (Demos, 1995; Tomkins, 1962; Tomkins, 1963; Tomkins, 1991).

A prerequisite for communication via facial expressions is that the emotional message expressed by the facial display is transmitted to and "decoded" by a receiver. Preparedness theories suggest that we have a biologically prepared capacity to react to or decode stimuli relevant for survival (Gibson, 1979; Seligman & Hager, 1972; Öhman & Dimberg, 1978). It is proposed that all species, including humans, are biologically prepared to react to some events or stimuli more easily than others. Since social behaviour and communication are important for survival, it follows that this preparedness theory should also cover social situations such as the communication of emotions in face to face interactions (Dimberg, 1989). Gibson deals with the perception of meaning through the concept of affordance, which involves conjunction between the properties of the organism and the environment. The perceptual system has evolved to ”pick up” certain environmental information relevant for survival. Affordances may involve characteristics of physical properties as well as of other persons. It could be argued that the process of spontaneous communication may be viewed in terms of social affordances (Buck, 1984; Dimberg, 1989).

Today there is considerable evidence in favour of the idea that both sending and receiving capabilities are biologically prepared systems for emotional communication. If the communication of emotions is biologically prewired it could be predicted that the basic facial expressions and the “decoding” of these expressions would be the same in different cultures, and these abilities should be expected to exist among species related to human beings such as the non-human primates. These propositions are supported by existing data (Dimberg, 1989).

Studies on facial expression-recognising and expression-posing in both Western and other cultures have produced convincing findings in support of Tomkins' affect theory, in which the different biologically based affects are assumed to be expressed as different facial expressions. In several studies performed in different cultures it has been demonstrated that the "observers" of facial expressions can accurately identify the emotional category of the stimuli viewed by the "senders" of facial expressions. These findings support the idea that the basic emotional displays are the same in different cultures and in support of the efference hypothesis (Camras, Holland, & Pattersson, 1993; Ekman, 1994; Izard, 1994a; Keltner & Ekman, 2000). It has also been shown that basic emotions, such as distress, anger, surprise, and joy are facially expressed by infants soon after birth, usually within the first seven months (Anderson & Guerrero, 1998). It can thus be suggested that spontaneous facial expressions serve as a readout system for different biologically prepared affects and are evoked by prewired affect programs (Dimberg, 1997a; Dimberg, 1997b; Ekman, 1993; Lundqvist, 1995; Plutchnick, 1983).

Some support of Gibson’s and Seligman’s theory of social affordances can be found in Sackett’s study of infant rhesus monkeys, who had been isolated from other monkeys from birth (Sackett, 1966). When confronted with a photo of a large threatening male monkey they reacted with appropriate fearful behaviour. Öhman and Dimberg have shown that angry facial expressions, but not happy faces, appear to be particularly effective when used as conditioned stimuli in aversive conditioning (Öhman & Dimberg, 1978). These findings support the preparedness theory and the idea that humans are biologically prepared to react to facial expressions.

Correspondence between spontaneous facial expressions and emotions

Research on facial expression supports the differential or typological emotion theory of emotion (DET) that predicts that basic innate emotions are linked to distinct facial displays, but do not agree on which emotions and the number of emotions that can be regarded as basic. Most research on facial expressions, however, support sadness, anger, fear, disgust, surprise, shame and happiness as basic emotions linked to distinct facial expressions (Cacioppo, Petty, Losch, & Kim, 1986; Ekman, 1989; Ekman, 1994; Izard, 1994a; Keltner & Ekman, 2000). The findings in support of discrete facial expressions are most compelling regarding overt facial expressions that are visible by an observer and can be measured by for example the Facial Action Coding System (FACS) (Ekman, 1989; Ekman & Friesen, 1978; Ekman, Friesen, & Ancoli, 1980). Support for discrete emotions is less compelling regarding covert, microexpressions measured by electromyography (EMG). There is, however in research, using EMG as detector of microexpressions, evidence for increased corrugator activity (the frown muscle) in response to the negative emotions anger, fear, sadness, and disgust, and for increased zygomatic activity (the smiling muscle) in response to the positive emotion happiness (Cacioppo, Matzke, Petty, & Tassinary, 1988; Hietanen, Surraka, & Linnanskoski, 1998; Lang, Greenwald, Bradley, & Hamm, 1993; Schwartz, Ahern, & Brown, 1979; Smith, McHugo, & Lanzetta, 1986; Witvliet, 1998). It may be hypothesised that EMG activity during low intensity emotions expressed in microexpressions reflect a bivalent motivational-emotional tendency rather than discrete emotions (Cacioppo, Klein, Berntsson, & Hatfield, 1993).

Emotional contagion

There is ample evidence that people in social interactions tend to catch and respond to each other’s feelings. “This phenomenon is assumed to be produced both by innate stimuli features, by acquired stimuli features and by emotional imagery. Thus, the catching of other peoples' emotions in real life situations can be assumed to be multiply determined” (Hatfield, Cacioppo, & Rapson, 1992 pp.153-154). A lot of alternative mechanisms have been suggested to be involved in this catching of other persons' feelings: 1) conscious analysis of another’s person's emotional behaviour, 2) conditioned or unconditioned emotional reactions, involving internal autonomic or neurochemical reactions, 3) an automatic tendency to mimic another person's emotional behaviour, which leads to synchronised feelings of the sender and the receiver (Surraka, 1998).

This last form of primitive catching of the other person's feeling has been called emotional contagion and can be defined as "the tendency to automatically mimic and synchronise facial expressions, vocalizations, postures, and movements with those of another person and consequently to converge emotionally" (Hatfield et al., 1992, pp. 153-154). The theory building around emotional contagion through mimicry started already about a hundred years ago, when Lipps suggested that we might have innate tendencies to instinctively mimic or imitate other people. As a result of the mimicking we mirror the internal feeling of the other person (Lipps, 1903). Today, the fact that faces mirror the emotional facial expressions of those around them is well documented in a number of studies (Chartrand & Bargh, 1999; Dimberg, 1982; Dimberg, 1989; Dimberg & Karlsson, 1997; Kappas, Hess, & Banse, 1992; Surraka, 1998; Vaughan & Lanzetta, 1980; Zajonc, Adelmann, Murphy, & Niedenthal, 1987). A recent study has, in addition, shown that the mimicking reactions can be evoked even at the preattentive level, a support for the assumption that mimicry reactions are automatic reactions that operate outside our conscious awareness (Dimberg et al., 2000). Support for facial mimicry resulting in emotional contagion has been found in a study by Lundquist et. al (Lundquist & Dimberg, 1995).

Mimicking may be explained as a result of actions of the mirror neurones. These kinds of neurones have recently been identified in non-human primates and they seem to be specialised for visual information about the action of others. When a monkey is watching another monkey performing an act, the corresponding neurones will fire in pre-motor cortex as if the monkey had performed the act himself. The result is a mirror (but mainly inhibited) pre-motor activation in the observer (Perrett & Emergy, 2000; Williams et al., 2001). If these results are translated to reactions on facial expressions it could be hypothesised that the observation of facial expressions will result both in activation of mirror neurones and in facial microexpressions, a micro mimicking reaction.

Correlation mechanisms involved between spontaneous mimicry reactions and emotional contagion

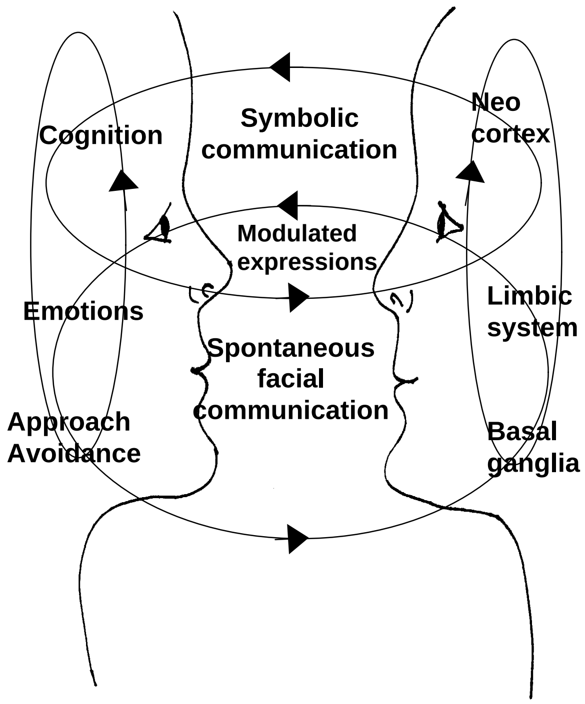
The mechanisms involved between automatic mimicry and emotional contagion are, however, unclear. Facial feed back is one explanation suggested for emotional contagion. One idea about the function of facial expressions is suggested by the facial feed back hypothesis, which propose that the facial muscle activity provides proprioceptive information (afferent facial feedback) that influences the emotional experience (Burgoon, Buller, & Woodall, 1996; Ekman, Levenson, & Friesen, 1983; Hess, Kappas, McHugo, Lanzetta, & Kleck, 1992; Izard, 1971; Lanzetta & Kleck, 1976; McIntosh, 1996; Tomkins, 1984). The facial feed back hypothesis has been supported by empirical studies, using subjects who voluntarily alter their spontaneous expressions by inhibiting or amplifying them (Bush, Barr, McHugo, & Lanzetta, 1989; Camras et al., 1993; Kappas, McHugo, & Lanzetta, 1989; Starck, Martin, & Stepper, 1988). The human tendency to mimic facial expressions (Dimberg, 1982; Dimberg, 1989; Dimberg & Karlsson, 1997; Kappas et al., 1992; Vaughan & Lanzetta, 1980; Zajonc et al., 1987) combined with the afferent facial feedback hypothesis, has resulted in the interpersonal facial feed back hypothesis (IFFH). This hypothesis combines the interpersonal mimicry reaction tendencies and the intrapersonal facial feed back mechanism and may help to explain the mechanisms behind emotional contagion (Capella, 1993).

Buck, who has questioned the role of facial feed back as involved in emotional experience, has instead suggested that emotional "raw knowledge" is the result of differential neurochemical activation (Buck, 1999). The mechanism behind the correlation between spontaneous mimicry and emotional contagion can in this perspective be viewed as a process where facial displays operate as conditioned or unconditioned stimuli that simultaneously trigger neurochemical reactions, involved in emotional raw knowledge, and hardwired facial expressions (Buck, 1999; Dimberg, 1997b).

Facial reactions at controlled levels of processing

Although the various studies cited above support the idea of a correspondence between facial expressions and emotional experience, problems connected with this simple hypothesis have been indicated. A major controversy is the relative influence on facial expressions that spontaneous emotions have on these expressions versus conscious cognitive and social contextual factors (Ekman & Friesen, 1969; Hess, Philippot, & Blairy, 1998; Izard, 1990; Matsumoto, 1987). Spontaneous facial expressions as well as spontaneously evoked emotions are modified and controlled by implicit or explicit social rules learned in the individual's socialisation process (Ekman & Friesen, 1969). When studying facial displays it is thus important to consider also cognitive factors and individual differences in emotional regulation (Ekman & Friesen, 1969; Ekman & Friesen, 1982; Ginsburg, 1997; Hess, Banse, & Kappas, 1995; Hess et al., 1998; McHugo & Smith, 1996; Tassinary & Cacioppo, 1992; Vrana & Rollock, 1998). Processes involving secondary memory systems and emotional regulation, can be expected to influence emotions and facial expressions at more controlled levels of emotional information processing.

One possible factor that may influence the emotional experience and the facial reactions to aversive stimuli at the controlled level of processing is a habitual, rapid attentional shift from negative emotional thoughts to distracting positive memories. This attentional shift may amplify the positive emotional memory networks, which in turn, may facilitate a process of emotional regulation and modulate facial expressions (Fraley, Davis, & Shaver, 1998).



Emotional communication at different levels of cognitive control

Deliberate or automatic changes of spontaneously elicited facial expressions, may also modulate or inhibit the emotional experience through proprioceptive facial feed back directly influencing emotional subcortical networks (Bush et al., 1989; Camras et al., 1993; Izard, 1990; Kappas et al., 1989; Lanzetta & Kleck, 1976; McIntosh, 1996; Starck et al., 1988). Another mechanism that may modulate the emotional experience, and thus influence the facial expression at the controlled level, can be a non-conscious self-perception of the facial expression (Duclos & Laird, 2001).

Both deliberately and automatically elicited changes of spontaneous facial expressions and automated shifts of attention probably occur as a modulating reaction to a previous spontaneously elicited emotional reaction. Thus, such reactions would be expected to be more involved at the controlled stages of information processing influenced by top-down secondary memory processes.

Neural correlates of facial processing

Facial expressions can be viewed as the expressive result both of processing of emotional information and of an emotional "executive" process. These processes are assumed to interact and may work at different levels of awareness. The posterior part of the brain is more involved in the processing of information, while the frontal areas are more involved in executive/expressive functions and in affect regulation (Banich, 1997; Luria, 1973; Schore, 1994).

Neural regions involved in facial processing

Many researchers assume that the expressive face is a biologically prepared emotional signal and that this prepared capability involves special neural correlates (Buck, 1985; Buck & Ginsberg, 1991; Dimberg, 1989; Dimberg & Öhman, 1996; Rolls, 1999). Studies have reported activity in the left amygdala in response to fearful faces but not to happy expressions (Morris, Frith, Perrett, & Rowland, 1996). The perception of angry faces activates the right orbito-frontal cortex and the anterior cingulate cortex and the perception of disgusted faces activates the anterior insula and limbic cortico-striatal-thalamic region. Studies using event-related potentials (EEG) as measures have found different reactions to angry, happy and fearful faces in children as young as 7 months (Keltner & Ekman, 2000). These studies are in support of Differential Emotions Theory (DET) (Dougherty et al., 1996; Izard, 1971; Tomkins, 1962; Tomkins, 1963; Tomkins, 1981; Tomkins, 1984).

It has further been shown that subjects do not have to be aware of their exposure to fearful faces in order to show activity in the amygdala. Processing of and reactions to the fearful facial expression at this level can thus be assumed to be a rapid subcortical emotional reaction out of awareness (LeDoux & Phelps, 2000; Rolls, 1999). Support of preattentive appraisal of facial expressions has been found in earlier studies (Stenberg, Wiking, & Dahl, 1998; Zajonc, 1980). It has also been shown that facial expressions of anger presented outside of awareness evoked fear related facial and autonomic responses and were distinct from responses evoked by smiles (Esteves, Dimberg, & Öhman, 1994).

To further interpret the subcortically processed information of the expressive face and to respond to it in a mature way both right cortical brain areas and the orbitofrontal areas must be involved. The orbitofrontal cortex has been suggested to be especially important for the processing of emotionally expressive faces, since it links cortical sensory modalities and motor control networks, which might be responsible for facial regulation of internal emotional phenomena (Bowers, Blonders, Feinberg, & Heilman, 1991; Schore, 1994; Thorpe, Rolls, & Maddison, 1983; Tucker & Derrberry, 1992). Populations of neurones that selectively respond to facial expressions reflecting both primary and secondary reinforcement values of a face have been observed in the orbitofrontal cortex. These findings support the idea that the orbitofrontal cortex functions as integrator of subcortical and cortical learning, in which emotional communication via facial expressions and affect regulation may be involved (Rolls, 1999).

Neural structures involved in facial expressions

The previously mentioned mirror neurone activation might be one of the potential antecedents of micro-mimicry reactions (Perrett & Emergy, 2000; Williams et al., 2001).

Different neurological structures are thought to be involved in the production of spontaneous and voluntarily produced facial expressions. Fibres originating in the primary motor cortex are supposed to be responsible for producing voluntarily posed expressions, whereas subcortical structures and the facial motor nuclei (the 7^{th} cranial nerve) in the brainstem are thought to be involved in the production of spontaneous expressions (Buck, 1984; Buck, 1994; Gross, 1999; Matsumoto & Lee, 1991; Rinn, 1984). Facial expressions are supposed to be based on biologically prewired programs, but can also involve socially learned display rules built into the prewired expression that are produced automatically by a high degree of learning and rehearsal (Buck, 1994; Matsumoto & Lee, 1991). These automatically modulated expressions may be involved in affect regulation via feedback mechanisms. The orbitofrontal area is considered to be involved in cortical control over subcortical facial displays (Rothbarth et al., 1989; Tucker, 1992).

The neural mechanisms behind facial feedback have by Izard been explained by facial muscle feedback that activates central neural activity in the limbic cortex, the hypothalamus and the reticular system in the brainstem (Izard, 1971). The facial nerve, which innervates the skeletal muscles of the face, terminates at the nucleus of the solitary tract as do visceral projections (Beckstead & Norgren, 1979; Kalia & Mesulam, 1980). This convergence of the facial nerve and visceral projections may account for Izard's proposal that somatic feedback from the face is involved in modulating autonomic activity (Schore, 1994). Tomkins proposes that feed back from the face triggers changes in blood flow and temperature and that these physiological responses activate subcortical affect programs, which mediate emotion (Tomkins, 1962). Zajonc finally has presented evidence supporting that facial muscle activity involved in emotional expressions regulates the volume and temperature of blood supply to brain areas (Zajonc, 1985).

The present approach to facial communication

In the present studies, the spontaneous facial muscle reactions at preattentive or automatic levels indicated either positive (zygomaticus, the "smiling-muscle") or negative (corrugator, the "frowning-muscle") emotions (Cacioppo et al., 1988; Cacioppo et al., 1986; Dimberg, 1982; Hietanen et al., 1998; Lang et al., 1993; Schwartz et al., 1979; Smith et al., 1986; Tassinary & Cacioppo, 2000; Tassinary, Cacioppo, & Geen, 1989; Witvliet, 1998). The muscle reactions were measured by electromyographic recording (EMG), when the subjects were looking at angry or happy faces. EMG recording is a sensitive measure of muscle activity, and it was employed since reactions in this investigation were supposed to be weak, rapid and often invisible (Cacioppo, Berntsson, Larsen, Poehlmann, & Ito, 2000; Tassinary & Cacioppo, 1992). The reactions measured in the present studies were hypothesised to differ only between positive and negative emotions (Cacioppo et al., 1993), since an increased corrugator response may indicate either anger, fear, distress/sadness or disgust (negative emotions), and an increased zygomatic response indicates positive emotions (Cacioppo et al., 1988; Hietanen et al., 1998; Lang et al., 1993; Schwartz et al., 1979; Smith et al., 1986; Witvliet, 1998). It may be hypothesised that EMG activity during low intensity emotions expressed in microexpressions reflect a bivalent motivational-emotional tendency rather than discrete emotions (Cacioppo et al., 1993). The angry face was in the present study assumed to represent a prototype of a negative expression and expected to evoke negative emotional contagion and the happy face represented positive expression and was expected to evoke positive emotions.

A mimicry reaction was defined as a change in a subject's emotional state, expressed by changes in facial muscle activity, in the direction of the emotion expressed by the facial stimulus. Negative facial expressions as stimuli were expected to elicit negative emotional experiences and positive facial expressions positive emotional reactions (emotional contagion). Reactions of both muscles in the expected direction were interpreted as a mimicking reaction. The expected directions were an increase in the corrugator muscle (frowning: negative emotions) when subjects were exposed to the angry face compared to when exposed to the happy face (negative contagion) and an increase in the zygomatic muscle ("smiling": positive emotions) when exposed to the happy face compared to when exposed to the angry face (positive contagion).

A way forward from the controversy between researchers viewing facial expressions as spontaneous elicitors of internal emotional states, and researchers assuming cognitive and contextual control over facial expressions could be to adopt a process-oriented perspective. Such a perspective views behaviour as created in a process involving different stages of information processing, that evolve from biologically prepared affective reaction tendencies to more consciously controlled processes. The approach adopted in the present studies aimed at investigating reactions to facial expressions at different levels of information processing, so as to allow comparisons between reactions at different levels of cognitive control of spontaneously evoked expressions.

The facial expressions at preattentive and automatic levels are supposed to reflect spontaneous emotional reactions to emotional stimuli more influenced by bottom-up processes. Primary memory processes and subcortical affective structures in the brain may be more dominating at this level of processing. A correspondence between facial stimulus and facial reaction (mimicry reactions) could normally be expected at this level.

Facial reactions at the controlled level assumed to involve more of secondary memory systems are more difficult to predict as controlled processing at a secondary memory level may modulate both emotions and facial expressions. The view on facial expressions as determined both by spontanous emotions and by modulation through implicit and explicit social rules is sometimes referred to as the two-factor model of facial displays (Fridlund, 1991; Kappas, Behrer, & Thériault, 2000).

Man as biologically prepared for attachment

The manner in which individuals relate to other people can be assumed to be a product both of their temperamental dispositions and of their early interactions with their primary caregivers, interactions that are assumed to result in different patterns of attachment (Howe, 1995; Rutter & Rutter, 1993). The early emotional communication between infant and caregiver is assumed to be an essential determinant for the quality of attachment (Bowlby, 1969; Bowlby, 1973; Schore, 1994; Stern, 1985; Stern, 1990). The parameter “pattern of attachment” was introduced in the present thesis, based on the assumption that the quality of attachment may influence the manner in which individuals communicate their emotions and how they respond to others in emotional communication situations.

What is attachment theory?

Attachment theory conceptualises humans as biologically prepared for making strong affectional bonds to particular others (Ainsworth, 1982; Bowlby, 1977; Bowlby, 1980). According to attachment theory, the child moves through a series of stages in the attachment process to its primary caregiver, a process that depends both on the genetically programmed prerequisites for development and the child's attachment experiences (Bowlby, 1969; Bowlby, 1973; Bowlby, 1980; Rutter, 1981). Certain interrelated concepts in attachment theory ought to be distinguished: (a) the quality of an individual's attachment, (b) attachment behaviour, and (c) the attachment behavioural system.

The term attachment is sometimes used to refer to the quality of an individual's attachment, whereof the two main categories of attachment are the secure and the insecure patterns of attachment. To feel attached to someone is to feel safe and secure. By contrast, insecurely attached persons may have ambiguous feelings towards their attachment figures; love and dependency concur with fear of rejection and a wish to punish their attachment figures (Holmes, 1993).

Attachment behaviour is triggered by separation or by threatened separation from the attachment figure. It involves behaviours that aim at attaining proximity to the attachment figure, or a potentially new attachment figure and it is terminated by proximity.

Attachment and attachment behaviour is based on the attachment behavioural system (ABS) that represents the internal working model-of-self and others, that are formed by the biological prepared special-purpose system of attachment in interaction with the attachment experiences stored in long term memory. According to attachment theorists experiences from previous interactions with significant others are internalised to shape cognitive-affective structures that guide an individual’s expectations in relationships (Ainsworth, 1990; Bowlby, 1969; Bowlby, 1973; Cassidy, 1994; Holmes, 1993; Howe, 1995).

Early emotional communication and the formation of attachment

Attachment is supposed to be mediated by the quality of the caregiving and the emotional communication between infant and caregiver (Bowlby, 1969; Bowlby, 1973). Since infants communicate nonverbally with gestures and primitive vocalizations, caretakers need to be highly attuned to such communications (Beebe et al., 2000). Face-to-face interactions are of special interest in the formation of attachment (Schore, 1994). The baby's smile evokes a mirroring smile in the caretaker and the more he or she smiles back the more the baby responds in turn (Beebe & Lachman, 1988; Holmes, 1993; Termine & Izard, 1988). Thus, in a way, the baby sees himself or herself, when he or she looks at the caretaker's face. An internal model of a secure attachment figure and a sense of self-worth are created by interactions characterised by the infant's pleasure of looking at the caregiver's supporting emotional face, listening to her/his encouraging voice and experiencing the comfort of being hold (Bowlby, 1969; Holmes, 1993). In a later phase of the development the caregiver and infant participate in "interactive repair" sequences, a regulatory process in which the caregiver in frustrating upbringing situations has to induce some stress in the infant and then participate as a comforting external regulator to reduce the child's stress response. These dyadic transactions regulate the infant's affect state in the short term and are assumed to lead to structural changes in the brain in the long term. Thus, emotions are initially regulated by the caregiver's comforting responses, but as development proceeds the ability of self-regulation of emotional reactions increases as a result of interaction experiences and neuropsychological maturation (Thompson, 1994; Tronic & Cohn, 1989; Wilson, Passik, & Faude, 1990). It is thus the individual's history of relationships that gives rise to the cognitive organisation of the internal working model-of-self in interaction with others, a construction consisting of affect-laden attachment experiences stored in long term memory. The self should be conceived of as "an internal organisation of feelings, attitudes, expectations and meanings concerning relationships, which arises in the caregiving matrix" (Sroufe, 1989, p. 71). What is on the social outside eventually establishes on the inside and becomes a heavily affect-laden cognitive internal working model (Bowlby, 1969; Bowlby, 1973; Howe, 1995; Stern, 1985). When these models are solidified after the first few years of life new relationships tend to be assimilated into the existing models and they are assumed to become partly inaccessible to consciousness as they become habitual and automatic. Early repeated experiences of interactions will increase transfer efficiency at certain synapses and create automatic, preferred neural pathways (Bargh, 1984; Breatherton & Munholland, 1999; Collins & Read, 1994; Cotterill, 1989).

Different patterns of attachment in adulthood

A basic principle in attachment theory is that attachment relationships continue to be important throughout life (Ainsworth, 1990; Bowlby, 1979; Main, Kaplan, & Cassidy, 1985). The internal working models-of-self and others, created in infancy, are supposed to be the foundation that the adult's internal working models-of-self and others are built on. The manner in which people handle their present relationships depends in large on the experiences of their past relationships. Although parent-child interactions are considered critical to the foundation of the internal working models, other relationships, within and outside the family, make important contributions as well (Bowlby, 1973 ; Bowlby, 1980; Collins & Read, 1994; Howe, 1995; Rutter, 1988).

Based on Bowlby's idea of internal working models Bartholomew & Horowitz introduced a two-dimensional scale, the Relationship Scales Questionnaire (RSQ), to analyse adults' attachment pattern. According to this approach individuals can be scored in two dimensions representing their model-of-self and their model-of-others, respectively (Bartholomew, 1990; Bartholomew & Horowitz, 1991; Griffin & Bartholomew, 1994). Based on the intersection between the two dimensions representing positive or negative model-of-self and others, four prototypical patterns of attachment have been identified.

Children with loving and consistently responsive caregivers are assumed to develop a secure attachment pattern characterised by a positive self-view and a positive view of others. Individuals with a secure attachment pattern trust others, have realistic relational expectations, acknowledge negative emotions, and turn to others for support (Anderson & Guerrero, 1998). Individuals with an insecure, preoccupied pattern of attachment have a positive view of others but a negative self-view. They depend on their relational partners for self-validation, worry about the well-being of their relationships, dwell on negative affect, and seek support and comfort in a "hypervigiliant" manner (Anderson & Guerrero, 1998; Collins & Read, 1994; Kobak & Sceery, 1988). Individuals with a dismissing-avoidant attachment pattern have a positive view of themselves but a negative view of others. They see relationships as unimportant, view themselves as highly self-sufficient, deny feeling negative affect, and insist on handling problems alone (Anderson & Guerrero, 1998). Dismissing-avoidant individuals are by themselves and their friends described as somewhat introvert, cold, and emotionally inexpressive (Fraley et al., 1998). They repress negative emotions in order to maintain personal integrity at the expense of reality (Hazan & Shaver, 1994; Main & Weston, 1982). Individuals in the fourth category, the fearful-avoidant, have a negative view both of themselves and of others. They fear rejection and worry about being hurt if they get too close to others (Anderson & Guerrero, 1998). These different patterns of insecure attachment can be seen as automated internal and external coping strategies to gain comfort and security in an unresponsive and unpredictable early relationship (Main et al., 1985).

The two internal working models correspond, as shown by factor analytic studies, closely to the factors Anxiety (model-of-self) and Avoidance (model-of-others) and are considered as important determinants of variations in individuals' thoughts, behaviours and feelings in close relationships (Bartholomew, 1990; Bartholomew & Horowitz, 1991; Fraley & Waller, 1998). Fearful-avoidant individuals have been described as combining anxiety with avoidant behaviour, while the dismissing category is characterised by a combination of avoidant behaviour and lack of or repression of anxiety (Brennan, Clark, & Shaver, 1998).

Table 1. Different patterns of attachment based on Bartholomew and Horowitz's two-dimensinal scale representing model-of-self and model-of-others.

Preoccupied pattern of attachment • Negative model-of-self • Positive model-of-others (also termed insecure ambivalent)	**Secure pattern of attachment** • Positive model-of-self • Positive model-of-others
Fearful-avoidant pattern of attachment • Negative model-of-self • Negative model-of-other (also termed insecure avoidant)	**Dismissing-avoidant pattern of attachment** • Positive model-of-self • Negative model-of-others (also termed insecure avoidant)

Internal working models and emotions

Working models-of-self and others can be seen as internal structures involving both cognitive and affective components. Bowlby conceptualised the internal working models in terms of information processing (Bowlby, 1979). The role of emotions in this information processing approach has never been sufficiently clarified by attachment theorists, despite that the core of attachment is attainment of emotional security (Breatherton & Munholland, 1999; Cicirelli, 1996). The internal working models are however by most theorists supposed to be “heavily affect-laden”, and are assumed to influence emotional responses in social relationships (Cicirelli, 1996; Collins & Read, 1994) and people's strategies of emotion regulation (Bowlby, 1973; Cassidy, 1994; Feeney, 1995). Secure attachment is supposed to be an inner resource that may help a person to cope with negative feelings and stressful events. In contrast, insecure attachment is viewed as a potential risk factor leading to poor coping with life-stress (Anderson & Guerrero, 1998; Brennan & Shaver, 1995; Kobak & Sceery, 1988; Mikulincer & Florian, 1998; Simpson, Rholes, & Phillips, 1996). Thus, different patterns of attachment are assumed to reflect different modes of regulating and controlling negative emotions in interpersonal interaction, which in turn give different prerequisites for further cognitive processing. Differences in internal working models tend to bias both what is attended to and what is remembered in a direction congruent with the prevalent mood (Collins & Read, 1994). Further, individuals with high levels of negative emotions are assumed to have restricted cognitive and attentional resources and will have a tendency to rely on overlearned schemas when relating to others (Eysenck, 1977; Kim & Baron, 1988).

Internal working models and social cognition

The internal working models have, apart from their basic differences in relation to the individual's feelings of security, been assumed to include differences in four cognitive components involved in social cognition: "(1) memories of attachment-related experiences, (2) beliefs, attitudes and expectations about self and others in relation to attachment, (3) attachment-related goals and needs, and (4) strategies or plans associated with achieving attachment-related goals" (Collins & Read, 1994, p. 60). The internal working models are supposed to be used to simulate and predict the behaviour of others and to organise one's own behaviour in social interactions. If these models, due to insecure attachment, exclude certain information or give rise to unrealistic affective goals, they do not always function as means to adaptive social behaviour. For example, people with negative self-schemas are expected to have "seeking approval" and "avoiding rejection" as chronically active goals, which operate out of awareness. They are likely to have an attentional focus that keeps them very sensitive for signs of rejection by others (Collins & Read, 1994; Howe, 1995). Dismissing-avoidant individuals, who are anxious to maintain autonomy, are on the other hand supposed to be highly sensitive to the signs of intrusion or control by others. Their desire to minimise attachment will direct them away from features that make attachment needs salient. This bias in social information processing and people's own participation in the creation of their own social environment tends to make working models resistant to change. Good or vicious circles in relationships may therefore be created as a result of differences in individuals' internal working models (Collins & Read, 1994; Howe, 1995).

Internal working models at different levels of consciousness

As a consequence of the defensive exclusion of information, individuals may have two incompatible sets of internal working models, one consciously accessible and one inaccessible or only intermittently accessible to consciousness. These inconsistent models, operating at different levels of awareness, are supposed to be especially characteristic for dismissing-avoidant and preoccupied individuals.

Dismissing-avoidant individuals are supposed to have one positive model-of-self operating at a conscious level and one outside awareness, a model of a fragile self. Their attitude of autonomy may be seen as a way to defend themselves from being hurt by others. Similarly, the positive and sometimes unrealistic and idealised model-of-others in preoccupied individuals, may disguise a less positive model-of-others, a model of significant others as sometimes uncaring and unavailable. The idealised model-of-others may be considered as a strategy to cope with a high level of separation anxiety (Bartholomew, 1990; Breatherton & Munholland, 1999; Howe, 1995; Klohnen & John, 1998).

Internal working models can be assumed to be activated through two general pathways. The first is a direct pathway, which may be referred to as "primary appraisal" of a social situation, an emotional response that is not controlled by secondary memory top-down processing. Differences in this first emotional response to a social situation will then bias cognitive processing by directing attention toward environmental features and memories consistent with the emotional response. The second path is an indirect pathway mediated by controlled secondary memory processing, which may be labelled secondary appraisal. A person's initial emotional response may either be maintained, amplified or altered depending on how the emotional experience is controlled and interpreted (Collins & Read, 1994).

This conception of internal working models as operating at different levels of consciousness is in line Fraley and Waller's proposal that indicates that the two different dimensions involved in creating different patterns of attachment correspond closely to Anxiety (model-of-self) and Avoidance (model-of-others) (Fraley & Waller, 1998; Griffin & Bartholomew, 1994). These internal models "may influence emotion and behaviour at different temporal stages of information processing and behavioural regulation. It is possible that the dimension of Anxiety (model-of-self) captures variations in physiological and emotional parameters rather than in cognitive structures, whereas Avoidance (model-of-others) captures variations in the organisation of knowledge structures rather than emotional thresholds" (Fraley & Waller, 1998, p 106).

Neural and neurobiological aspects on attachment

Neural and neurobiological aspects on the development of attachment

Panksepp proposes that two different emotional systems are involved in attachment behaviour, one related to love and social bonding and another to separation-distress (Panksepp, 1998; Panksepp, Nelson, & Bekkedal, 1997). The neurotransmitters oxytocin and the endogenous opioids seem to have an important role in the construction and maintenance of social bonds in animals (Panksepp et al., 1997). The corticotrophin releasing stress hormone (CRP) is associated with the separation-distress system involved in separation-distress vocalisations, thought to emerge from the subcortical thalamocingulate brain area, supposed to be involved in family related behaviours. Oxytycin and opioids, assumed to be important in social bonding, are powerful inhibitors of separation vocalisations in various species (Panksepp, 1998; Panksepp et al., 1997).

The two emotional attachment systems, involved in the interactions between the caregiver and the infant, are supposed to effect the postnatal growth of the brain (Schore, 1994; Schore, 2000). Studies in developmental neuroscience emphasise that the development of the infant's emotional brain is mainly influenced by transactions with the social world and not by transactions with the physical environment (Panksepp, 1998; Schore, 1994; Tucker, 1992). Positive emotional interactions in early infancy, especially mediated by mirroring positive face-to-face transactions, seem to induce affects of joy and elation in the infant (Stern, 1985). The positive emotion of joy is associated with cerebral production of opioids, which in turn is supposed to promote the attachment process (Hoffman & Ratner, 1973; Hoffman, 1984; Panksepp, 1981; Panksepp et al., 1997; Steklis & Kling, 1985). These events are psychobiologically mediated by the activation of the dopaminergic ventral tegmental limbic system and the stimulation of the reward centre in the child's brain, that are assumed to promote growth of the neurones and result in neural projections to the orbitofrontal region (Schore, 1994). The ensuing interaction period, from about 10 to 18 months, is supposed to be characterised by the infant's short separations from its caregiver and result in separation anxiety, associated with higher levels of the stress hormone corticotrophin (CRP), involved in the arousal of the sympathetic autonomic nervous system. Affective reunions, after these short separations, are assumed to activate opioids, and regulate the child's state of internal arousal. The next development period during the second year is characterised by dramatic changes in transactions between caregiver and infant. The caregiver is transformed to a socialisation agent. In upbringing situations the caregiver must necessarily increase frustrations and inhibition of behaviours that are initially reinforcing to the infant. The mother uses stress-inducing facial expressions in these transactions to inhibit the positive activating affects. The affect of shame is triggered, characterised by a sudden shift from positive activating affects to parasympathetic autonomic nervous system activity, responsible for inhibiting behaviour (Schore, 1994). These transactions of mild, not humiliating, frustrations are assumed to play an important role in the growth of the neurones of the lateral tegmental limbic circuit, involved in the control of the parasympathetic, inhibiting, autonomic system, to promote projections into the orbitofrontal association cortex (Schore, 1994). To obtain an optimal affect regulation, the caregiver must, according to Schore, participate in mirroring transactions that amplify positive affects, associated with the increasing levels of opioids and energising dopamine, as well as in interactive repair transactions after stress related separations (stress related sympathetic autonomic activation), and finally in frustrating socialisation interactions involved in shame inducing affects, associated with a sudden shift from positive activating affects to parasympathetic inhibiting activation. Well-attuned interactions may result in an optimal level of arousal, resulting in orbitofrontal regulation of subcortical activation and a balance between the sympathetic and the parasympathetic autonomic systems. To be able to self-regulate emotions and tolerate and cope with conscious experience of negative emotions a balance between these two system seems essential (Schore, 1994). Psychobiologically attuned caregivers of securely attached infants maintain interactions within a moderate range that is wide enough to maintain interactions but not so intense as to cause distress and avoidance (Schore, 1994; Stern, 1985; Stern, 1990).

Neurobiology of insecure attachments

There is rich evidence that shows the unfavourable consequences of impoverished environment on brain development. On the other hand few empirical studies support the long-term fertilising effects of positive socio-emotional environments on the brain. (Panksepp, 2001). Inconsistent, or nearly nonexistent, external regulation of emotion by the caregiver during the critical period of development may result in limitations in the individual's emotion regulatory capacities (Bowlby, 1969; Bowlby, 1973; Bowlby, 1979; Mikulincer & Florian, 1998; Schore, 1994). It is known that moderate levels of arousal are associated with positive feelings and focused attention, while extreme levels of arousal (high or low) are associated with negative feelings and distracted attention (Schore, 1994). Many studies on separation support the assumption that the release of corticotrophin, associated with stress and anxiety, is associated with negative affective consequences for the nervous system during severe early separations (Panksepp, 2001).

The dismissing-avoidant attachment pattern is supposed to be characterised by an emotion regulation strategy of avoidance of higher level processing of negative information. These negative signals would activate the attachment behavioural system, associated with separation anxiety. This repression strategy is supposed to be a result of inability of the caregiver to stimulate or regulate the child's affect-arousal states (Schore, 1994). Infants, who are rejected by their caregivers, respond initially with hyperarousal and distress, but shift gradually from a sympathetic-dominant agitated separation distress state to a parasympathetic-dominant despair state (Bowlby, 1969; Izard, 1991; Schore, 1994). They are supposed to be fixed in a state of unregulated conservation-withdrawal, a parasympathetic activation dominated by heart rate deceleration and a low level of activity (Izard, 1991; Kaufman & Rosenblum, 1969; McCabe & Schneiderman, 1985; Schore, 1994). Dismissing-avoidant individuals are considered to be susceptible to overcontrolled developmental psychopathologies and overregulation disturbancies (Emde, 1990; Lewis & Miller, 1993). This habitual avoidance of attachment-provoking anxiety may ultimately result in a deactivation of their attachment system, and may help them to keep up their own image of a positive self and protect them from being hurt by others (Ainsworth, 1985; Klohnen & John, 1998). Mikulincer and Orbach have argued that avoidant individuals do not only avoid external negative signals, but they also learn how to erect barriers against their internal negative emotional signals, especially those related to anxiety (Milkulincer & Orbach, 1995). It is hypothesized that although these infants no longer express the need for contact, separation anxiety is not extinguished but goes underground, and exists simultaneously with the positive image of autonomy (Sroufe, Fox, & Pancke, 1983).

The insecure ambivalent pattern (here: preoccupied pattern) of attachment may be the result of an infant’s early experiences with a caregiver, who is physically present but emotionally inaccessible or inconsistent. A high level of separation distress, involving high levels of corticotrophin hormones and an overactivation of the sympathetic autonomic activation system, is assumed to characterize these individuals. An impaired orbital inhibiting function in these individuals is supposed to result in an inferior capability to suppress sympathetic driven distress and thus in difficulties to handle negative emotions (Schore, 1994). Insecure ambivalent or preoccupied individuals are assumed to be susceptible to under-controlled and impulsive disturbances (Lewis & Miller, 1993). Their strategy of coping with their internal distress is to seek support and comfort from others in a “hypervigiliant” manner” (Anderson & Guerrero, 1998; Collins & Read, 1994; Kobak & Sceery, 1988).

Children who have been severely abused or neglected are assumed to develop a disorganised pattern of attachment. The abuse and neglect are supposed to produce rapid alterations of autonomic sympathetic hyperarousal and parasympathetic hypoarousal that create a chaotic internal emotional environment in the infant. They show severe difficulties in stress management and dissociative behaviours (Schore, 2001).

The neurobiology of internal representations of the caregiver's face

The caregiver is assumed to act as an external regulator of affect in the interactions between infant and caregiver, a regulation partly mediated by the caregiver’s emotional face (Hofer, 1984; Schore, 1994). The internal representation of the caregiver's face is supposed to be saved in networks in the anterior temporal cortex, specialised for responding to emotionally expressive faces (Hasselmo, Rolls, & Baylis, 1989; Ojemann, Fried, & Mateer, 1980). This information is then transferred to the orbitofrontal association areas that categorise, abstract, and save it in memory networks associated with hippocampus (Schore, 1994; Thorpe et al., 1983). The orbitofrontal areas allows the individual to react to internally stored representations, rather than information immediately present in the environment (Damasio, 1994; Schore, 1994; Tucker, 1992; Tucker & Derrberry, 1992). Izard considers that one of the first affective-cognitive structures (schemata) to develop in the attachment process is that between the image of the mother's face and the feeling of enjoyment (Izard, 1994b).

Orbitofrontal top-down projections are the major source of delivery of cortically stored information to the hypothalamus, and the orbitofrontal messages may thus influence the activity of subcortical structures involved in affect, as well as in motivational and energetic functions. Thus, the storage of early visuoemotional memories would allow for the internal image of the caregiver's face to trigger the infant's interoceptive, autonomic reaction to this input also in the absence of the direct perception of the object (Schore, 1994). Such internal representations of the self-in-interaction-with-others are abstractions of the infant's autonomic response to the visual perception of the emotionally expressive face of the attachment object. Thus, the affect-laden image of the caregiver's face is assumed to be a stored representation that is capable of evoking the same pattern of automatic somatic and physiological responding as was evoked in the early actual social transaction situations. These internal affective representations of the caregiver's face may be responsible for differences in affect regulation involved in different patterns of attachment (Schore, 1994)

The present approach: Attachment and emotion regulation

A further assumption in the present studies was that different patterns of attachment may influence the emotional facial reactions in interaction situations. Different patterns of attachment were studied in relation to emotional facial reactions to angry and happy faces. In the present studies a self-report scale, the Relationship Scales Questionnaire, RSQ, measured patterns of attachment and the internal working models-of-self and others (Bartholomew, 1990; Bartholomew & Horowitz, 1991; Griffin & Bartholomew, 1994). Based on the result of this questionnaire, individuals can be categorised in one of the four different attachment patterns as well as in positiv or negative internal working models (model-of-self and model-of-others).

As already discussed, the model-of-self has been found to be related to the factor Anxiety. Since individual differences both in basic individual levels of anxiety and different emotion regulation strategies are supposed to be involved attachment patterns, these patterns are supposed to influence emotional contagion and mimicry reactions in interaction situations. In the present studies differences in regulation of negative emotions were supposed to be involved mainly at the controlled level of information processing and were thus hypothesised to separate the attachment groups' facial reactions at the later controlled, and emotionally regulated, levels of information processing. Repressed aspects of attachment pattern, operating out of awareness, were assumed to be reflected in an earlier and automatic part of the information processing represented by spontaneous facial reactions. The model-of-others has been hypothesised to reflect knowledge or cognitive structures, rather than emotional parameters, and was not expected to influence the facial emotional reactions.

Thus, the internal working models and attachment patterns were conceptualised in terms of information processing at different levels of information processing. The attachment pattern may be conceived of as a result of primitive emotional contagion that at the next level of information processing is modulated or regulated and finally these emotional reactions may be coped with by flexible, cognitive systems.

Facial mimicry reactions as related to empathic ability and attachment pattern

What is empathy?

Emotional empathy, and its relation both to facial mimicry and to pattern of attachment, is in focus in this thesis. Empathy is a complex concept on a high level of abstraction and the experimental and theoretical literatures have failed to agree on a single definition of it. One general definition, proposed by Eisenberg, has been formulated "Empathy is an emotional response that stems from another's emotional state or condition, and involves at least a minimal degree of differentiation between self and other" (Eisenberg & Fabes, 1990, p.132). Despite lack of a complete agreement, many researchers share the view that empathy refers to the experiencing of another's affective or psychological state and has both affective and cognitive components (Basch, 1983; Eisenberg, Murphy, & Shepard, 1997; Eisenberg & Strayer, 1987; Gladstein, 1983; Hatfield, Cacioppo, & Rapson, 1994; Holm, 1985; Zahn-Waxler & Radke-Yarrow, 1990). The cognitive aspect of empathy, that is the capacity to understand another person's internal state, involves both the ability of affective perspective taking and role-taking capability. The cognitive ability involved in affective perspective taking and the interpretative capacity to decode nonverbal emotional communication must be distinguished from emotional contagion and emotional empathy that directly involve the feelings of both the sender and receiver (Eisenberg et al., 1997; Hatfield et al., 1994).

In a review article Gladstein identifies two major types of empathy: (a) emotional empathy, or feeling the same way as another person and (b) cognitive or role-taking empathy (Gladstein, 1983). Gladstein further suggests that empathy should be viewed as a multistage interpersonal process that can involve emotional contagion, identification and role taking, and finally that the empathic process may lead to helping behaviour (Gladstein, 1983). This view on empathy as a multistage process starting with shared feelings, followed by cognitive interpretations, that finally may or may not result in helping behaviour is shared by many researchers (Basch, 1983; Eisenberg & Fabes, 1990; Holm, 1985).

Empathy as biologically prepared

Buck and Ginsberg have formulated the "communicative gene hypothesis" that proposes a genetically prepared capability of communication between individuals. The biological unit is here assumed to be the communicative relationship between individuals (Buck & Ginsberg, 1991; Buck & Ginsberg, 1997). Buck and Ginsberg consider some genes to be selfish and function to support the survival of the organism, whereas other genes are assumed to serve social functions. This view contrasts with the selfish gene hypothesis, which regards all “acts” of the genes as selfish (Dawkins, 1978). Groups or dyads in communication may or may not have genes in common, but both expressive displays and receiving capabilities are elements of the communicative relationship and function as a mediator of successful spontaneous communication between individuals, a capability that is fundamental to survival. This type of raw knowledge of the motivational state of the other group members, based on phylogenetic adaptation, is by Buck and Ginsberg considered to be the root of empathy, intuition and altruism (Buck & Ginsberg, 1991; Buck & Ginsberg, 1997). Empathy and altruism as biologically prepared capabilities have also been suggested by other researchers (Brothers, 1989; Hoffman, 1981; Levenson, 1996; Levenson & Ruef, 1997; MacLean, 1985).

Empathic ability and facial mimicry

The idea of a biologically prepared ability to communicate feelings at an automatic level can be traced back to affect theory and psychoanalytical theories (Basch, 1983; Emde, 1990; Modell, 1973; Stern, 1985; Tomkins, 1962; Tomkins, 1963; Winnicott, 1974). In Basch's approach to empathy, somatic mimicry is considered to be an early and automatic component involved in empathy, termed affective resonance, and is defined as ”A given affective expression of one member of a particular species that tends to recruit a similar response in other members of that species...... This is done through the promotion of an unconscious, automatic, and in adults not necessarily obvious, imitation of the senders bodily state and facial expression by the receiver. This then generates in the receiver the autonomic response associated with that bodily state and facial expression, which is to say the receiver experiences an affect identical with that of the sender ” (Basch, 1983, p.108). Modern experimental literature on facial expressions and mimicry has, as mentioned above, introduced the term "emotional contagion" for the same phenomenon (Hatfield et al., 1994). Hatfield et al. have hypothesised that individuals, that tend to be more inclined to mimic facial, vocal and postural expressions and in addition are aware of their own emotional responses, should be especially vulnerable to emotional contagion (Hatfield et al., 1994). The mirror neurone system might suggest that empathy could emerge from affective resonance (emotional contagion) as an implicit, procedural process, with empathy developing as an automatic means of understanding another person (Wolf et al., 2001). The biologically prepared tendency to neural mirroring the movements of others have been proposed to explain children's development of an understanding of the internal state of others (Theory of Mind) (Perrett & Emergy, 2000; Williams et al., 2001). It has been demonstrated that autistic individuals, who are suggested to lack "theory of mind", have deficits in imitative capacity (Rogers & Pennington, 1991; Whiten & Brown, 1999).

Experimental support for differences in facial expressiveness and physiological responses as involved in different forms of empathy has been found in previous research. In a study of empathic accuracy a higher accuracy in subjects’ ratings of emotional facial expressions was found in subjects who were more emotionally expressive (Levenson & Ruef, 1997). In an experimentally introduced task of social interaction, more facially expressive subjects showed more helping behaviour (Shuto, 1987). Eisenberg and co-workers found a positive relationship between facial expressiveness, heart rate measures (HR) and a self-report scale of emotional empathy (Eisenberg, Fabes, Bustamante, & Mathy, 1988). Another investigation, including adult women scoring high and low on empathy, used electrodermal, facial, and HR reactions as measures of their sensitivity to scenes of smiling and crying infants. The high-empathy group was more inclined to match the facial expressions of the infants and showed larger electrodermal as well as HR responsiveness to the scenes (Wiesenfeld, Whitman, & Malatesta, 1984).

Empathic ability and personality

As can be predicted from attachment theory, most studies on empathy have given support to a positive relationship between empathy and secure attachment pattern. Meins and co-workers showed that a child's understanding of others is positively related to a secure pattern of attachment (Meins, Fernyhough, Russell, & Clark-Carter, 1996). Fonagy, Redford and Chairman showed that securely attached children were superior on a theory-of-mind scale, compared to insecurely attached children (Fonagy, Redfern, & Chairman, 1995). In a study by Gyland children with a secure pattern of attachment scored higher on a self-report scale of emotional empathy (a revised QMEE- scale). These children, however, did not score higher on empathy when their teachers evaluated the children's empathic behaviour (Gyland, 1997). Another study including both internal working models and affective processes in school children found that there was a positive relationship between secure attachment and scores on a self-report scale of empathy (Niec, 1998).

Adult attachment and the organisation of affective experience were in focus in a study using the Adult Attachment Interview (AAI) as a measure of attachment (Blumbeerg, 1998). Dismissing subjects scored in this study significantly lower on a self-report scale of empathy termed the Interpersonal Reactivity Index (IRI), and showed significant difficulties in identifying feelings as measured by the Toronto Alexithymia Scale – 20. Contrary to predictions, no significant differences were found in perspective taking (PT) or empathic concern between dismissing and preoccupied subjects (Blumbeerg, 1998). Another study identified personality characteristics associated with altruism and related those characteristics to the Big Five personality factor dimensions (Bekendam, 1997). The Big Five or Five Factor Model of personality describe personality as composed of five different factors. A positive relation was found between the Empathy factor and the Agreeableness factor and a negative relation was found between The Empathy factor and Emotional Stability (Ashton, Paunonen, Helmes, & Jacksson, 1998). Dimensions of emotional intelligence were investigated in a study involving the factors Attachment (Adult Attachment Scale), Affect regulation (Affect Regulation Scale), Alexithymia (Toronto Alexithymia Scale-20) and empathy (IRI) (Bekendam, 1997). Subjects were male clients who participated in group treatment for impulsive disorders. It was found that secure attachment was positively related to adaptive Affect Regulation Styles, Empathic concern (IRI-subscale), Perspective taking (IRI-subscale) and negatively related to Alexithymia, whereas the opposite was true for the insecurely attached, who were characterised by maladaptive Affect Regulation Styles, high Personal Distress (IRI-subscale), and a high level of Alexithymia. Specifically, the preoccupied participants demonstrated vulnerability to negative emotions, as measured by the Personal Distress scale (IRI-subscale), whereas the dismissive-avoidant subjects scored low on the Personal Distress scale, suggesting denial of negative emotions. The fearful-avoidant group showed the most maladaptive Affect Regulation Styles, high Personal Distress and a high level of Alexithymia (Bekendam, 1997).

Previous research on sensitizers and repressors has indicated that individuals differ in their tendency to be aware of emotional messages, especially negative ones. Individuals are classified as sensitizers, if they are alert to potential threats and sensitive to variations in their own emotions and in those of others. Sensitizers also tend to dwell on potential problems. On the contrary, repressors are eager to avoid, repress or deny threatening internal and external signals even though their physiological reactions and overt behaviour indicate the contrary (Byrne, 1964). Hatfield et al. have hypothesised that sensitizers should be more susceptible to emotional contagion than repressors (Hatfield et al., 1994).

Cognitive social psychologists have argued that mood affects susceptibility to emotional contagion and that happy individuals find it easier to pay full attention to others, to absorb and react to other's emotions and behaviours. Individuals, who are depressed or angry, may have more trouble in absorbing information (Oately & Jenkins, 1992; Sedikies, 1992). Hatfield et al. studied whether happy subjects were indeed more likely to attend to and catch the emotions of target persons. Subjects were primed to experience happy, neutral or sad moods, and after mood manipulation they were asked to observe videotapes of the target persons in emotional situations. Subjects caught, regardless of their mood, the target person's mood. There were also some indications, although not significant, that happy students were more attentive to target person's expressions of emotion and were further more likely to mimic both happy and sad emotions than were sad subjects (Hsee, Hatfield, & Chemtob, 1992). These findings suggest that happy people are more receptive to other's emotions.

The present approach to mimicry, empathy and attachment

One important focus of the present investigations was emotional empathy, and its relation both to emotional facial reactions, as measured by EMG, and to different patterns of attachment. Emotional empathy was measured by a self-report scale termed the Questionnaire Measure Of Emotional Empathy (QMEE) (Choplan, McCain, Carbonell, & Hagen, 1985; Mehrabian & Epstein, 1972). The QMEE was constructed to measure emotional components of empathy. It is a self-report measure of a person’s emotional reactions to others engaged in different emotional situations and has been found to correlate with helping behaviour, but has also been shown to be positively related to the Neuroticism factor (Choplan et al., 1985; Eysenck & Eysenck, 1978). Participants in the present experiments were, in addition, instructed to report their feelings after the exposure to the facial stimulus. Further, EMG measured their emotional muscle reactions to the facial stimuli. These measures, the QMEE, the EMG responses, and the Self-report scale of subjective feelings can all be assumed to represent the emotional component of empathy. Cognitive aspects of empathy, as for example role taking and the interpretative capacity to decode facial expressions, were not studied in the present investigations.

A process perspective on empathy was applied in the present thesis. It is based on the assumption that emotional contagion or affective resonance, as measured by EMG-reactions, is an early, automatic component involved in empathy (Basch, 1983). Consequently, mimicry reactions at the automatic level of information processing were expected to be positively related to emotional empathy as measured by QMEE.

High-empathy subjects were assumed to be able to verbalise their physiological emotional reactions, since empathic ability has been shown to be negatively related to Alexithymia (Bekendam, 1997; Blumbeerg, 1998). Individuals suffering of Alexithymia are supposed to be handicapped in their ability to identify emotional bodily states. A positive relationship was, thus, expected between somatic emotional reactions, as measured by facial muscle reactions (EMG), and the self-reported feelings in subjects scoring high on the QMEE.

A positive relation between secure attachment and emotional empathy could be predicted from some of the aforementioned results obtained in studies of empathy and personality (Bekendam, 1997; Fonagy et al., 1995; Gyland, 1997; Hsee et al., 1992; Meins et al., 1996). Empirical studies have also shown a positive relation between empathy and a high level of emotional distress (e.g. in sensitizers), assumed to be related to a negative model-of-self (Ashton et al., 1998; Bekendam, 1997; Byrne, 1964; Hatfield et al., 1994). Since previous research on empathy and attachment has yielded somewhat contradictory findings, it was difficult to predict which of the attachment groups that would show the greatest capability of emotional empathy, as measured by QMEE. Dismissing subjects have, however, scored significantly lower on self-report measurement scales of empathy and have shown significant difficulties in identifying feelings as measured by an Alexithymia Scale (Bekendam, 1997). They have also been assumed to be repressors of negative affect (Anderson & Guerrero, 1998; Brennan et al., 1998; Mikulincer & Florian, 1998). Consequently dismissing-avoidant subjects were expected to score low on the QMEE, that may be especially sensitive as a measure of negative emotional contagion (Choplan et al., 1985; Eysenck & Eysenck, 1978).

SUMMARY AND RESULTS OF STUDIES I-IV

Study I

Based on experiment I

Aims

The hypotheses of this investigation were based on a conception of mimicking and emotional contagion as early automatic components involved in empathy (Basch, 1983). The main aim of Study I was to examine emotional communication through facial mimicry in experimentally created "face-to-face interaction situations" at different levels of information processing, and especially how mimicry behaviour is related to individual differences in emotional empathy. Automatic mimicry was expected to be elicited already at very short exposure times and to be related to emotional empathy, a higher level of emotional empathy being linked to stronger mimicry reactions. A secondary aim was to investigate possible correspondence between facial muscle reactions and self-reported feelings and if this correspondence is related to individual differences in emotional empathy. A further aim was to investigate possible differences between high and low empathy subjects concerning self-reported feelings when exposed to angry as well as to happy faces.

Method

Subjects

Forty-two subjects (twenty-two women), all students from different departments at Lund University, participated on a volunteer basis in the experiment.

Stimuli and procedure

Percept-genetic research and methodology (Kragh & Smith, 1970; Smith, 1991) inspired the design of Study I. Percept genetic methodology is based on the theory of microgenesis in which the perceptual act is seen as a process, which evolves through a series of qualitatively different stages that unfold over time from microseconds to seconds (Brown, 1985). In the course of a percept-genesis the more objective and conscious world around us is visualised as growing out of a subjective and subconscious personal core (Kragh & Smith, 1970; Smith, 1991). In the present study different levels of awareness in information processing were induced by successively prolonged exposure times of facial stimuli, starting with very short exposure times supposedly eliciting automatic reactions at a preattentive level, continuing on to longer exposure times representing conscious information processing and more controlled reactions (see pp. 26-27 for further clarification regarding information processing levels).

Pictures of facial expressions taken from Ekman and Friesen's "Unmasking the Face" (Ekman & Friesen, 1975) were used as stimuli representing the sender's side in a face-to-face interaction situation. Digitized and saved as grey-scale picture files, the pictures were exposed on a computer monitor. The Psyscope program was used to create a computerised version of the picture sequence used in the experimental design. Four faces, two of males and two of females, showing either an angry or a happy expression, were selected. Pictures of the same person were used both for the happy and the angry expressions. A non-figurative grey-scale masking picture was presented for 50 ms immediately after presentation of a target picture to assure that preattentive processing took place at the first exposure times (Esteves & Öhman, 1993).

All subjects were exposed to one happy face and one angry face that were shown at 13 different exposure times; 17, 25, 30, 35, 40, 45, 50, 75, 100, 150, 200, 500, and 1000 ms. The shortest exposure times followed by the masking picture were expected to assure preattentive processing. Processing during an exposure time of 1000 ms was assumed to represent controlled information processing. Each stimulus was exposed 6 times at each exposure time (called a set of 6 stimulus exposures) so as to increase the accuracy of the measurements. In order to compensate for position effects the exposure sequence was balanced so that half the subjects looked at the angry face first (50 % at a male and 50 % at a female picture) and half at the happy (50 % at a male and 50% at a female) face first. Thus, the design was balanced with regard both to the facial expression and to the gender of the stimulus face. The subjects were instructed to report what they had seen and estimate their own feelings after each set of 6 stimulus exposures on a "mood-scale" ranging from negative to positive.

Measures

EMG: Electromyography (EMG) was used to register facial reactions. "Smiling-reactions" (positive emotions) were detected by registering electric activity in the zygomaticus major and "frown-reactions"(negative emotions) by registering electric activity in the corrugator supercilii (see pp. 30, 36-37 for further elaboration of the relationship between facial expressions and emotions) (Cacioppo et al., 1988; Cacioppo et al., 1986; Dimberg, 1982; Hietanen et al., 1998; Hjortsjö, 1970; Lang et al., 1993; Schwartz et al., 1979; Smith et al., 1986; Tassinary & Cacioppo, 2000; Tassinary et al., 1989; Witvliet, 1998)**.** The electrodes were placed bipolary from the Corrugator and the Zygomaticus muscle regions on the left side of the face (Fridlund & Cacioppo, 1986). The electrodes over the corrugator region were attached slightly medial to the border of the eyebrow head and directly above the eyebrow on an imagery vertical line through the inner border of the iris in accordance with instructions in guidelines for human electromyograhic research (Fridlund & Cacioppo, 1986). In order to detect zygomatic activity, the electrodes were attached midway along an imagery line from the corner of the mouth to the lower edge of the cheekbone (Fridlund & Cacioppo, 1986).

Self-reported feelings: The subjects estimated their own feelings after each set of 6 stimulus exposures on a “mood-scale” ranging from negative to positive.

Questionnaire: After the experiment subjects completed a self-report measure of emotional empathy, the Questionnaire Measure Of Emotional Empathy (QMEE). This questionnaire has been developed to measure the empathic emotional response, but not cognitive aspects of empathy. Several studies have supported its validity and reliability (Choplan et al., 1985; Mehrabian & Epstein, 1972). Mehrabian and Epststein tested its validity in experimentally created interaction situations. High empathy subjects showed less aggressive behaviour and more helping behaviour. High scores on QMEE has been found to correlate with social awareness and more advanced moral development (Eisenberg-Berg & Mussen, 1978). A significant correlation has however also been found between Neuroticism (mesured by EPQ: Eysenck Personality Questionnare) and QMEE (Eysenck & Eysenck, 1978). One possible explanation for this correlation is that highly empathic individuals have the ability to become easily aroused by others in distress.

Data reduction and statistical analysis

Questionnaires: The participants were divided into one low-empathy group and one high-empathy group. Fifteen subjects were included in the low-empathy group and 27 subjects were included in the high-empathy group. The cutoff point (46) between the low- and high-empathy groups was placed at a lower level than the mean value for the sample (52) due to the participants’ mean being high compared with the norm group (33), about one third of the participants thus being classified as low-empathy subjects.

EMG-reactions: The strength of the reactions of the facial muscles to a given stimulus at a particular exposure time was calculated as the mean amplitude from the onset of the first exposure to the end of the sixth exposure (a set of six stimulus exposures) (Fridlund & Cacioppo, 1986). The rms parameter (root mean square) was used to measure the EMG amplitude, which represents a measure of the strength of the muscle contraction. The rms measure performs the square root on squared EMG samples during a certain measurement period (Fridlund & Cacioppo, 1986).

Reduction of processing levels: To simplify and focus the calculations and the interpretation of the results, the mean values obtained for each muscle at a certain exposure time when exposed to a face were reduced to mean muscle activity at four different information processing levels. Thus, each subject received 16 different EMG-values (2 Faces x 2 Muscles x 4 processing levels). The four different processing levels were called preattentive, automatic (17-40 ms), medium (45-75 ms), and controlled (100-1000 ms) level of processing.

Table 2: Stimulus exposure times (milliseconds) included in the 4 different levels of information processing used in the statistical analyses of data in experiment I.

Processing level	Preattentive level	Automatic level	Medium level	Controlled level
Exposure time	Below subjective threshold	17ms - 40 ms	45 ms - 75ms	100ms -1000ms

The method of operationalising the preattentive level used in the present design was based on the subject's verbal report when exposed to the stimulus, the exposure time being coded as preattentive if the subject was unable to recognize the facial expression. Subjects were instructed to describe what they had observed after each set of stimulus exposures (see pp. 26-27 for further clarification regarding processing levels).

Statistical analyses of EMG reactions: Between group differences in EMG reactions were analysed in repeated measures ANOVA:s including all subjects (Faces x Muscles x Emotional empathy) with Faces (Happy and Angry) and Muscles (Zygomaticus and Corrugator) as within group factors and emotional empathy (high and low) as between group factor. These analyses were performed at each level of processing.

Mimicking in the whole group as well as in empathy sub groups were analysed with repeated measures ANOVAs (Faces x Muscles). If a significant interaction was obtained between Faces and Muscles with reaction tendencies for both muscles in the expected direction it was interpreted as a mimicking reaction. The expected directions in a mimicking reaction were an increase in the corrugator muscle (frowning) when exposed to the angry face compared to the happy face and an increase in the zygomatic muscle ("smiling") when exposed to the happy face compared to the angry face.

Self-reported feelings and EMG: After each set of 6 exposures of a given stimulus, subjects were instructed to report their feelings. The reported feelings were coded in three main categories: negative (1), neutral (2) and positive (3). Two mean values for the level of muscle activity (zygomaticus and corrugator) were calculated for each of the three categories, representing different self-reported emotions. These calculations were made independent of stimulus and of exposure time. Accordingly, each subject was assigned 6 EMG-values (2 Muscles x 3 Self-reported feelings). The interaction between Muscles , Self-reported feelings, and Emotional empathy was analysed in a repeated measure ANOVAs (Muscles x Self-reported feelings x Emotional empathy) with Emotional empaty as between group factor. The interaction between Self-reported feelings and EMG-activity was also analysed with repeated measures ANOVAs (Muscles x Self-reported feelings) in each empathy group separately.

Results and conclusions

At the preattentive level no mimicking reactions were found, neither for the whole group nor for the high- or low-empathy groups.

Repeated measures ANOVAs (Faces x Muscles x Empathy) both at the automatic level (17-40 ms, cf. Fig 1) and at the medium levels reached significance ($p < 0.05$ and $p < 0.01$ respectively). The difference between the high- and low-empathy groups disappeared at the controlled level. At the automatic and the medium levels the high-empathy subjects showed mimicking behaviour as shown in ANOVAs (Faces x Muscles), $p = 0.06$ and $p < 0.05$, respectively.

In contrast to the high-empathy subjects' mimicking reactions, the low-empathy subjects tended to show inverted zygomaticus muscle reactions, "smiling" when exposed to an angry face. ANOVAs (Faces x Emotional empathy) including only zygomatic muscle reactions reached significance both at the automatic and the medium levels.

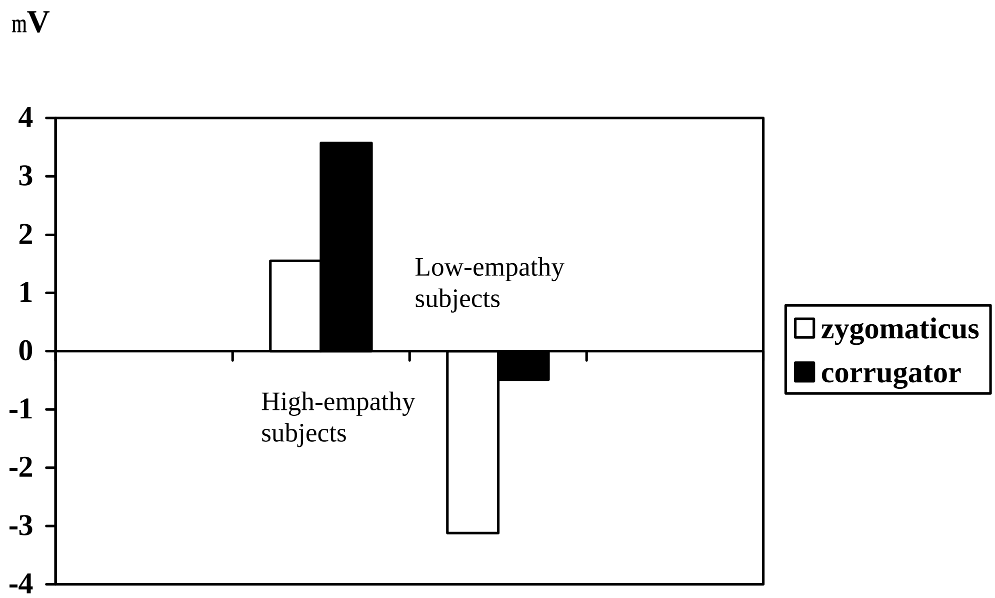


Figure 1. *Automatic level (17- 40 ms*): Differences in mean muscle activity between exposure to happy and angry faces for high-empathy subjects and for low-empathy subjects. Zygomatic activity = positive emotions, Corrugator = negative emotions. Positive values indicate expected direction (mimicry reactions).

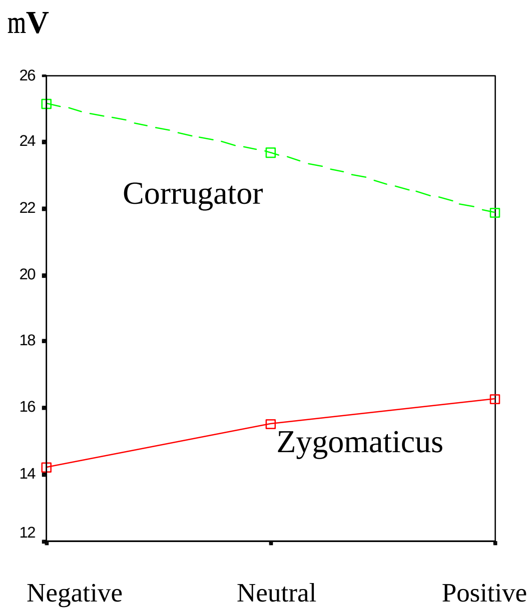


Figure 2 a. *High-empathy group*: Mean zygomaticus (positive emotions) and mean corrugator (negative emotions) activity at different self-reported feelings (3 categories), all levels of exposures and stimuli included.

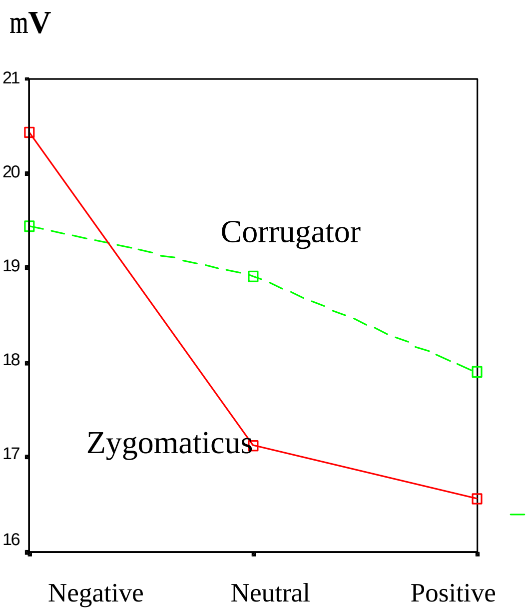


Figure 2 b. *Low-empathy group:* Mean zygomaticus (positive emotions) and mean corrugator (negative emotions) activity at different self-reported feelings (3 categories), all levels of exposures and stimuli included.

The high-empathy group was furthermore characterised by a significant correspondence between facial expressions and self-reported feelings ($p < 0.01$), which was not found in the low-empathy group (cf. Fig. 2a and 2b). No significant differences were found between the high- and low-empathy subjects in their verbally reported feelings, when they were exposed to a happy or an angry face.

In conclusion, the results supported the hypothesis of mimicking as an early automatic component involved in emotional empathy. In contrast to the high-empathy subject's mimicry reactions the low-empathy subjects showed inverted “smiling” reactions to angry faces both at the automatic and medium levels of exposure. One tentative explanation of the unexpected “smiling-reactions” to angry faces by low-empathy subjects may be that “smiling” reactions provide a means for repression of negative emotions. The differences between the empathy groups appeared to be related to differences in automatic somatic reactions to the facial stimuli rather than to self-reported feelings or conscious controlled facial reactions to the facial stimuli.

Studies II, III, and IV

Based on experiment II

Aims of study II

Although mimicking is supposed to be a biological prepared reaction tendency (Buck, 1984; Buck, 1999; Ekman et al., 1972; Izard, 1994a; Meltzofff & Moore, 1977; Sackett, 1966) it was shown in study I that low-empathy subjects did not display facial mimicry reactions. The differences between high- and low-empathy subjects in mimicking can be hypothesised to be partly explained by differences between individuals in their manner of relating to other people, associated their with attachment pattern based on their internal working models-of-self and others. The foundations of these models are assumed to develop early in life through the infant’s interaction with their primary caregiver (Bowlby, 1969; Bowlby, 1973).

The aim of Study II was to compare facial mimicry behaviour in individuals with positive versus negative models-of-self and models-of others. Subjects with a negative model-of-self, assumed to have greater difficulties in regulating negative emotional responses to stressful events (Anderson & Guerrero, 1998; Brennan & Shaver, 1995; Kobak & Sceery, 1988; Mikulincer & Florian, 1998; Simpson et al., 1996), were expected to display more negative facial reactions and to verbally report more negative feelings than subjects with a positive model-of-self. These differences were hypothesised to be strongest at the controlled level of information processing reflecting individual differences in emotion regulation. Further, level of Anxiety was compared in subjects with positive versus negative model-of-selves, since model-of self has been found to be closely related to level of anxiety (Fraley & Waller, 1998; Griffin & Bartholomew, 1994).

Models-of-others are supposed to reflect knowledge or cognitive structures rather than emotional reaction tendencies (Fraley & Waller, 1998) and consequently this variable was not expected to interact with the physiological emotional measure, EMG reactions, employed in the present study.

Aims of study III

Individuals with a dismissing-avoidant pattern of attachment have been assumed to repress negative affect (Anderson & Guerrero, 1998; Brennan et al., 1998; Mikulincer & Florian, 1998). They have further been hypothesised to have multiple and inconsistent internal working models, one model being inaccessible to consciousness, operating automatically and being coupled with anxiety and negative affect. The model operating at a conscious level is a positive model-of-self. The other model, operating outside awareness, is a model of a fragile self (Bartholomew, 1990; Breatherton & Munholland, 1999; Klohnen & John, 1998). These models can be assumed to operate at different temporal stages in the processing of information and expected to influence mimicking behaviour, emotional empathy and level of anxiety.

The main aim of the present study was to compare mimicry behaviour and emotional contagion between dismissing-avoidant and non-avoidant subjects at different levels of information processing. Dismissing-avoidant subjects were hypothesised to show less corrugator (negative emotions) activity when looking at angry faces at the controlled level of processing than non-avoidant subjects and also to report less negative feelings than non-avoidant subjects. Further, dismissing-avoidant subjects were expected to score lower on the emotional empathy test (QMEE) and on the trait-anxiety scale than non-avoidant subjects.

Aims of study IV

Some of the results reported in study I, especially the “inverted facial reactions”, smiles to angry faces shown by low-empathy subjects, were unexpected. One aim of study IV was to get further support for, or reject this finding. The major aim of the present study was to examine how facial mimicry behaviour in “face-to-face interaction situations” is related to individual differences in emotional empathy at different levels of information processing. Based on the results of study I it was hypothesised that a higher level of emotional empathy would be linked to automatic mimicry reactions at short exposure times and further, low-empathy subjects were hypothesised to display inverted “smiling reactions” to angry faces.

Method

Sixty-one subjects (33 men), all students from different departments at the Lund University participated on a volunteer basis in experiment II.

The method used in experiment II was essentially the same as in experiment I. Some methodological changes were introduced to assure preattentive processing at the shortest exposure time. The stimuli were presented via two tachistoscopes on a half-transparent screen (35 x 35 cm). The target stimuli were presented with one tachisoscope and were immediately followed by the masking picture presented with the other. These tachistoscopes, with automatically controlled exposure times and switching of lightening from one picture to the next, made rapid interchange between target and masking picture possible. Only three different times of exposure of facial stimuli were used (17, 56 and 2350 ms) in experiment II. The three different exposure times were assumed to activate preattentive (17 ms), automatic (56 ms) and controlled (2350 ms) processing levels (see pp. 26-27 for further clarification regarding processing levels).

Table 3: Different stimulus exposure times (milliseconds) and their corresponding information processing levels in Experiment II.

Levels of processing	Preattentive level	Automatic level	Controlled level
Exposure times	17 ms	56 ms	2350 ms

The EMG signal was sampled at 1000 Hz, integrated and rectified. The strength of the muscle contraction was calculated as the mean of the rectified EMG signal from stimulus onset until 2500ms after stimulus onset (Fridlund & Cacioppo, 1986). A self-report questionnaire (The Relationship Scales Questionnaire, RSQ) was further introduced in experiment II. This scale is a measurement of adult's internal working models and pattern of attachment (Griffin & Bartholomew, 1994). This questionnaire is based on viewing attachment pattern as constructed along two dimensions, model-of-self and model-of-others. The combination of these dimensions creates four prototypical patterns of attachment (see pp. 40 -41)

(Bartholomew & Horowitz, 1991). The RSQ has shown sufficient convergent validity when using attachment interviews as well as other self-report scales when rating pattern of attachment (Griffin & Bartholomew, 1994). A study including 515 Swedish students aimed at a construct validation of the Swedish translation of the RSQ. The Swedish version of the RSQ was found to measure essentially the same constructs as the original test (Bäckström & Holmes, 1999). This study supported previous findings with a strong negative correlation between the model-of-self and the Neuroticism factor and a positive correlation between model-of-others and the Extraversion factor in the Five Factor Model of personality (Bäckström & Holmes, 1999; Griffin & Bartholomew, 1994).

Data reduction and statistical analysis

Questionnaires: Based on the results of the QMEE subjects were divided into two groups by use of median split: one low-empathy group and one high- empathy group. Thirty subjects were included in the low-empathy group and 31 subjects in the high-empathy group.

Based on the scores obtained on the Relationship Scales Questionnaire (RSQ) 27 persons were placed in a negative model-of-self-group (those with negative values) and 34 in the positive model-of -self-group (those with positive values). Twenty-six persons were categorised into the negative model-of-others group and 35 into the positive model-of-others group. Twelve persons were categorised as dismissing-avoidant (positive model-of -self combined with negative model-of-others) and the remainder of the subjects (49) as non-avoidants.

Based on the scores obtained on the STAI -T (Spielberger, 1983) subjects were assigned to a low- (below the median) or a high- (above the median) trait-anxiety group. Thirty participants were categorised as low-anxiety subjects and 30 participants were placed in the high-anxiety group.

EMG-reactions: The strength of the muscle reactions to a certain stimulus during a certain exposure time (processing level) was calculated from onset of the stimulus to 2 500 ms after onset. The AcqKnowledge program was used to calculate the mean of the signal during the selected time period (Fridlund & Cacioppo, 1986). Each subject was assigned one mean corrugator value at each processing level and one mean zygomaticus value at each processing level (2 muscles x 3 processing levels) when exposed to the happy face and the same for the angry face. Thus, each subject received twelve mean EMG-values (2 faces x 2 muscles x 3 processing levels).

Statistical analyses of EMG reactions: Between group differences in EMG reactions were analysed in repeated measures ANOVA:s including all subjects (Faces x Muscles x Personality factors) with Faces (Happy and Angry) and Muscles (Zygomaticus and Corrugator) as within group factors and Personality as between group factor. The different Personality factors involved in these calculations were in Study II: Model-of-self (positive and negative) and Model-of-others (positive and negative), and in Study III: Dismissing-avoidant and non-avoidant subjects and finally in study IV: Emotional Empathy (high and low). These analyses were performed at each level of processing.

Mimicking in the whole group as well as in subgroups were analysed in repeated measures ANOVA:s (Faces x Muscles). If a significant interaction was obtained in a repeated measures ANOVA (Faces x Muscles) with reaction tendencies for both muscles in the expected direction it was interpreted as a mimicking reaction. The expected directions were an increase in the corrugotor muscle (frowning) when exposed to the angry face compared to the happy face and an increase in the zygomatic muscle ("smiling") when exposed to the happy face compared to the reactions when exposed to the angry face.

Tonic affective state: The tonic affective state or base line emotional state (mood) has been considered as an interaction between negative tense arousal (here: corrugator activity) and positive energetic arousal (here: zygomatic activity) (Watson & Tellegren, 1985). Each subject's quotient between the corrugator and zygomatic mean values (mean values calculated independent of exposure time and stimuli) was calculated. A post hoc analysis (in study II) was based on the comparison (t-test) between these quotients for different internal working model groups.

Self-reported feelings: The self-reported feelings were assigned values from 1 (negative) to 5 (positive). Differences between groups concerning self-reported feelings were analysed with the non-parametric Mann Whitney U-test.

Results and conclusions

Study II

In line with the hypothesis that the negative model-of-self subjects would have a higher level of anxiety these subjects scored significantly higher ($p < 0.05$) on the anxiety-test (STAI -T). They also showed a significant overall stronger corrugator than zygomatic activity compared to positive model-of-self subjects, further evidence of a negative tonic affective state ($p < 0.05$, cf. fig. 3). At the longest exposure time (2350 ms), representing emotionally regulated responses at a secondary memory level, negative model-of-self subjects showed a significantly stronger corrugator response ($p < 0.01$, cf. fig. 4) and reported more negative feelings than subjects with a positive model-of-self. These results supported the hypothesis that subjects with a negative model-of-self would show difficulties in self-regulation of negative affect. In conclusion, pattern of attachment may be interpreted as a personality factor being composed of an affective, anxiety dependent component, related to the individual's model-of-self. At the secondary memory (controlled) level, differences in mimicry reactions between positive and negative models-of-self subjects may reflect differences in emotional regulation of negative affect. In line with expectations, model-of-others, supposed to represent mainly knowledge structures, did not interact with the emotional measures employed: mimicry reactions, tonic affective state, or self reported feelings. Model-of-others may then be assumed to reflect people's decision how to cope with relations.

The negative model-of-self subjects scored, somewhat unexpectedly, significantly ($p < 0.05$) higher on the emotional empathy test (QMEE) than subjects with a positive model-of-self and showed a significant mimicry reaction ($p< 0.05$) at the controlled level of processing.

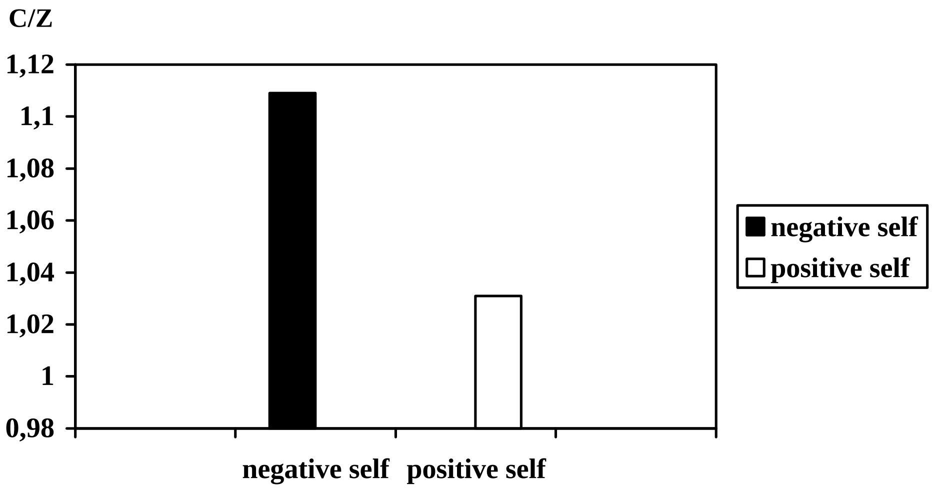


Figure 3. The quotient between mean corrugator and mean zygomatic activity for negative and positive model-of-self subjects at the different experimental conditions, independent of stimulus and exposure time.

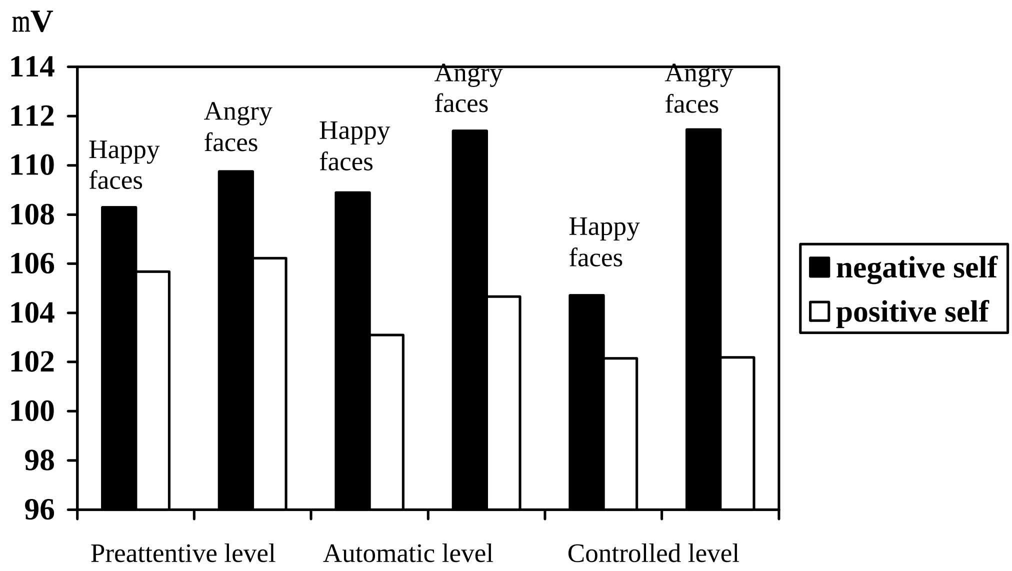


Figure 4. Mean corrugator activity for negative and positive model-of-self subjects at the different experimental conditions.

Study III

A repeated measures ANOVA (Faces x Muscles x Attachment Pattern), did not reached significance at the automatic level (cf. fig. 5). The dismissing-avoidant subjects displayed "normal" corrugator reactions to angry faces at the automatic level of information processing (56 ms), representing conditioned emotional reactions. Thus, at this level they did not repress negative emotions (corrugator reactions). An ANOVA (Faces x Muscles x Attachment Pattern) with Attachment pattern (dismissing-avoidant and non-avoidants) as between group factor, reached significance at the controlled level ($p < 0.05$, cf. fig. 6). At the more cognitively controlled level of information processing the dismissing-avoidant subjects showed inverted zygomatic reactions (“smiled”) and no corrugator response to the angry face, whereas the non-avoidant subjects reacted with a significant mimicking reaction. The non-avoidant subjects reacted with mimicking reactions both at automatic ($p = 0.07$) and controlled levels of processing ($p < 0.05$).

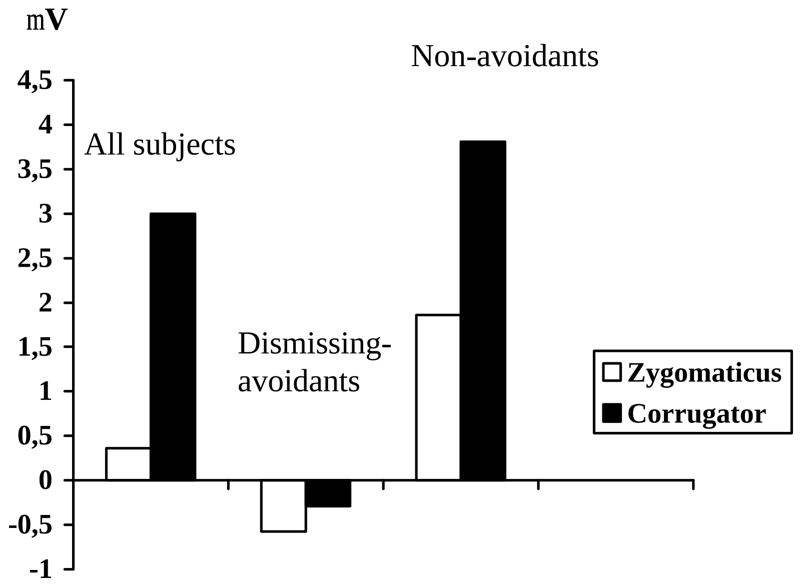


Figure 5. *Automatic level (56 ms)*: Differences in zygomaticus (positive emotions) and corrugator muscle (negative emotions) activity between exposure to happy and angry faces for all subjects, for dismissing-avoidant subjects and for non-avoidant subjects. A positive difference in muscle activity between exposure to happy and angry faces indicates a mimicking reaction.

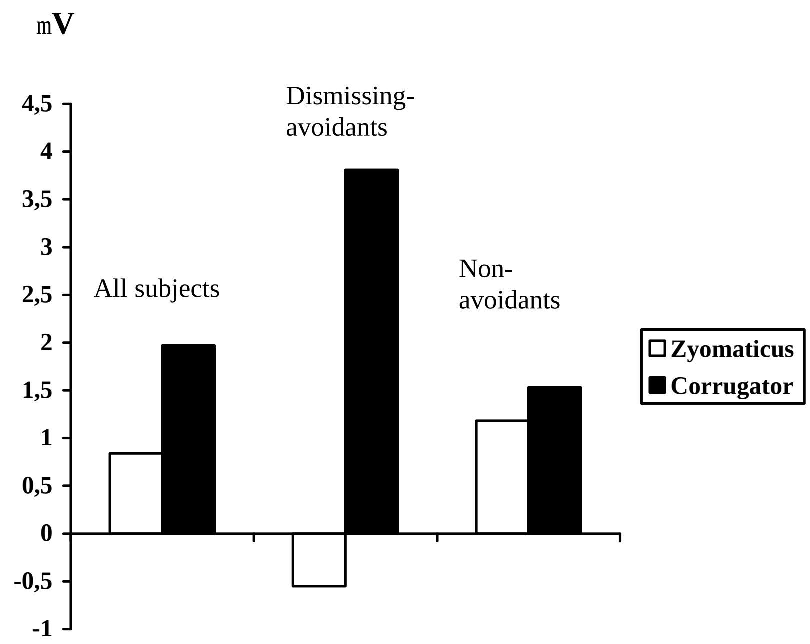


Figure 6. *Controlled level (2350 ms)*: Differences in zygomaticus (positive emotions) and corrugator muscle (negative emotions) activity between exposure to happy and angry faces for all subjects, for dismissing-avoidant subjects and for non-avoidant subjects. A positive difference in muscle activity between exposure to happy and angry faces indicates a mimicking reaction.

The dismissing-avoidant subjects' decreased corrugator responses and increased zygomatic responses at the controlled level, when exposed to the angry face, may be interpreted as a repression of their earlier negative emotional reaction, since dismissing-avoidant persons have been assumed to repress negative affect (Anderson & Guerrero, 1998; Brennan et al., 1998; Mikulincer & Florian, 1998). The results can further be viewed as supporting the idea that dismissing-avoidant individuals have one model-of self operating outside awareness, a model of a fragile self, and another at a more conscious level, a positive model-of-self (Bartholomew, 1990; Breatherton & Munholland, 1999; Klohnen & John, 1998).

Study IV

No mimicking reactions were found at the preattentive level, neither for the whole group nor for the high- or low-empathy groups and the findings were thus in line with the results obtained at the this level in Study I.

A repeated measures ANOVA (Faces x Muscles x Emotional Empathy) at the automatic level with Emotional empathy as between group factor reached significance, $p < 0.05$. In study IV the whole group, as well as the high-empathy group, showed significant mimicking reactions at the automatic level ($p < 0.05$ and $p < 0.01$, respectively), whereas the low-empathy group did not display any mimicking at this level. The present study thus confirmed the results of Study I regarding differences between high and low-empathy subjects. Both studies showed a significant difference in facial mimicry reactions between high- and low-empathy subjects at short exposure times (automatic levels: 17- 40 ms in Study I and 56 ms in Study IV). In study I, as well as in study IV, the low-empathy subjects showed tendencies to "smiling-reactions" to angry faces. The unexpected " smiling-reactions" to angry faces for low-empathy subjects may provide a means for repression of negative emotions.

DISCUSSION

The main findings of the present studies were that facial mimicry reactions emerged at the automatic levels of information processing both in Studies I and IV for high-empathy subjects, whereas the low-empathy subjects, on the contrary, showed inverted "smiling" reactions to angry faces. In Study I the high-empathy group was also characterised by a significantly higher correspondence between facial expressions and self-reported feelings than

low-empathy subjects. No differences were found between the high- and low-empathy subjects in their verbally reported feelings, when presented a happy or an angry face.
Further, differences in mimicry reactions between attachment groups emerged at the controlled or emotionally regulated level of information processing. The dismissing-avoidant subjects showed “normal” corrugator reactions at the automatic level of information processing and showed at the controlled level inverted zygomatic (smiling) reactions and no corrugator reactions, indicating negative feelings, to angry faces. Negative model-of-self subjects reported a higher degree of trait anxiety than subjects with a positive model-of-self. They also showed an overall higher corrugator than zygomatic activity independent of facial stimulus and exposure times, a support for a negative tonic affective state. At the longest exposure time, representing emotionally regulated responses at a secondary memory level, the negative model-of-self subjects showed a significantly stronger corrugator response (negative emotions) to angry faces and reported more negative feelings than subjects with a positive model-of-self.
The dismissing-avoidant subjects scored significantly lower on the emotional empathy test compared to non-avoidants, whereas the negative model-of-self subjects scored significantly higher than positive model-of-self subjects on emotional empathy.

Mimicry and emotional empathy at the automatic level

The difference in mimicry reactions between the emotional empathy groups emerged already at the automatic level of information processing in both Studies I and IV. Facial mimicry reactions were found for high-empathy subjects but not for low-empathy subjects. These findings support Basch’s hypothesis, which conceives of a form of primitive emotional contagion, via mimicry reactions, as an early automatic component involved in the process leading to empathy (Basch, 1983). The result is also supported by previous research, in which it has been found that individuals, who are more facially expressive in response to emotional stimuli have a higher degree of empathic ability (Eisenberg et al., 1988; Levenson & Ruef, 1997; Shuto, 1987; Wiesenfeld et al., 1984).
Previous research has however not separated reactions at different levels of information processing. Facial mimicry reactions at the automatic level are supposed to be conditioned emotional responses, the second level in Leventhal's and Öhman's models (Leventhal, 1984; Öhman, 1993). The short exposure times involved (from 17 to 56 ms), followed by a masking picture, interrupting information processing, presumably do not activate secondary memory

level processes, supposed to regulate automatically evoked emotions (Kagan, 1994; LeDoux, 1996).

The fact that the QMEE-test measures emotional empathy reactions to others, probably particularly emotional distress reactions to other persons in distress (Choplan et al., 1985; Eysenck & Eysenck, 1978), may explain that the differences between emotional empathy groups emerged already at the automatic level, supposed to represent emotional conditioned reactions. The contrasting reactions manifested at this level may indicate differences between the empathy groups in their tendencies to show conditioned emotional distress or anxiety reactions, a form of primitive negative emotional contagion.

In Study I the high-empathy subjects were characterised by a significantly higher correspondence between their facial muscle activity and their self-reported feelings than low-empathy subjects, and further no differences were found between the high- and low-empathy subjects in their verbally reported feelings, when presented a happy or an angry face. Thus, the differences between the empathy groups appeared to be related to differences in automatic somatic reactions rather than to differences between cognitive interpretations of the emotional stimuli.

Experimental support for automatically evoked EMG reactions to emotional stimuli has recently been reported by Dimberg et al. and Kappas et al. (Dimberg et al., 2000; Kappas et al., 2000). Dimberg et al. found mimicking reactions to facial stimuli already at the preattentive level (Dimberg et al., 2000), and Kappas et al. showed that automatic emotional EMG reactions to emotional stimuli could not be inhibited, even if subjects were instructed to voluntarily inhibit their facial expressions. These previous findings and the present results do not support the view that facial expressions are mainly signals of social intentions or communicative acts comparable to verbal speech (Bavelas, Black, Lemery, & Mullet, 1987; Fridlund, 1997). Rather, they support the view that spontaneous facial expressions are automatic emotional reactions out of intentional control.

Inverted zygomatic reactions for low-empathy subjects

Inverted smiling reactions to angry faces were obtained for low-empathy subjects in Study I and IV. Studies by Lanzetta and colleagues have also provided evidence for inverted reactions to faces, which were interpreted as counterempathic reactions (Englis, Vaughan, & Lanzetta, 1982; Lanzetta & Englis, 1989). A study by Lang et al., using emotional pictures as stimuli and facial EMG as dependent measure, related zygomatic activity to the subjects' ranking of the emotional valence of the pictures. A positive relation was found between level of zygomatic activity and the emotional valence judgements of the stimuli except for the most aversively ranked stimuli which elicited stronger zygomatic muscle reactions (Lang et al., 1993). These reactions were interpreted as grimaces to disgusting pictures. Brown et al. found simultaneous zygomatic and corrugator activation after emotional imagery of fear, but only corrugator activation after imagery of sadness and anger (Brown & Schwartz, 1980). These smiles were by Ekman et al. interpreted as either "distress smiling" or cross-talk from nearby located muscles (Ekman et al., 1980). Thus, increased zygomatic activation in response to negative external signals or negative feelings has been found in previous research and has been interpreted as either cross-talk from other muscles or as indicators of different negative emotions.

Another tentative explanation for the inverted zygomatic reactions found in the present studies may be that these "smiles" provide a means for repression of negative affects in low-empathy subjects. In line with the assumption that facial expressions modulate or inhibit emotional experience through proprioceptive facial feed back (Adelmann & Zajonc, 1989; Colby, Lanzetta, & Kleck, 1977; Izard, 1990; Lanzetta & Kleck, 1976; McIntosh, 1996), a rapid change of the facial expression from a negative to a positive “smile” may via facial feed back repress negative feelings. The inverted “smile reactions” may also be mediated through a habitual attentional shift from negative anxiety-provoking thoughts to distracting positive memories (Fraley et al., 1998; Milkulincer & Orbach, 1995). Repressive individuals have been found to deflect attention away from potentially threatening stimuli (Boden & Baumeister, 1997). Both an attentional shift and the ensuing facial response, that via feed back can be assumed to further amplify the positive emotional networks, may facilitate regulation of negative emotions. A support for the interpretation that the inverted "smiling" reactions may provide a means for repression of negativ emotions is that these inverted smiles were found in the dismissing-avoidant subjects, who are assumed to be characterised by repression of negative emotions. They "smiled" at angry faces at the controlled level of information processing, but showed a high level of corrugator activity at the automatic level of information processing.

One further possible explanation of low-empathy subjects’ increased zygomatic muscle activity, when exposed to angry faces, may be that the zygomatic electrical activity was influenced by an increase in electrical activity in the nearby located orbicularis oris superioris muscle (cross-talk between muscles), which tightens and compress lips together (Tassinary &

Cacioppo, 2000). Biting and pressing lips together, possibly indicating aggressive emotions, could be a conceivable response to the angry faces for low-empathy subjects.

Finally, an interpretation of the inverted "smile" as an automated appeasement or disarming reaction should not be excluded. The interpretation is however less plausible, since the reactions were found mainly in dismissing-avoidant individuals characterised by avoidance of others.

One argument against the interpretation of inverted facial expressions, as involved in repression of negative emotions, is that in Study I the low-empathy subjects reported negative feelings at the same time as they showed both high zygomatic and corrugator activity. Since the calculations of the correspondence between facial muscle activity and reported feelings were made independently both of facial stimuli and exposure times these findings are hard to interpret.

Attachment, emotion regulation and empathy

In the present studies differences in facial reactions between the attachment groups emerged at the controlled level of information processing. This finding is in line with expectations, since different patterns of attachment are thought to be related to differences in emotion regulation strategies (Bowlby, 1969; Bowlby, 1973; Bowlby, 1979; Breatherton & Munholland, 1999; Cassidy, 1994; Mikulincer & Florian, 1998; Schore, 1994). The controlled level of information processing level is supposed to evoke emotional reactions, controlled by secondary memory processes, assumed to be a result of the cortical analysis of the facial stimuli that influences secondary emotional reactions about 50 milliseconds later than the first level of information processing, carried out by the amygdala (Kagan, 1994). At this processing level, the internal storage of the image of the caregiver’s face would be expected to influence the autonomic reaction to the facial stimulus (Schore, 1994).

The internal working models, hypothesised to reflect different modes of regulating and controlling negative emotions, are supposed to become partly inaccessible to consciousness as they become habitual and automatic (Breatherton & Munholland, 1999). Individuals with a dismissing-avoidant pattern of attachment are, at the reportable conscious level, characterised by a positive view of themselves (model-of-self) and a negative view of others (model-of-others). This avoidance of negative external information and their denial of experience of negative emotions (Brennan et al., 1998; Mikulincer & Florian, 1998), was expected to interfere with normal mimicry behaviour and emotional contagion.

The dismissing-avoidant subjects scored in the present studies as expected lower, although not significantly, than the non-avoidant subjects on the trait-anxiety test. Some support for the contention that dismissing-avoidant individuals protect themselves from negative emotions by inverted “smiling” reactions towards angry faces was obtained in Study III. These subjects showed the “normal” corrugator reactions, indicating negative emotions, at the automatic level of information processing. This finding may be interpreted as supporting the idea that although these individuals no longer express separation anxiety, it is not extinguished but goes underground, and exists simultaneously with their positive self-image of autonomy (Sroufe et al., 1983). At the controlled level the dismissing-avoidant individuals showed inverted “smiling” zygomaticus reactions and no corrugator reactions. In line with predictions from attachment theory (Brennan et al., 1998; Hazan & Shaver, 1994; Klohnen & John, 1998; Main & Weston, 1982; Mikulincer & Florian, 1998), these reactions may be interpreted as an emotion regulation strategy that may help the dismissing-avoidant subjects to keep their positive image of themselves and their attitude of autonomy and self reliance.

The negative model-of-self subjects showed, as expected, difficulties in controlling negative emotional reactions (Anderson & Guerrero, 1998; Brennan & Shaver, 1995; Kobak & Sceery, 1988; Mikulincer & Florian, 1998; Simpson et al., 1996), as indicated both by corrugator reactions and self-report measures, at the controlled level of processing. They also scored significantly higher on the anxiety test than individuals with a positive model-of-self and further showed a negative tonic affective state. According to attachment theory, and also congruent with object relation theory, the reactions displayed by the negative model-of-self subjects, when confronted with a stressing situation, may be interpreted as indicative of a lack of an “internalised supportive care giver”.

Dismissing-avoidant subjects have in previous research scored significantly lower on a self-report measurement scale of empathy and have shown difficulties in identifying feelings as measured by an Alexithymia Scale (Bekendam, 1997). They are also supposed to be characterised by repression of negative emotions (Anderson & Guerrero, 1998; Brennan et al., 1998; Mikulincer & Florian, 1998). Thus, the dismissing-avoidant subjects were in the present studies expected to score low on the QMEE, which has been shown indications of being especially sensitive as a measure of negative emotional contagion (Choplan et al., 1985; Eysenck & Eysenck, 1978). These expectations were supported by the result, since the dismissing-avoidant subjects in the present studies scored significantly lower on QMEE than non-avoidant subjects. This result may be explained as a repression of apprehensive reactions to others' negative emotional expressions. The negative model-of-self subjects scored, somewhat unexpected, significantlly higher on QMEE than positive model-of-self subjects and showed a mimicry reaction at the controlled level of processing, whereas the positive model-of-self subjects did not display any mimicry reaction. Some previous studies have shown a positive relation between empathy and a high level of emotional distress, assumed to be related to a negative model-of-self (Ashton et al., 1998; Bekendam, 1997; Byrne, 1964; Hatfield et al., 1994). The negative model-of-self subjects' higher level of emotional empathy may be interpreted as a tendency to be easily distressed by others showing negative emotional reactions (negative emotional contagion).

A process perspective

The present results give some support to the conception that different processing stages are involved in both the manner individuals relate to others and in more elaborated forms of empathy. A process approach integrates primitive emotional contagion, emotional regulation, and higher level cognitive perspectives on attachment and empathy. The conception of attachment as a result of processes is in line with Fraley's and Waller's assumption that the internal working models correspond closely to Anxiety (model-of-self) and Avoidance (model-of-others) (Fraley & Waller, 1998), and that these models may influence different temporal stages of information processing and behavioural regulation. Anxiety (model-of-self) is supposed to capture variations in physiological and emotional parameters, whereas Avoidance (model-of-others) captures variations in the organisation of knowledge structures rather than emotional thresholds. A three-level theory of emotion and the development of attachment has independently been proposed by Cicirelli (Cicirelli, 1996). The first level conceives of certain primitive emotions elicited without cognitive interpretation, with rapid reactions for purposes of survival. The second level involves primitive affective-cognitive structures and finally higher order cognitive processes and language are supposed to be involved at the third level (Cicirelli, 1996).

Basch and other empathy researchers, stress that the process leading to empathic understanding has both affective and cognitive components (Basch, 1983; Eisenberg & Fabes, 1990; Gladstein, 1983; Holm, 1985). Emotional contagion via automatic mimicry is by Basch considered to be the starting point in the empathic process (Basch, 1976), a contention quite in line with the results of Studies I and IV. These indicated that the first stage in the empathic process seem to be a primitive form of emotional contagion as shown by the positive relation between emotional empathy and mimicking at the automatic level of processing. In line with Fraley's and Waller's proposal, this form primitive emotional contagion, as shown by high-empathy subjects, may be related to Anxiety, since the QMEE seem to measure tendencies to negative emotional contagion.

The second stage of the process assumed to lead to empathy can be interpreted as related to individual differences in emotional regulation. Individuals with a dismissing-avoidant pattern of attachment scored low on the QMEE scale and appeared to avoid negative emotions both verbally, as indicated by a low level of state-anxiety, and by inverted smiling reactions at the controlled level of information processing. These reactions may be interpreted as repression of negative emotional contagion. On the other hand, individuals with a negative model-of-self, assumed to be characterised by difficulties in controlling negative emotions, showed strong corrugator reactions, indicating negative emotions, and reported high levels of negative feelings at the controlled level of processing. Negative-model-of self subjects also scored significantly higher on the emotional empathy scale, here presumably being a measure of sensitivity to mainly negative emotional contagion. Thus, individual differences in regulation of negative emotional arousal also seem to be related to differences in emotional empathy as measured by the QMEE. One prerequisite for emotional empathy may be that normal apprehensiveness in social interaction situations is not made inaccessible to consciousness.

The third step in the process may be represented by the knowledge structures involved in model-of-others (Fraley & Waller, 1998). This parameter did not, as expected, interact with the physiological emotional measures employed in the present investigation. Model-of-others, probably involved both in relational and empathy processes, may reflect a response, based on the previously evoked emotional responses related to the self, which may result in intentional behaviour aiming at further involvement with, or in avoidance of the other person. According to Eisenberg, emotional distress evoked by the other person may, with further cognitive elaboration and emotional regulation, result in role taking and sympathy, and finally lead to altruistic helping behaviour (Eisenberg & Fabes, 1990). On the other hand, negative emotional contagion may lead to additional personal distress and self-focused attention (Wood, Salzberg, & Goldsamt, 1990) that may interfere with role-taking and altruistic behaviour (Eisenberg & Fabes, 1990). Thus, since more cognitively elaborated empathic understanding is the result of a consecutive process, the relation between spontaneous facial expressions and higher forms of empathy is very complex. Future investigations including measures of positive emotional contagion and of more cognitively elaborated forms of empathy are required to further elucidate these relationships.

Another aspect of the emotional process involved in the present experiments was the participants' self-reports of their own feelings, reported immediately after their exposure to the emotional stimuli. This level of emotional response can be considered as an operationalisation of subjective feelings corresponding to Buck's knowledge-by-description (Buck, 1984; Buck, 1993; Buck, 1999). A positive relation between the descriptive level and the somatic emotional reactions was found for high- but not for low-empathy subjects in Study I. This finding is in line with previous research, in which it has been found that subjects, who were out of touch with their emotional physiological reactions (high in Alexithymia), scored low on empathy tests (Bekendam, 1997; Blumbeerg, 1998).

Tonic affective state and model-of-self

The mood or tonic affective state has been regarded as a result of an interaction between negative tense arousal (BIS) and positive energetic arousal (BAS) (Watson & Tellegren, 1985). The positive affective system is by Davidsson et al. assumed to be related to approach behavior and the left hemisphere, whereas the negative system is supposed to be related to avoidance behavior and involving the right hemisphere (Davidsson, 1995). In this investigation the tonic affective state was operationalised as the quotient between the corrugator and zygomatic mean values (independently of stimuli and exposure times). Corrugator reactions represented tense arousal (negative emotions) and zygomatic reactions positive energetic arousal. The result supported a significantly higher level of tense arousal (negative emotions) for negative model-of-self subjects than for positive model-of-self subjects.

It has been found that model-of-self is significantly correlated to the Neuroticism factor in The Five Factor Model of personality, a negative model-of-self related to a high degree of neuroticism (Bäckström & Holmes, 1999; Griffin & Bartholomew, 1994). The Five Factor Model of personality is a set of five personality traits derived from factor-analytic studies of people's description of their own and others' personalities (John & Srivastava, 1999). People scoring high on the Neuroticism factor are described as emotionally unstable, anxious, self-pitying, and worrying, and Neuroticism has by Tellegen been defined as the tendency to negative emotionality (Tellegen, 1985). A recent approach to the Five Factor Model of personality tries to explain these five personality traits as a result of different underlying emotions and emotion regulation strategies (Keltner, 1996). Neuroticism has been correlated with increased facial expressions of anger, contempt and fear (Keltner, 1996). Thus, the results obtained in the present study regarding model-of-self subjects showing a negative tonic affective state as expressed by their relation between the tension of corrugator and zygomatic facial muscle are in line with previous research on emotions, facial expressions, and personality.

Limitations of the present studies

The design with different exposure times used in the present investigations, aiming at reflecting different stages of control in emotional information processing, has less often been applied in psychophysiological research. In addition, conclusions concerning differences between attachment groups are based on a single experiment. Thus, the results reported in this thesis give rise to new plausible hypotheses rather than provide definite answers. Further investigations are needed to obtain additional information about the relation between facial expressions, emotional empathy and the internal working models and how these relations function at different stages of information processing.

Negative feelings and corrugator reactions

A positive relationship was shown between self-reported feelings and facial muscle activity in high empathy subjects and in addition a positive relationship was found between facial mimicry and the degree of emotional empathy as measured by QMEE at the automatic level. These findings support the hypothesis that the facial muscle reactions are connected to emotional experiences. The increase in corrugator activity to angry faces was connected to negative self-reported feelings. The question whether these negative feelings represent fear, anger, distress or disgust could not be answered by the present investigation, since increased corrugator activity has been found to be related to different negative emotions (Cacioppo et al., 1993). Furthermore the self-report measure only differed between positive and negative emotions. A self-report measure including also a question about the quality of the emotion might have answered this issue.

Mechanisms underlying the correlation between mimicry and emotional contagion

The present studies support a positive relation between an automatic mimicry reaction, reported feelings and emotional empathy. The mechanisms behind this relation could however not be elucidated by the applied design. Subjective feelings could be the result of facial proprioceptive feed back, as proposed by the facial feed back hypothesis. On the other hand, conditioned emotional reactions could simultaneously result in both subjective feelings and mimicry reactions. Autonomic or neurochemical reactions to emotional stimuli may result both in subjective feelings and mimicry reactions. Nor could the question of the respective role of conscious cognitive interpretations, physiological or somatic feed back for facial expressive reactions and subjective feelings at later stages of information processing be answered by the present investigations.

Sampling rate in Experiment I

A restriction of the methodology in experiment I was that the selected sampling rate (100 Hz) was too low to meet the recommendation of a sampling rate twice that of the most rapid EMG frequencies of interest (Fridlund & Cacioppo, 1986). This means that the signal was sub-sampled and that more reliable measurement data probably would been obtained if the sampling rate recommended by Fridlund and Cacioppo had been employed. This methodological shortcoming was eliminated in experiment II.

Preattentive level

Further support for mimicking as an automatic reaction outside awareness would have been obtained, if, as hypothesised, subjects had shown mimicking reactions at the preattentive level. The appearance of mimicking behaviour at the preattentive level has, however, recently been demonstrated by Dimberg et al. (Dimberg et al., 2000). The small group of subjects (n = 30) involved in the analysis in Study I might explain the lack of significant result at the preattentive level in this study. Sixty-one subjects could, however, be included in the analysis at the preattentive data in Study IV. In spite of the methodological improvements no mimicking reaction was obtained at the preattentive level in Study IV. The difference between Dimberg's findings and the present results could depend on the longer exposure times (30ms) of the target stimuli in Dimberg's study. The method used when calculating the mean of the EMG-reactions could also provide an explanation for the divergent results.

Dimberg and co-workers compared mean muscle reactions to angry and happy faces from 500 ms after stimulus onset, whereas in the present investigations mean reactions were compared from stimulus onset.

Emotional base level

The conclusions concerning group differences were mainly based on comparisons of EMG activity between exposure to either happy or angry faces on a certain information processing level. The order of exposure of angry and happy faces was balanced to remove position as a confounding factor when comparing reactions to the facial stimuli.

When discussing differences in reactions between different information processing levels to the same stimulus, a measure of the change in activity from a pre-stimulus EMG baseline would have improved the conclusiveness of the experiments through elimination of a possible baseline displacement in EMG activity as confounding factor. Expectations, or top-down processes, could be predicted to influence the emotional base line as well as the reaction to the stimulus, when the emotional stimulus is processed at more controlled levels. Such a displacement of the pre-stimulus EMG "base level" between the different information processing levels could, however, be assumed to reflect an adaptation also existing in real life situations in processing of emotional information.

An EMG base line was however difficult to obtain due to technical reasons in the experiments reported in this thesis.

QMEE - a measure of negative emotional contagion?

A further shortcoming of the present studies was that the self-report measure of emotional empathy, QMEE, may mainly measure a person’s emotional distress reactions to other’s in emotionally distressing situations, since this self-report scale has been found to correlate with Neuroticism (Choplan et al., 1985; Eysenck & Eysenck, 1978). A more comprehensive measurement of empathy should, as well, include other aspects of empathy such as positive emotional contagion and cognitive aspects of empathy.

Choice of facial stimuli

Happy and angry faces were used as stimuli in the present studies. This choice of facial stimuli was based on the fact that in previous studies these facial expressions have been shown to evoke mimicry reactions in the zygomatic and corrugator muscles (Dimberg, 1982; Dimberg, 1989; Dimberg & Lundquist, 1989; Vaughan & Lanzetta, 1980). According to Cacioppo, bivalent reactions (positive or negative) rather than discrete emotional reactions may be expected at the first primitive level of emotional response indicated by facial microexpressions (Cacioppo et al., 1993). The angry face was in the present study assumed to represent a prototype of a negative expression and expected to evoke negative emotional contagion. Self-report scales indicating only the bivalent positive-negative dimension of subjective feelings were used. It might, however, be argued that other negative facial expressions than angry faces, as for example expressions of sadness or fear, could be relevant or even better as facial stimuli, when aiming at measuring emotional empathy reactions.

Number of subjects

Another limitation of the studies reported in this thesis was that all attachment groups could not be compared with respect to their facial muscle reactions, since the order of exposure (angry or happy face first) was a confounding factor prohibiting such analyses (except for the dismissing-avoidant group). This caveat could be eliminated by including a larger number of participants in the experiment or by selecting a stratified sample of participants.

SUGGESTIONS FOR FUTURE RESEARCH

Future studies on emotional empathy, facial mimicry, and attachment pattern should initially exclude the described methodological limitations. Thus, future studies should include a larger number of participants, include sad and fearful faces as negative emotional stimuli, and in addition use a self-report measure with questions about the quality of the feelings. The technique applied to measure EMG reactions and the experimental design can be improved, so as to allow establishing an EMG baseline. In the present studies the calculation of mean EMG reactions started from stimulus onset, but could be refined by a calculation starting from 500 ms after stimulus onset. Self-report measures of empathy including both cognitive aspects of empathy and positive emotional contagion, would further elucidate facial expressiveness in relation to these forms of empathy. It would be of interest to use the Adult Attachment Interview (AAI) to complement the RSQ as a measure of attachment pattern. The role of mimicry in empathic ability could be further elucidated, if clinical groups with empathy disturbances were compared to non-clinical groups.

To further clarify the mechanisms behind the inverted facial expressions to angry faces projective tests identifying defence mechanisms and an Affect Regulation Scale could be used, an improvement that perhaps would show how different affect regulation strategies relate to facial emotional expressions, attachment and empathy.
Factor analytic work on mood reveals a two-factor structure, positive (energetic arousal) and negative affect (tense arousal) (Watson & Tellegren, 1985). Emerging evidence points to different neural substrates of positive and negative mood. The interaction of these two systems (Dillard, 1998) is assumed to decide the tonic affective state of the individual. The positive system is by Davidsson et al. assumed to be related to approach behavior and the left hemisphere. The negative system is supposed to be related to avoidance behavior and involving the right hemisphere (Davidsson, 1995). In Study II subjects with a negative model-of-self showed a significantly different quotient between the corrugator and zygomatic muscle activity than subjects with a positive model-of-self, here assumed to reflect a tonic affective state or mood. Measures of the relation between the EEG activity in the different hemispheres in comparisons to the relative activity of the zygomatic and corrugator muscles could perhaps further clarify the involvement of the different hemispheres in positive and negative emotions that may be involved in a person's model-of-self.

SUMMARY AND CONCLUSIONS

Reflections about the mechanisms involved in the emotional communication process between individuals inspired the design applied in the present studies. The approach can be viewed in terms of a systems theory approach to information processing. Man is considered to be a bio-psycho-social creature in continuous communication with the social environment, a communication performed both at a biologically based spontaneous emotional level inaccessible to awareness and at a culturally based symbolic level. Spontaneous facial expressions were regarded as efferents of biologically based emotions and were expected to be related to empathic ability and to patterns of attachment.
Emotional facial reactions were studied at different levels of information processing in experimentally created face-to-face interaction situations. Subjects were categorised as in high- or low-empathic based on results on a self-report scale of emotional empathy, QMEE. A difference in facial mimicry reactions between high- and low-empathy subjects was demonstrated at the automatic level of information processing, at which high-empathy subjects showed a mimicking reaction, whereas the low-empathy subjects did not. On the

contrary, the low-empathy subjects showed a tendency to “smile” in response to angry faces. Thus, the result supported the hypothesis that automatic mimicry is an early, automatic element involved in emotional empathy. The inverted smiling reactions to angry faces may be interpreted as an automated strategy for repression or regulation of negative emotions.

Pattern of attachment, measured by the Relationship Scales Questionnaire (RSQ), was introduced as a new variable in experiment II, since attachment patterns were hypothesised to be related both to emotional empathy and to facial mimicry. Patterns of attachment have further been assumed to be involved in emotion regulation. Insecure attachment, especially attachment patterns associated with a negative model-of-self, are hypothesised to be related to difficulties in regulating negative emotions. The dismissing-avoidant pattern of attachment is supposed to be related to repression of negative emotions.

In line with this hypothesis, subjects with a negative model-of-self showed difficulties in controlling negative emotional reactions, as indicated both by results on the anxiety-test (STAI-T), their tonic affective state, their corrugator reactions and their self-reports at the controlled or regulated level of information processing.

Support for the contention that dismissing-avoidant individuals protect themselves from negative affect by “smiling” towards angry faces was obtained in experiment II. These subjects showed the same corrugator reactions to angry faces, indicating negative emotions, as non-avoidant individuals at the automatic level of information processing, whereas they showed inverted “smiling” zygomaticus reactions to angry faces and no corrugator reactions at the controlled level of processing. These inverted smiling reactions at the controlled level may be interpreted as an emotion regulation strategy that may help the dismissing-avoidant subjects to avoid negative emotions and to keep their positive image of themselves and their attitude of autonomy and self-reliance.

As predicted from attachment theory individuals with a dismissing-avoidant pattern of attachment scored significantly lower than non-avoidant subjects on the QMEE scale. One prerequisite for emotional empathy may be that normal distress reactions in social interaction situations are not made inaccessible to consciousness. Negative model-of-self subjects scored, somewhat unexpectedly, significantly higher on the QMEE scale compared to individuals with a positive model-of-self. Negative model-of-self subjects were also characterised by mimicking at the controlled level of processing, especially pronounced for the corrugator muscles. A possible explanation of the negative-model-of-self subjects' higher level of emotional empathy may be that the QMEE scale is primarily measuring tendencies to be emotionally distressed by another person’s distress.

In line with Fraleys and Waller's model of attachment and Basch's view on the empathy process, our way of relating to others may be described as a result of a process starting with a primitive form of emotional contagion, which at more elaborated processing levels interacts with more cognitively controlled operations. Fraley and Waller propose that the affect-laden model-of-self, that has been found to correlate with the Neuroticism factor, influences the first part of the process. Model-of-others, that has been found to correlate with the Extraversion factor, is hypothesised to be of a more cognitive character, that operates at later stages of the process. The differences between the empathy groups in the present studies emerged already at the automatic level, a result that may be interpreted as influenced by differences in their tendencies to primitive negative emotional contagion (anxiety). The next step may be described as a result of differences in their emotion regulation strategies, related to their model-of-self. A prerequisite for empathy may be that apprehensive reactions to others' distress are not made inaccessible to consciousness, an emotion regulation strategy characteristic of the low-empathic dismissing-avoidant subjects in the present studies. The final step could be described as an intentional process, related to model-of-others, that may result in either approach or avoidance of the other person. In the present studies no relation was found between the emotional facial reactions and model-of-others.

The designs used in the present studies with a process perspective on personality and emotional communication has less often been applied in psychophysiological research. The results may be regarded as a base for fruitful future research rather than confirmations of the hypotheses.

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