VISUAL DISCRIMINATION OF FACIAL EXPRESSIONS OF EMOTION

by

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B.A., Simon Fraser University, 1993

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
in
PSYCHOLOGY

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THE UNIVERSITY OF NORTHERN BRITISH COLUMBIA

June 1998

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ABSTRACT

A habituation paradigm was employed to examine the theoretical nature of facial processing. Three specific issues were addressed. It may be possible to infer the double dissociation and relative salience of facial identity versus facial expressions of emotion (FEE's). A habituation paradigm may also be used to examine three hypotheses regarding the nature of FEE processing; it may be configural (Etoff & Magee, 1992), featural (Yamada, Matsuda, Watari & Suenaga, 1993), or a combination of both, depending upon the particular FEE (Kiriti & Endo, 1995; McKelvie, 1994). Third, the role of priming in FEE processing was examined. Skin conductance responses (SCR’s) were recorded while subjects (N=107) watched video tapes of four actors performing FEE’s. Changes in identity and expression were manipulated independently. Increases in SCR were reliable indicators of stimulus presentation or change, while decreases in SCR were reliable indicators of habituation to stimulus repetition. Results showed that changes in both identity and FEE produced magnitudes of response recovery that were significantly different from zero, demonstrating stimulus specificity. Results indicated no significant differences between their respective magnitudes; both changes appeared to be equally salient to subjects. When the magnitudes of response recovery to changes in FEE’s were examined alone, results did not produce strong evidence in favour of any of the hypotheses of FEE processing. However, there is evidence to suggest that priming may play a role in response recovery and habituation to FEE’s. This study showed that the use of a habituation paradigm has utility in the study of facial processing, although more research is required.
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ACKNOWLEDGEMENTS

I gratefully acknowledge the invaluable input of my committee in the conception and completion of this thesis. Primarily, I would like to thank my supervisor and fearless leader, Glenda Prkachin, for her ever present support and friendship along every stage of this thesis, as well as her endurance of hours of frustration in the video editing lab. I would also like to thank Ken Prkachin, who magnanimously donated hours of his busy schedule, including weekends, not only to serve as a stimulus model and improve my mastery of the data acquisition system, but also to educate me on the finer nuances of psychophysiological measurement. I would also like to extend my gratitude to Bruno Zumbo for his enthusiasm, counsel, and support over the years.

I am greatly indebted to many of my fellow students who volunteered their time and advice over the course of this thesis. Special appreciation goes to Jeremy Anderson and Liz Rocha who so unselfishly and unselfconsciously agreed to pose as stimulus models. I would also like to thank all those who helped with subject recruitment, all who volunteered their time to participate just because they were nice, and the people who showed up at their scheduled time. To all my friends, I give special thanks. For their unparallelled friendship and advocacy, I owe them my sanity.

I would like to thank my family, who continued to support my studies even if it was at their expense (literally). Their belief in my aspirations has been one the principal motivators in my academic pursuits. To all those friends and family who suffered at the expense of my ambitions and still liked me anyway, I thank them for their patience. Finally, I would like to recognize the unfailing companionship and unconditional positive regard of Hillary L. Edmond, the finest sentient in the known universe.
CHAPTER ONE

Visual discrimination of facial expressions of emotion in adults

The visual scene is complex; therefore, the visual system must attend to or select objects for further analysis (Walsh & Perrett, 1994). The human face is a highly complex and salient stimulus, conveying many types of information that are critical to social behaviour (Adolphs, Tranel, Damasio & Damasio, 1994). The ability to detect and discriminate between different individuals and different facial displays has significant implications for intrapersonal and interpersonal functioning. For example, one of the deficits found in schizophrenia is an inability to extract information from faces (Archer, Hay, & Young, 1994). It is not surprising, then, that the visual pattern of faces is highly salient and has strong control over pathways that direct attention and gaze (Walsh & Perrett, 1994). The salience of faces was further demonstrated by Roskos-Ewoldson and Fazio (1992), who found that the presence of facial stimuli in locations that should have been ignored actually attracted attention away from target locations and target processing.

Given the importance of facial expression in social behaviour, people are predisposed to respond adaptively to facial expressions of emotion (Dimberg, 1982). Facial affect is an important factor in the attribution of emotional states in others (Fernandez-Dols, Wallbott, & Sanchez, 1991). Facial displays of affect are postulated to have developed over the course of evolution (Fernandez-Dols, Wallbott, & Sanchez, 1991). As a result, they are thought to evoke both emotional and physiological reactions in a perceiver (Dimberg, 1982).

Various lines of evidence suggest that humans and other primates have genetically predetermined mechanisms, or are “hardwired”, for the detection of facial expression.
Developmental literature shows that very young infants can discriminate between different faces and facial expressions (Serrano, Iglesias & Loeches, 1992). Cross-cultural research has shown agreement in the interpretation and production of facial expressions of the basic emotions of fear, happiness, anger, surprise, disgust and sadness across both literate and preliterate cultures (see Ekman & Oster, 1982). The evolutionary relevance and universality of basic facial expressions suggest that we may have a specialized perceptual system that is tuned to the particular combinations of facial movements that signal facial affect. Neurophysiological evidence has shown that there are neurons in temporal cortex that code selectively for biologically meaningful stimuli, including faces (Desimone, 1991).

Positron Emission Tomography (PET) studies of facial perception have shown that large areas of the cortex are activated during the processing of faces (Sergent, Ohta & MacDonald, 1992). Therefore, face processing is widely distributed in the brain. Neuroanatomical evidence has shown that different populations of neurons in the temporal lobe respond selectively to biologically meaningful stimuli, such as hands, faces, body movement, and the perception of social signals, for example, facial affect and gaze direction (Walsh & Perrett, 1994).

Two important types of information co-occur in a face. Static information conveys information about a person's identity, where the configuration of features provides important perceptual information for face recognition (Baenninger, 1994). Therefore, identity recognition involves the extraction, from a general configuration common to all faces, of the particularities that make a face unique (Sergent, Ohta, & MacDonald, 1992). The dynamic relationships between facial features convey information about another individual's emotional state (i.e., facial expressions of emotion) and direction of attention (i.e., direction of gaze). Hence, the perception
Discrimination of Facial Expression

of emotional expression depends on configural properties that reflect changing spatial relationships among the features (McKelvie, 1994). Although a single facial component may provide a clue to a particular facial expression of emotion, the perception of facial affect is dependent upon interaction among the moving internal features of the face.

Adolphs, Tranel, Damasio, & Damasio (1994) reported a double dissociation between the processing of facial identity and facial affect, suggesting that the two are subserved by two anatomically separable neural systems. Evidence also suggests that facial expression and identity are coded by separate populations of cells in the monkey (Desimone, 1991). While identity appears to be coded by neurons in the inferior temporal gyrus, facial expression is coded by neurons in the superior temporal sulcus (STS) (Desimone, 1991). In addition to the processing of facial affect, cells in the STS also appear to code for gaze direction and eye position, two powerful cues for detecting the direction of another’s attention (Harries & Perrett, 1991). Neurons in STS do not appear to be involved in the processing of identity in humans (Sergent, Ohta & MacDonald, 1992).

Similarly, behavioural evidence suggests that the processing of identity is independent from the processing of facial expression of emotion (FEE). Hanaya (1992) found that the information used in processing FEE’s is different from the information used in individual identification, the former being more configural while the latter is more featural. Adaptation research also provides a behavioural demonstration that is consistent with the physiological findings of neurons that respond selectively to facial expressions of emotion. Prkachin and Prkachin (1994) showed that adaptation was selective to the particular FEE that was exposed, and was independent of the individual face on which the expression occurred. The fact that
adaptation did occur for most of the FEE's suggests that different populations of neurons in STS code for the different FEE's. Therefore, the processing of facial expression of emotion and the processing of facial identity appear to be separate, parallel processes.

**Perception of Facial Affect: Configural or Featural Processing?**

According to White (1995), the detection of faces can be conceptualized as being the result of two distinct processes. The preattentive process begins with the visual field being scanned in parallel for biologically relevant features (configural processing) which are then integrated to form representations of the face. Integration is thought to be a controlled, resource-limited and serial process (featural processing) that requires the application of focused attention (White, 1995). However, the degree to which integration occurs in the perception of facial affect is widely debated in the existing literature. Various expressions of emotion are thought to reflect differing spatial relationships among facial features (McKelvie, 1994). However, some disagreement exists among researchers as to how facial expression is processed by the human perceptual system. Little is known about the process for perceiving and recognizing facial affect: are all facial expressions processed in the same way, or does the mode of processing depend on a particular facial expression (Kirita & Endo, 1995)?

Three hypotheses of the processing of facial affect exist in the literature. The first hypothesis is that the perception of facial affect is a special process, not unlike speech perception, that is independent of the larger process of pattern perception (Desimone, 1991). In other words, facial affect is processed categorically (configurally) and facial emotion is perceived as discrete categories (see Ekman & Oster, 1982). This hypothesis is supported by the research of Etcoff and Magee (1992), who concluded that all basic facial expressions of emotion except
surprise (i.e., anger, disgust, sadness, happiness and fear) were perceived categorically. They concluded that continuous information contained in blends of emotional expression were transformed by the perceptual system into categorical information.

The second hypothesis of the processing of facial expressions of emotions is that faces are not treated differently by the visual system than other objects. According to this hypothesis, the visual system would give graded responses to blends of emotions, depending on the degree of displacement of facial features. Therefore, under this conception, the perception of facial affect is based upon an analytical or featural analysis. This perspective is congruent with the research conducted by Yamada, Matsuda, Watari and Suenaga (1993), who postulate that humans perceive emotion on the face by analyzing the displacement of feature points on the face.

The third hypothesis of processing of facial expressions of emotions is that facial expressions of emotion may be perceived either categorically or analytically, depending upon the particular facial expression to which the visual system is exposed. A possible determinant of mode of processing may be spatial frequency (Kirita & Endo, 1995). Low spatial frequencies are thought to be mediated by neurons with faster conduction velocities, whereas the information contained in high spatial frequencies is mediated by neurons with slower conduction velocities (Kirita & Endo, 1995). Therefore, facial expressions of emotion which contain many low frequency components are more likely to be processed configurally, and facial expressions of emotion which contain many high frequency components are more likely to be processed analytically.

This hypothesis is given some support by the literature, which suggests that an unevenness exists in the perception, discrimination, identification, and labeling of facial
expressions of emotion (Prkachin, unpublished). This suggests that we do not attend or respond in exactly the same way to all emotional expressions; the processes engaged by each emotional expression may be different. Kirita & Endo (1995) found that while happy faces appeared to be processed configurally, sad faces were processed analytically. Happy faces are recognized more quickly and accurately than any other facial expression (Ekman & Oster, 1982, Hanaya, 1994), followed by sadness (Ekman & Oster, 1982), while fear, surprise, anger and disgust are harder to detect (Prkachin & Prkachin, 1994) and discriminate (Ekman & Oster, 1982). McKelvie (1994) concluded that surprise and happiness were processed configurally, while anger, disgust, fear, and sadness were processed analytically (note that these conclusions are in almost direct opposition to the conclusions reached by Etcoff & Magee, 1992). An habituation paradigm may provide evidence in support of one of these hypothesis, unfortunately, no examples of this type of research with facial expressions of emotion with adults as subjects were found in the literature.

Rationale for Using Habituation in the Study of Facial Affect

Facial expressions of emotion are thought to evoke emotional reactions in the perceiver that have a biological basis (Dimberg, 1982). Electrodermal responses, a component of the orienting response in humans, have been shown to be sensitive to the facial expressions of happiness and anger (Dimberg, 1982, Esteves, Dimberg, & Ohman, 1994). The orienting response is believed to be associated with the reallocation of resources for the analysis of the stimulus (for example, unexpected, novel, or biologically relevant stimuli) (Esteves, Dimberg, & Ohman, 1994). According to Seligman (1970), biological evolution has predisposed organisms to more easily form associations between some stimuli rather than others. In other words, certain stimuli are predisposed to be more salient than others. Further, Ohman and Dimberg (1978)
postulate that the same mechanism that discriminates between facial expressions of emotion may also be involved in biologically preparing the organism to react appropriately to the particular facial expression. Therefore, there is theoretical reason to believe that a habituation paradigm is suitable for the study of facial identity and facial expressions of emotion.

Because a habituation paradigm only involves the detection and to some extent, the discrimination of facial affect, and does not involve the identification and labelling of facial expression, it is thought to share features with attention (as opposed to other cognitive processes such as memory and language) (Prkachin, unpublished). Because habituation paradigms may be used to examine stimulus salience, a determinant of attention, the use of a habituation paradigm to study faces seems appropriate. The principles of habituation will be discussed thoroughly in the subsequent sections.

**Principles of Habituation**

**The Orienting Response**

The orienting response (OR) is believed to be one of the most fundamental behavioural properties of living organisms (Sokolov, 1963). The OR is a characteristic pattern of physiological responses that are elicited by changes in the stimulus environment (Rockstroh et al., 1989), indicating arousal or a response to a stimulus (Stern, Ray & Davis, 1980). OR components are sensitive to stimulus novelty and stimulus change, and should habituate rapidly with stimulus repetition (Rockstroh et al., 1989). Changes in stimulus characteristics should enable response recovery or dishabituation, depending on whether the stimulus is changed or the original stimulus is re-presented (Rockstroh et al., 1989). Sokolov (1963) postulated that the functional significance of the OR is to increase “analyser sensitivity” which optimizes perceptual
processing by increasing the signal to noise ratio in active neurons and increasing the speed of
general nervous system processing. Active attentional processes are thought to be important in
the elicitation of the OR (Rockstroh et al., 1989).

The OR is a constellation of responses including decreased motor activity and increased
muscle tone, faster and lower voltage EEG (beta waves), peripheral vasoconstriction, increased
skin conductance and heart rate deceleration (Stern et al., 1980). However, heart rate may
accelerate rather than decelerate if the stimulus has startling or surprising characteristics
(Rockstroh et al., 1989). Dimberg (1984) showed that the presentation of happy and angry faces
both evoked cardiac deceleration and skin conductance, showing that OR components are
sensitive to facial expression. Elicitation of an OR is a sine qua non in an habituation paradigm,
for without an initial OR, habituation cannot be measured.

Habituation

Habituation is described as the diminution or cessation of responding that occurs to the
repeated presentation of the same stimulus (Stern et al., 1980). This stimulus-specific decline in
responding to repeated stimulation grow stronger as the number of repetitions increases (Kaplan,
Goldstein, Huckeby & Cooper, 1995). It is considered an elementary form of learning that is
simple, robust, and reliable (Rockstroh et al., 1989) and is thought to be universal in all
organisms (Petrinovich, 1973). If a stimulus elicits an OR, repeated presentation results in
decreased response strength over time (Petrinovich, 1973).

Rate of habituation is affected by the intensity of the stimulation, the uniqueness of the
stimulus, and its complexity (Stern et al., 1980). Habituation is also affected by the rate of
presentation of stimuli, and stimulus duration (Petrinovich, 1973; Stern et al., 1980). Any
stimulus that catches and keeps a subject's attention for one reason or another (i.e., intensity, surprise, salience, uniqueness) will inhibit habituation. It is only when a stimulus loses its distinctive meaning and becomes predictable that habituation occurs (Stern et al., 1980).

Habituation can have both intrinsic and extrinsic components (Davis & File, 1984). Intrinsic, habituation is habituation that occurs in local stimulus-response circuits of neurons (see Kandel, 1979, for review), whereas extrinsic habituation is dependent upon modulatory systems that influence response magnitude but do not actually elicit the responses (i.e., arousal, attention, motivation) (Davis & File, 1984). Therefore, habituation is influenced by both the extrinsic parameters of the stimulus and by intrinsic processes (Midgley & Tees, 1983).

**Dishabituation, Response Recovery, and Generalization**

An organism is said to discriminate between two stimuli if the behaviours that occur in the presence of the two stimuli differ in some measurable way (Heinemann & Chase, 1987). Dishabituation and response recovery are two important aspects of the habituation paradigm. After a series of identical stimuli have been presented and response levels are recorded, a new stimulus that differs along some dimension is presented. Dishabituation is a renewed response (an OR) that occurs after a stimulus is presented, habituated, withheld, and re-presented (Petrinovich, 1973, Kaplan et al, 1995). Response recovery is renewed responding that occurs when a novel stimulus occurs after a habituated stimulus (Petrinovich, 1973, Kaplan et al, 1995). The response recovery (the OR) to the new stimulus will itself habituate over time (Petrinovich, 1973).

Response recovery is an important part of any habituation paradigm, in that it allows the researcher to examine stimulus generalization or stimulus specificity. Stimulus specificity is
signified by a reinstatement of a response when a different stimulus is presented. This may occur because the new stimulus elicits the same response as the first stimulus, but does not share the same synapses used by the habituating stimulus (Davis & File, 1984). Conversely, stimulus generalization is seen when repetition of one stimulus leads to a decrease in the response to the second stimulus. This is thought to occur if the two stimulus pathways share some habituating synapses; the greater the sharing, the greater the generalization (Davis & File, 1984).

Generalization is the opposite or inverse of discrimination and is dependent upon the degree to which stimuli differ in their physical properties (i.e., the number of elements that the stimuli have in common) (Heinemann & Chase, 1987). Therefore, the change in the level of response would indicate the similarity of the new stimulus to the previous stimulus, a very different stimulus will elicit large response recovery, while a similar stimulus should elicit a small recovery response (Peeke & Petrinovich, 1984). The degree of response recovery is a direct function of the perceived amount of stimulus change (Graham, 1973).

**Habituation and Stimulus Salience**

The habituation paradigm allows researchers to examine the influence of stimulus factors on response variables (Midgely & Tees, 1983). Therefore, it is possible to determine which properties of a visual stimulus (in this case, the face) are important determinants of salience for normal human subjects because the rate at which orienting can be elicited, the magnitude of response recovery, and the rate of habituation of the response can be used as an index of salience (Midgely, Wilkie, & Tees, 1988). In other words, the effect of stimulus manipulation can be assessed in two ways. With one method, the magnitude of response recovery after stimulus change can be examined. If an orienting response recovers when a stimulus FEE changes, it can
be concluded that attention may have been directed at the FEE. Conversely, if an OR does not recover when stimulus identity changes, it is possible to conclude that attention was not directed at identity but may have been directed to FEE. Stimuli can be compared in terms of their respective rates of habituation, a slower rate of habituation implying that more attention has been directed to the stimulus while a faster rate would imply less attention. Hence, a habituation paradigm enables the researcher to assess the importance of particular stimulus characteristics in eliciting an orienting response (Midgely & Tees, 1981).

Habituation of the Skin Conductance Response

Habituation of autonomic responses are common measures of attention in humans. Autonomic responses are reliable indicators of the habituation process (Stern et al., 1980). One of the most reliable and most commonly used autonomic responses is skin conductance (Graham, 1973). The skin conductance response (SCR) reliably depicts an OR one to six seconds after stimulus onset (Barry, Feldmann, Gordon, & Cocker, 1993) and habituates rapidly, with the greatest decrement occurring between trials 1 and 23, an asymptotic level being reached between 3-20 trials depending on stimulus parameters (Graham, 1973). Of all of the autonomic responses, SCR is one of the most rapidly habituating responses (Graham, 1973).

Theories of Habituation

Three distinct theories of habituation exist. Sokolov's (1963) mismatch theory of habituation postulates that changes in response during habituation are due to inhibition only. However, this theory could not explain the presence of the initial OR. A second theory of habituation is that of Groves and Thompson (1970). In their dual-process theory, Groves and Thompson (1970) extended Sokolov's ideas beyond the idea of inhibition of response to include
sensitization. In their model, habituation and sensitization work in concert to produce changes in response magnitude that are characteristic of habituation. These two models are the most commonly cited in current literature. Unfortunately, neither model can explain why omission of a stimulus produces an OR.

The third theory proposes that habituation may be due to priming (Siddle, 1985). Priming refers to the extent to which a stimulus is pre-represented in short term memory (Siddle & Spinks, 1992). Priming is thought to occur by either prior presentation of the stimulus, or by the presentation of highly associated cues (Siddle & Spinks, 1992). Unprimed stimuli are postulated to be processed more elaborately than primed events (Siddle & Spinks, 1992). According to this theory, the iterated stimulation that is the hallmark of a habituation paradigm leads to progressively more effective priming, less processing of the stimulus, and consequently, to smaller and smaller responses (Siddle & Spinks, 1992). According to this model, the orienting response reflects anticipated information processing requirements (Siddle & Spinks, 1992).

However, priming can also be associatively generated, where the presentation of one stimulus may lead to the anticipation of another stimulus (Siddle & Spinks, 1992). Because faces are biologically relevant stimuli and many FEE’s naturally cooccur both within individuals and between individuals (i.e. fear and/or happiness often follow surprise, anger in one actor may evoke fear in another, etc.), it is possible that the presentation of one FEE may lead to the anticipation of presentation of a second FEE with which it is highly associated. In this condition, an orienting response should not be expected for the second FEE. Therefore, unexpected combinations of stimuli may evoke larger response recovery than expected combinations. This possibility, although predicted by the Siddle and Spinks (1992) model, has never been examined
Overview of the Present Study

This study used skin conductance to examine habituation to facial identity and the six basic facial emotions of expression (see Ekman & Friesen, 1975) in adult subjects. The primary purpose of this study was to examine the viability of using a habituation paradigm in the study of faces and facial expression. After being presented with one model performing a particular facial expression of emotion, subjects must either a) generalize recognition to a new example of the same expressive category (same expression, different model) or b) generalize recognition to a new example of the same identity (different expression, same model). Given that a habituation paradigm employing skin conductance as the dependent variable has the sensitivity to detect changes in facial identity and facial expression, this design should enable the researcher to look at the effects of changing facial identity and facial affect independently, enabling the comparison of the relative salience of each. If skin conductance responses are an index of discrimination, this paradigm can then be used to infer the nature of facial processing.

Most studies of facial expression have relied on still photographs for stimuli (see Ekman & Oster, 1982), these stimuli are radically different from the dynamic nature of facial affect outside of the laboratory (Archer, Hay & Young, 1994). The detection and analysis of motion is one of the fundamental tasks of vision; practically everything of interest in the visual world moves (Moshvon & Newsome, 1992). The importance of movement in the direction of attention is heightened by the finding that neurons in a cortical visual area (V4), which are known to be sensitive to movement, appear to mediate the direction of attention in the macaque (Walsh & Perrett, 1994). The movement of internal facial features is not important for identity recognition,
however, feature movement is important for the analysis of facial expressions of emotion. While the processing of facial identity is based upon static information, Hebb (1946) argued that the recognition of facial affect is the classification of a deviation from a baseline of behaviour. It is possible that emotion may be processed by motion sensitive mechanisms and may depend on an internalized or remembered representation of optic flow due to the movement of internal facial features (Huang, Burt & Mase, 1993). Moving faces should serve as more naturalistic stimuli. For all these reasons, video-taped moving facial stimuli were used for the present study.

**Habituation and the Perception of Facial Expressions of Emotion**

A habituation paradigm may aid in examining the nature of the perception of different facial expressions of emotion. Given the three possible hypotheses of facial affect processing, it is possible to make some tentative predictions. If the perception of facial affect is configural, then response recovery should be seen for every change in expression (holding identity constant). A possible exception to this may be pairings involving surprise (see Etcoff & Magee, 1992).

If the perception of facial affect is featural, some generalization should be seen between changes in facial expression dependent upon the degree of similarity of displacement of features. Yamada, Matsuda, Watari, and Suenaga (1993) examined the displacement of sixteen feature points in reference to nine predetermined displacement parameters. They found that surprise and fear were similar in terms of displacement, as were anger, disgust and sadness. Therefore, if the perception of facial expressions of emotion is featural, one would expect some generalization between fear and surprise, and possible pairings of anger, disgust, and sadness.

If facial expressions of emotions are perceived both categorically and analytically, depending upon the particular facial expression to which the visual system is exposed, results are
more difficult to predict. Given the advantage for detecting, identifying and labeling happy faces (Kirita & Endo, 1995) happy faces appear to be processed configurally. Therefore, it would be expected that any facial expression paired with happiness, in any order, will produce response recovery. Sad faces are thought to be processed analytically (Kirita & Endo, 1995), therefore, some generalization should be expected between sad faces and faces similar in terms of displacement, such as fear and anger. McKelvie (1994) concluded that surprise and happiness were processed configurally, while anger, disgust, fear, and sadness were processed analytically. Therefore, it would be expected that any facial expression paired with happiness or surprise, in any order, will produce response recovery. Furthermore, some generalization is expected between all possible combinations of anger, disgust, fear and sadness.

Another source of predictions is the errors commonly made in identifying and labelling facial expressions of emotion. Research has shown that anger and disgust are the most difficult emotions to detect (Prkachin & Prkachin, 1994) and are most often confused with each other (Ekman & Friesen, 1975, Ekman & Oster, 1982, McKelvie, 1994). Fear and surprise are also often confused (Ekman & Friesen, 1975, Ekman & Oster, 1982, McKelvie, 1994). Therefore, it is reasonable to expect response generalization between fear/surprise, surprise/fear, anger/disgust, and disgust/anger combinations of facial expressions.

If habituation is also due to priming (Siddle, 1985), other predictions are possible. There may be priming effects due to order of stimulus presentation, especially because faces are biologically relevant stimuli and many FEE’s naturally co-occur both within individuals and between individuals (i.e. fear and/or happiness often follow surprise, anger in one actor may evoke fear in another, etc.). Therefore, unexpected combinations of stimuli may evoke larger
To the author's knowledge, only one study has been published which used a habituation paradigm to examine the discrimination and recognition of facial expressions. Serrano, Iglesias, and Loeches (1992) used habituation, with visual fixation durations as the dependent variable, to examine the responses of four to six month old infants to anger, fear, and surprise. They found that infants paid more attention to expressions of anger and surprise than fear, suggesting that these two expressions are more salient to infants than fear. However, it is unlikely that these results will be replicated for adults, as adults should have considerably more experience than infants have with fear-inducing situations and fear expressions.

Serrano, Iglesias, and Loeches (1992) also found that all stimulus pairings, except for fear followed by surprise (five out of six possible pairings), showed response recovery. It is possible that this result may be replicated in this study. However, the attempt to generalize from studies on infants to adults is guarded. In addition to this, Serrano, Iglesias, and Loeches only used three of the six basic facial expressions of emotion. Unfortunately, to date, no research of this kind appears to have been conducted with human adults.
CHAPTER TWO

Method

Stimulus Collection

Four models, 2 females and 2 males, were used to generate the facial stimuli used in this study. One female model was a 29 year old Asian/Caucasian, the other female model was a 24 year old fair-haired Caucasian. One male model was a middle-aged, dark-haired Caucasian, the other male model was a 23 year old fair-haired Caucasian. All models were familiar with the Facial Action Coding System (FACS) (see Ekman & Friesen, 1978) and all were familiar with Ekman & Friesen’s (1975) descriptions of the six basic facial expressions of emotion. Because it was my desire to have the stimulus identities as disparate as possible, and because both race and gender are major factors in determining identity (Yamaguchi, Hirukawa, & Kanazawa, 1995), these four models were chosen. Neither model wore any identifying clothing, jewellery, make-up or corrective lenses because paraphernalia may distract subjects from the internal, endogenous information in the stimulus faces (Baenninger, 1994).

The models were videotaped at a fixed distance (approximately 1.5 m), so that only the head, neck and part of the shoulders were visible on the video monitor. Models were seated during video-taping to minimize body movement. The models were videotaped simulating the six basic facial emotional expressions (FEE’s) of happiness, fear, surprise, anger, sadness, and disgust as described in Ekman and Friesen (1975). A metronome was used to aid the models in synchronizing the rise time of the expression. Some experimentation was necessary in order to determine which metronome setting produced the most natural expressions. After piloting, a setting of 75 beats per minute was chosen. The models performed several examples of each of
the six emotions, so that at least five or six expressions which were synchronized with the metronome and contained the appropriate feature changes (AU’s) were available for editing to produce the final videotaped stimuli.

The experimenter (who is FACS proficient and familiar with the work of Ekman & Friesen) chose a “prototypical” expression for each model and each expression. The most prototypical FEE for each of the six emotions (for each model) were selected for test stimuli, yielding a total of twenty-four final stimuli (i.e., six emotions for each model). Appropriate expressions had onsets that were synchronized to the metronome (75 beats per minute), and that had no extraneous eye, head, or body movements, in addition to all the appropriate AU’s for the prototype. Each FEE was exactly 1.0 seconds in duration. These expressions were FACS coded independently by two different FACS certified coders to ensure that all appropriate AU’s were present and that AU’s were roughly the same intensity.

The twenty-four stimuli were used to make up the final stimulus tapes which consisted of stimulus triads. Each triad contained both a change in identity and a change in FEE, each independent of the other. Because of the nature of the stimulus triads, three possible order effects were possible. The first was order of presentation of FEE. This was examined as a within subjects variable. Therefore, all possible pairings of FEE’s, in all possible orders (30 pairs in total) were represented in this study. The second possible order effect, the order of stimulus change (identity vs. expression) and the third possible order effect, the order of presentation of stimulus gender, were not examined in this study due to time and subject constraints. Therefore, all subjects had the identity of the stimulus changed first, followed by the change in expression.
Ideally, another group of subjects would have the expression of the stimulus changed first, followed by a change in identity (i.e., $H_1F_1F_2$), however this was not feasible for this study. Therefore, the stimuli were repeated sequences of three stimuli (two different FEE's and two different identities, each manipulated independently)(see Table 1).

Table 1.

**Example of stimulus groups**

<table>
<thead>
<tr>
<th>Order of stimulus change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GROUP 1</strong></td>
</tr>
<tr>
<td>Order 1</td>
</tr>
<tr>
<td>H1H2A2</td>
</tr>
<tr>
<td>H1H3D3</td>
</tr>
<tr>
<td>H1H4F4</td>
</tr>
<tr>
<td>H2H3Sa3</td>
</tr>
<tr>
<td>H2H4Su4</td>
</tr>
<tr>
<td>A3A4D4</td>
</tr>
<tr>
<td>Order 2</td>
</tr>
<tr>
<td>A3A4D4</td>
</tr>
<tr>
<td>H2H4Su4</td>
</tr>
<tr>
<td>H2H3Sa3</td>
</tr>
<tr>
<td>H1H4F4</td>
</tr>
<tr>
<td>H1H3D3</td>
</tr>
<tr>
<td>H1H2A2</td>
</tr>
</tbody>
</table>

**Note.** This table shows an example of the groups utilized in this study. Each group contained six unique combinations of identity, and together represent the 30 possible combinations of facial expression. This table serves only for illustrative purposes, the triads in each group and their order were determined randomly for the actual test phase.

1 = identity 1, 2 = identity 2, 3 = identity 3, 4 = identity 4.

H = Happy FEE, Sa = Sad, Su = Surprise, A = Anger, F = Fear, D = Disgust.

---

1 Where 1 = identity 1 and 2 = identity 2, H = happy FEE, and F = fear FEE
Five video tapes were made for the study, each containing six randomly chosen triads of the 30 possible stimulus triads. This was done in order to reduce fatigue or boredom on the part of the subjects. During the pilot phase of this study, it was discovered that subjects appeared to quickly become bored. This boredom severely attenuated the orienting responses observed in the latter part of the pilot test. By reducing the number of triads to which each subject must be exposed, it was hoped that boredom would not be a factor in this study. On each of the five tapes, the stimulus triads were presented in two orders. In the first presentation, the six stimulus triads were presented in a predetermined random order. In the second possible presentation, the six stimulus triad were presented in the reverse order. By doing this, it was hoped that any spurious effects caused by novelty, boredom, and/or fatigue would be controlled.

The stimulus triads were arranged on videotape with video editing equipment (FAST-IVM Studio). As mentioned earlier, the stimuli were repeated sequences of three FEE’s. Each FEE included the sequence of facial movements from onset to the completion of muscle movements for the expression (the peak). Habituation is sensitive to stimulus duration (Petrinovich, 1973) with longer durations showing faster habituation than shorter durations. A one second duration (from FEE onset to peak) was used to facilitate the synchronisation of data collection to the video-taped stimuli.

Each FEE in a stimulus triad was repeated without interruption. Dimberg (1982) reported habituation of skin conductance (SCR) and heart rate (HR) to happy and angry faces after 8 seconds. The number of trials (stimulus repetitions) necessary for habituation was tested in a pilot study. Habituation was observed to begin after six seconds (maximum) and was complete
by ten seconds. Therefore, about ten repetitions of each stimulus were necessary to ensure habituation. The three stimuli in each triad were presented back to back so that the interstimulus interval was zero. The stimulus triads themselves were separated by a ten second interval (determined through piloting). Video editing was used to ensure that there were no abrupt stimulus changes (both within and between trials), so that any observed changes in the subjects’ responses could be attributed to the facial stimuli themselves and were not the effect of stimulus change per se. An 80dB 440 Hz auditory startle stimulus was inserted ten seconds after the final stimulus presentation, in order to obtain a maximal response for the calculation of an autonomic lability scores (range corrected scores) for each subject.

Subjects and Research Design

Subjects included equal numbers of males and females who were further divided into five groups. In each group, subjects were habituated to a model performing one of the six basic FEE’s, then tested and habituated to another model performing the same FEE (change in identity holding expression constant), then tested and habituated to second model performing the different FEE (change in expression holding identity constant). Because subject gender may be a factor in autonomic reactivity, gender was also included as a factor in data analysis.

Effect sizes were estimated from Dimberg’s (1982) study of skin conductance and heart rate and were within the large range according to Cohen’s (1992) criteria. Given that the estimated effect size was large, a minimum total of 26 subjects per group (13 males, 13 females), yielding a total sample of 104 was estimated to be required to detect a significant effect at the .05 level of significance and 80% power (Cohen, 1992). These power calculations were based upon responses to stationary stimuli and therefore, may have underestimated the effect sizes for SCR.
The use of motion should enhance the salience of the stimuli which should not only enhance the magnitude of response recovery and prolong habituation, but also reduce variability between subjects. Therefore, it seemed likely that a smaller number of subjects per group would still yield enough power to detect a significant effect at the .05 level of significance.

Based on the power analysis, approximately twenty subjects (equal numbers of males and females) were represented in each group. Half of the subjects in one group (approximately 5 males, 5 females) received the stimuli in a randomly predetermined order, while the other half received the stimuli in the reverse order.

Subjects (N=107, 18-68 years old, mean age = 24.1, males =50, females = 57) were recruited from the university population at the University of Northern British Columbia on a voluntary basis and some received course credit for their participation. The first group viewed Tape 1 and consisted of 10 males and 12 females with a mean age of 23.0. The second group of subjects (Tape 2) consisted of 10 males and 11 females with a mean age of 22.7. The third group of subjects, Tape 3, consisted of 10 males and 12 females with a mean age of 28.3. The fourth group viewed Tape 4 and consisted of 10 males and 10 females with a mean age of 22.7. The final group (Tape 5) consisted of 10 males and 12 females with a mean age of 22.6.

Apparatus

Stimulus Delivery

The subjects were tested in the lab, with only the experimenter present. The stimulus tapes were presented on a 32 cm x 42 cm VCR monitor. The stimulus faces were approximately 23 x 18 cm, similar to the size of an adult human face (Serrano et al, 1992). The subjects were seated roughly 2.5 m away from the monitor, but were allowed to move the chair if it increased...
Collection of Skin Conductance Data

Skin conductance responses were measured with the MP100 Biopac Galvanic Skin Response transducer. A bipolar electrode placement was used, with the electrodes placed on the palmar side of the third phalanx of the first and third fingers of the right hand. Galvanic skin response data was collected at a rate of five samples per second and transformed into SCR by a MP100 WSW Biopac workstation combined with a microcomputer.

Procedure

The subjects were asked to read and sign a consent form and seated in front of the video monitor. The subjects were told that the aim of the experiment was to measure physiological reactions to different types of stimuli and that they would be exposed to pictures of human faces while their skin conductance was measured. Electrodes were then applied. The subjects were randomly assigned to one of the five tapes (one of two orders).

Once the subject was comfortable, the session ensued. The subjects were recorded for 5 minutes without any stimulus presentation in order to familiarize them with the lab and the recording equipment. This baseline period was followed by the test period which, as mentioned previously, contained six stimulus triads. Subjects were then debriefed and given course credit, if applicable.

Data reduction

Reactivity was assessed by using raw skin conductance scores to compute an autonomic lability score (relative skin conductance) for each raw value. This measure of relative skin conductance is computed by subtracting the smallest observed value (in the entire session) from
the raw value, and dividing by the largest value subtracted by the smallest value in accordance with the following formula:

\[
\text{autonomic lability} = \frac{\text{SCR at Time } x - \text{smallest observed value of SCR for entire session}}{\text{Largest value of SCR - smallest value of SCR (for entire session)}}.
\]

Autonomic lability scores were used instead of raw SCR scores because subject differed in their baseline SCR values and degree of reactivity. The use of relative skin conductance allowed for comparison of individual SCR values. The data were then averaged over one second blocks, so that each block corresponded to one stimulus presentation.

Upon visual inspection of the raw data, it was evident that there were individual subject differences in the rates at which orienting was elicited and the rates of habituation of responses. Rates of orientation and habituation were amenable to analysis via regression analysis, however, this method is not widely cited in the habituation literature and would have involved a minimum of 180 regressions (19,260 maximum). Given that this study was the first known study of this nature and was exploratory and descriptive in nature, this type of analysis did not seem justified.

Given that the primary purpose of this study was to establish the viability of a habituation paradigm, a simple and robust treatment of the data was necessary. Therefore, only the magnitudes of response recovery were examined.

**Scoring**

Following the conventions established by Siddle (1985), a response was scored as an OR if it was an increase from prestimulus values of at least 0.02 range-corrected units that occurred 1-6 seconds after stimulus onset. For example, Figure 1 shows the raw response of one subject to
the presentation of a sad face occurring at 70 seconds; an increase in conductance occurring roughly 2 seconds after the onset of the stimulus. The OR to this stimulus was the range-corrected value for the highest point on the response curve, occurring at approximately 72 seconds. If no responses in the raw data record met these criteria, the average SCR for the first six seconds after stimulus onset was used.
Figure 1. Sample raw response of one subject to presentations of a sad face.
Calculation of Change Scores

Change scores were computed as indices for response recovery and habituation. This was done in order to represent the data succinctly without compromising intelligibility. According to Kenny (1975), change score analysis is equivalent to the time by treatment interaction of repeated-measures analysis of variance which is the effect of interest in this study. Change scores should be unbiased, given that subjects are randomly assigned to the treatment groups (stimulus tapes, in this case) (Maxwell & Howard, 1981).

The computation of change scores is presented diagrammatically in Figure 2. Figure 2 shows the summary of selected responses for one subject. The first point in the data, marked “A”, denotes the initial presentation of the FEE disgust. Point B represents the orienting response to the initial presentation of the disgust FEE. Point C is the autonomic lability score at the tenth repetition of the disgust FEE. Presentation of another identity performing a disgust FEE occurred at 10 seconds (point not shown). Point D is the orienting response to the new identity. Point E, the response at the tenth repetition of the new identity, shows the decline in response magnitude after habituation to the new identity. The fear FEE performed by the same actor was presented at 20 seconds (point not shown). Point F is the OR to the change in FEE from disgust to fear, with the identity remaining constant, and point G is the autonomic lability score for the tenth repetition of the fear FEE (see Figure 2).
Initial Stimulus Presentation
(10 stimulus repetitions)

Change in Identity
(10 repetitions)

Change in Facial Expression
(10 stimulus repetitions)

Mean Autonomic Lability

Habituation = C-B
Orienting = B-A

Habituation = E-D
Orienting = D-C

Habituation = G-F
Orienting = F-E

0 - 0.9 sec
Identity 1
OR
9 - 9.9 sec
Identity 2
OR
19 - 19.9 sec
FEE 2
OR
29 - 29.9 sec

Figure 2.
Example of the calculation of change scores using the selected responses of one subject.
The first change score, an index to the magnitude of the response to the presentation of the first stimulus, was computed by subtracting the value for the first stimulus presentation from the OR of the first stimulus (point B-point A, see Fig. 2). A second change score was computed in order to index the magnitude of habituation to the first stimulus. This was done by subtracting the autonomic lability value for the final presentation of the stimulus from the OR for the first stimulus (C-B). Another change score was calculated to index the magnitude of response to the change in the identity of the stimulus. This was achieved by subtracting the autonomic lability value for the final presentation of the previous stimulus from the OR to the change in identity (D-C). Habituation to the change in identity was indexed by subtracting the OR for the second stimulus from the autonomic lability value for the final presentation of the second stimulus (E-D). Similarly, another change score, an index of the magnitude of the response to the change in the facial expression of the stimulus was computed by subtracting autonomic lability score for the final presentation of the previous stimulus from the OR to the change in FEE (F-E). Habituation to the change in identity was indexed by subtracting the OR for the change in FEE from the SCR value for the final presentation of the stimulus (G-F). Therefore, a positive change score would indicate that response recovery had occurred, while a negative change score would indicate that habituation had occurred.
Discrimination of Facial Expression

CHAPTER THREE

Results

All results are reported in terms of change scores in order to facilitate interpretation. It is important to note that all one sample t-tests (criterion = 0) conducted on these scores mirror the results of paired samples t-tests with the autonomic lability values used in their computation in terms of statistical significance. In other words, if two variables used to compute a change score were statistically different from each other, the change score computed from those variables was statistically different from zero.

Gender Comparisons

All thirty triads were examined for gender differences prior to subsequent analysis by subjecting all calculated changes scores to a one-way analysis of variance (ANOVA). Of the thirty triads, six contained significant gender differences. The triad; fear, fear, sadness showed significant differences in the magnitude of habituation to the first example of fear; \( F(1, 20) = 8.52, p = .01 \). Females showed greater habituation after ten stimulus presentations than males, (-0.10 vs. 0.07, respectively). The triad containing surprise, surprise, sadness showed significant gender differences in the magnitude of habituation to the change in FEE from surprise to sadness, \( F(1, 20) = 7.62, p = .01 \). Females (-0.06) showed greater habituation after ten presentations than males (.02). Females and males responded differentially to the change in identity from one male model to another in the anger, anger, fear triad, \( F(1,19) = 4.64, p = .04 \). Females had significantly larger responses to this change in identity than males (.11 vs. -.01, respectively). Another triad showing gender differences was the sadness, sadness, fear triad, where females showed less habituation to the initial presentations of
sadness than males, F(1,19) = 4.59, p = .05 (-.02 vs. -.08, respectively). In the triad containing happiness, happiness, disgust, females (.06) showed significantly larger responses to the change in FEE from happiness to disgust than males (.00), F(1,20) = 4.32, p = .05. The surprise, surprise, fear triad showed significant gender differences the magnitude of habituation to the change in identity from a male model to a female model, F(1,20) = 4.27, p = .05, where females showed greater habituation to the female model than males (-.08 vs. -.03, respectively).

Although gender differences were found in the data, they did not occur with enough frequency or consistency neither within triads, between triads, nor between subjects to be considered systematic. Additionally, Bonferroni-type corrections for type I error were not used to establish statistical significance in the previously mentioned comparisons, making any significant results extremely conservative indicators of gender differences. Hence, for the remainder of the results, responses for females and males were combined.

Planned Comparisons Within Stimulus Triads

Tables 2-6 show the summary of changes in autonomic lability for each group of subjects. Values represent the mean magnitude of response changes for orienting and habituation along the experimental time line (with standard error reported in brackets). All change scores were subjected to one sample t-tests with a criterion value of zero. As mentioned previously, subjects were grouped according to the stimulus tape to which they were exposed. All tables follow the same format. For example, table 2 shows the summary of changes in lability for subjects who were shown Tape 1 (N=22) (see Table 2).
### Table 2

**Mean Changes in autonomic lability (and Standard error (SE’s) of the mean): Stimulus tape 1 (N = 22)**

<table>
<thead>
<tr>
<th>Stimulus order within triad</th>
<th>Initial response *</th>
<th>Initial habituation</th>
<th>Response to change in identity</th>
<th>Habituation to change in identity</th>
<th>Response to change in FEE</th>
<th>Habituation to change in FEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>fear, fear, sad</td>
<td>.16* (.07)</td>
<td>-.02 (.03)</td>
<td>.02 (.01)</td>
<td>-.07** (.02)</td>
<td>.01 (.01)</td>
<td>-.02 (.02)</td>
</tr>
<tr>
<td>anger, anger, happy</td>
<td>.15* (.07)</td>
<td>-.05** (.01)</td>
<td>.07* (.03)</td>
<td>-.04** (.01)</td>
<td>.02 (.01)</td>
<td>-.03 (.01)</td>
</tr>
<tr>
<td>surprise, surprise, sad</td>
<td>.09 (.06)</td>
<td>-.07** (.02)</td>
<td>.03 (.01)</td>
<td>-.04** (.01)</td>
<td>.01 (.01)</td>
<td>-.02 (.02)</td>
</tr>
<tr>
<td>happy, happy, sad</td>
<td>-.01 (.09)</td>
<td>-.04** (.01)</td>
<td>.03 (.02)</td>
<td>-.05* (.02)</td>
<td>.01 (.01)</td>
<td>-.04* (.02)</td>
</tr>
<tr>
<td>surprise, surprise, anger</td>
<td>-.08 (.06)</td>
<td>-.03** (.01)</td>
<td>.02* (.01)</td>
<td>-.01 (.01)</td>
<td>.02 (.01)</td>
<td>-.03** (.01)</td>
</tr>
<tr>
<td>disgust, disgust, fear</td>
<td>-.04 (.07)</td>
<td>-.08** (.02)</td>
<td>.06* (.03)</td>
<td>-.06** (.02)</td>
<td>.05* (.02)</td>
<td>-.03* (.01)</td>
</tr>
</tbody>
</table>

*Note. Two tailed one sample t-tests, criterion = 0.*

*Response estimates are conservative; first second used as baseline for change scores.*

* $p \leq 0.05$. **$p \leq 0.01$. 
One half of the subjects who viewed Tape 1 received the stimulus triads in the order listed on Table 2; fear, fear, sadness; anger, anger, happiness; surprise, surprise, sadness; happiness, happiness, sadness; surprise, surprise, anger; and disgust, disgust, fear. The other half viewed the stimulus triads in the reverse order. Within triads, subjects viewed 10 presentations of one FEE, followed by ten presentations of another actor performing the same FEE, followed by ten presentations of the second actor performing another FEE. For example, given the first triad on Table 2; fear, fear, sadness, subjects first viewed 10, one second presentations of an actor performing a fearful FEE, then 10, one second presentations of another actor performing a fearful FEE, then ten, one second presentations of the same actor performing a sad FEE. Stimuli were presented in an identical manner in every triad. The triads themselves were separated by a 10 second interstimulus interval.

Continuing with the example triad; fear, fear, sadness, values were interpreted in the following manner. Subjects showed a significant response increase to the initial presentation of fear, followed by non-significant decrease in responding (habituation) to repeated presentations of fear, followed by a non-significant increase in responding (response recovery) to the change in identity, followed by significant habituation to repeated presentation of the new example of fear, followed by non-significant response recovery to the change in FEE from fear to sadness, followed by non-significant habituation to repeated presentation of the sad FEE.
Table 3

<table>
<thead>
<tr>
<th>Stimulus order within triad</th>
<th>Initial Response a</th>
<th>Initial Habituation</th>
<th>Response to change in identity</th>
<th>Habitation to change in identity</th>
<th>Response to change in FEE</th>
<th>Habitation to change in FEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>sad, sad, anger</td>
<td>.20**</td>
<td>-.08**</td>
<td>-.01</td>
<td>-.02</td>
<td>.04**</td>
<td>-.05**</td>
</tr>
<tr>
<td></td>
<td>(.07)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.02)</td>
</tr>
<tr>
<td>anger, anger, fear</td>
<td>.17*</td>
<td>-.09**</td>
<td>.06</td>
<td>-.03</td>
<td>.03*</td>
<td>-.05**</td>
</tr>
<tr>
<td></td>
<td>(.07)</td>
<td>(.03)</td>
<td>(.03)</td>
<td>(.03)</td>
<td>(.01)</td>
<td>(.02)</td>
</tr>
<tr>
<td>sad, sad, fear</td>
<td>.05</td>
<td>-.05**</td>
<td>.02</td>
<td>-.02</td>
<td>.06**</td>
<td>-.03</td>
</tr>
<tr>
<td></td>
<td>(.08)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.03)</td>
</tr>
<tr>
<td>anger, anger, surprise</td>
<td>.03</td>
<td>-.04*</td>
<td>.02*</td>
<td>-.04*</td>
<td>.02*</td>
<td>-.04**</td>
</tr>
<tr>
<td></td>
<td>(.09)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.01)</td>
</tr>
<tr>
<td>happy, happy, anger</td>
<td>-.09</td>
<td>-.03*</td>
<td>-.02</td>
<td>-.06**</td>
<td>.05*</td>
<td>-.06**</td>
</tr>
<tr>
<td></td>
<td>(.07)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.02)</td>
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<tr>
<td>surprise, surprise, disgust</td>
<td>-.01</td>
<td>-.03</td>
<td>.10*</td>
<td>-.04*</td>
<td>.03</td>
<td>-.04*</td>
</tr>
<tr>
<td></td>
<td>(.10)</td>
<td>(.02)</td>
<td>(.04)</td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.02)</td>
</tr>
</tbody>
</table>

Note. Two tailed one sample t-tests, criterion = 0.

a Response estimates are conservative; first second used as baseline for change scores.

* p \leq 0.05. **p \leq 0.01.
Table 4

Mean changes in autonomic lability (and standard error (SE’s) of the mean): Stimulus tape 3 (N = 22)

<table>
<thead>
<tr>
<th>Stimulus order within triad</th>
<th>Initial response</th>
<th>Initial habituation</th>
<th>Response to change in identity</th>
<th>Habituation to change in identity</th>
<th>Response to change in FEE</th>
<th>Habituation to change in FEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>anger, anger, sad</td>
<td>.10 (.09)</td>
<td>- .08** (.02)</td>
<td>.01 (.01)</td>
<td>-.06** (.02)</td>
<td>.01 (.01)</td>
<td>-.02 (.02)</td>
</tr>
<tr>
<td>sad, sad, happy</td>
<td>.02 (.07)</td>
<td>- .05** (.02)</td>
<td>.04* (.02)</td>
<td>-.04** (.02)</td>
<td>.01 (.01)</td>
<td>-.03 (.02)</td>
</tr>
<tr>
<td>happy, happy, disgust</td>
<td>-.02 (.05)</td>
<td>- .05** (.01)</td>
<td>-.02 (.03)</td>
<td>.00 (.02)</td>
<td>.03 (.02)</td>
<td>.03* (.01)</td>
</tr>
<tr>
<td>fear, fear, disgust</td>
<td>.02 (.08)</td>
<td>- .06** (.01)</td>
<td>-.03 (.01)</td>
<td>.03* (.02)</td>
<td>.01 (.01)</td>
<td>-.02 (.02)</td>
</tr>
<tr>
<td>surprise, surprise, fear</td>
<td>.26** (.07)</td>
<td>-.03 (.02)</td>
<td>.01 (.01)</td>
<td>-.06** (.01)</td>
<td>.01 (.01)</td>
<td>-.05** (.01)</td>
</tr>
<tr>
<td>sad, sad, surprise</td>
<td>.05 (.08)</td>
<td>- .07** (.02)</td>
<td>.07* (.03)</td>
<td>-.04** (.01)</td>
<td>.05** (.02)</td>
<td>-.03** (.01)</td>
</tr>
</tbody>
</table>

Note. Two tailed one sample t-tests, criterion = 0.

* Response estimates are conservative; first second used as baseline for change scores.
* p ≤ 0.05. **p ≤ 0.01.
### Table 5

Mean changes in autonomic lability (and standard error (SE's) of the mean): Stimulus tape 4 (N = 20)

<table>
<thead>
<tr>
<th>Stimulus order with triad</th>
<th>Initial Response</th>
<th>Initial Habituation</th>
<th>Response to change in identity</th>
<th>Habitation to change in identity</th>
<th>Response to change in FEE</th>
<th>Habitation to change in FEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>disgust, disgust, sad</td>
<td>.00</td>
<td>-.07**</td>
<td>.08**</td>
<td>-.11**</td>
<td>.05*</td>
<td>-.05**</td>
</tr>
<tr>
<td></td>
<td>(.07)</td>
<td>(.02)</td>
<td>(.03)</td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.01)</td>
</tr>
<tr>
<td>surprise, surprise, happy</td>
<td>.11</td>
<td>-.11**</td>
<td>.05*</td>
<td>-.06</td>
<td>.01</td>
<td>-.05**</td>
</tr>
<tr>
<td></td>
<td>(.07)</td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.03)</td>
<td>(.01)</td>
<td>(.02)</td>
</tr>
<tr>
<td>disgust, disgust, happy</td>
<td>-.01</td>
<td>-.12**</td>
<td>.05**</td>
<td>-.07**</td>
<td>.04*</td>
<td>-0.2</td>
</tr>
<tr>
<td></td>
<td>(.09)</td>
<td>(.03)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.02)</td>
</tr>
<tr>
<td>fear, fear, happy</td>
<td>.04</td>
<td>-.05*</td>
<td>.04*</td>
<td>-.06**</td>
<td>.02*</td>
<td>-0.2</td>
</tr>
<tr>
<td></td>
<td>(.10)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.01)</td>
</tr>
<tr>
<td>disgust, disgust, anger</td>
<td>-.04</td>
<td>-.04**</td>
<td>.03*</td>
<td>-.05**</td>
<td>.04*</td>
<td>-.05**</td>
</tr>
<tr>
<td></td>
<td>(.08)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.01)</td>
</tr>
<tr>
<td>fear, fear, anger</td>
<td>.01</td>
<td>-.06**</td>
<td>.04*</td>
<td>-.04*</td>
<td>.02*</td>
<td>-.03*</td>
</tr>
<tr>
<td></td>
<td>(.11)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.01)</td>
</tr>
</tbody>
</table>

Note. Two tailed one sample t-tests, criterion = 0.

*a Response estimates are conservative; first second used as baseline for change scores.

* p ≤ 0.05. **p ≤ 0.01.
Table 6

Mean changes in autonomic lability (and standard error (SE's) of the mean): Stimulus tape 5 (N = 22)

<table>
<thead>
<tr>
<th>Stimulus order with triad</th>
<th>Initial Response</th>
<th>Initial Habituation</th>
<th>Response to change in identity</th>
<th>Habituation to change in identity</th>
<th>Response to change in FEE</th>
<th>Habituation to change in FEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>fear, fear, surprise</td>
<td>.08 (0.08)</td>
<td>-.06** (0.02)</td>
<td>.04 (0.02)</td>
<td>-.08** (0.01)</td>
<td>.02 (0.01)</td>
<td>-.05** (0.02)</td>
</tr>
<tr>
<td>sad, sad, disgust</td>
<td>.03 (0.07)</td>
<td>-.05** (0.02)</td>
<td>.05** (0.02)</td>
<td>-.05** (0.01)</td>
<td>.02 (0.01)</td>
<td>-.03 (0.03)</td>
</tr>
<tr>
<td>happy, happy, fear</td>
<td>.03 (0.08)</td>
<td>-.04 (0.02)</td>
<td>.02 (0.01)</td>
<td>-.05** (0.02)</td>
<td>.03* (0.01)</td>
<td>-.04** (0.01)</td>
</tr>
<tr>
<td>disgust, disgust, surprise</td>
<td>.08 (0.06)</td>
<td>-.04** (0.01)</td>
<td>.02 (0.01)</td>
<td>-.04** (0.02)</td>
<td>.02 (0.01)</td>
<td>-.05* (0.02)</td>
</tr>
<tr>
<td>anger, anger, disgust</td>
<td>.03 (0.07)</td>
<td>-.05** (0.02)</td>
<td>.03 (0.01)</td>
<td>-.01 (0.02)</td>
<td>.01 (0.01)</td>
<td>-.06** (0.01)</td>
</tr>
<tr>
<td>happy, happy, surprise</td>
<td>.15 (0.09)</td>
<td>-.11** (0.03)</td>
<td>.01 (0.01)</td>
<td>-.01 (0.02)</td>
<td>.09** (0.03)</td>
<td>-.05** (0.02)</td>
</tr>
</tbody>
</table>

Note. Two tailed one sample t-tests, criterion = 0.

* Response estimates are conservative; first second used as baseline for change scores.
* *p = 0.05. **p = 0.01.
The most salient feature of Tables 2-6 is that all of the thirty triads contain at least two significant response changes in the predicted direction. Therefore, there is sufficient evidence to conclude that the observed response changes were stimulus-linked, namely that increases in SCR were indicators of orienting to initial stimulus presentation or change, and decreases in SCR were indicators of habituation to repeated stimulus presentation. However, statistically significant response changes were not reliably observed for all stimulus changes, suggesting an unevenness in orienting and habituation to facial expressions of emotion; we do not attend or respond in exactly the same way to all emotional expressions (see Tables 2-6). In order to further examine this asymmetry, the changes to facial identity and facial expression were examined separately.

There are two points to note upon closer inspection of Tables 2-6. First, all of the one sample t-tests performed on the change scores were two-tailed, despite the fact that the hypotheses for the direction of orienting and habituation would have allowed for one-tailed tests. Hence, estimates of significance are conservative. Second, ideal baseline values were not used to estimate the initial responses to the first stimulus presentation and given estimates for this initial response may underestimate the actual values. Because both of these observations may result in type II errors, it is possible that potentially significant response changes were overlooked in this analysis.

To increase comprehension, changes in identity were segregated according to the FEE which stayed constant during the identity change. Of the five triads where identity changed while happiness was constant, no significant response recovery to the change in identity was observed. On the five occasions that identity changed while sadness remained constant,
significant response recovery to identity change occurred three times. When identity changed while anger stayed constant, significant response recovery to the change in identity was observed in two of five occurrences. Significant response recovery to the change in identity occurred in three of five triads when surprise remained constant during the change in identity. Significant response recovery to the change in identity was witnessed in four of five triads when identity changed while disgust remained constant.

Responses to changes in facial expression while identity remained constant were more complex. Table 7 shows the responses to changes in facial expression reported in Tables 2 - 6 compared by emotion presented first, and the emotion presented second. Three major observations are worthy of mention. First, no significant response recovery to the change in FEE was observed in any of the instances when subjects were initially habituated to surprise, regardless of which emotion was subsequently presented. In other words, when subjects were first habituated to surprise, they appeared to generalize to all FEE's that followed.

Second, regardless of the FEE to which subjects were first habituated, no significant response recovery to the change in FEE was seen for subsequent presentations of disgust. However, although subjects appeared to be generalizing to disgust regardless of what was first presented, when the response recoveries for disgust were grouped and tested as a unit, the magnitude of response recovery is significantly larger than zero, $t(108) = 3.50$, $p = .001$. 


Table 7

Summary of mean changes in autonomic lability (and SE’s of the mean) to changes in facial expression

<table>
<thead>
<tr>
<th>Emotion presented first</th>
<th>Happy</th>
<th>Sad</th>
<th>Anger</th>
<th>Surprise</th>
<th>Fear</th>
<th>Disgust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy</td>
<td>------</td>
<td>.01</td>
<td>.05*</td>
<td>.09**</td>
<td>.03*</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.02)</td>
<td>(.03)</td>
<td>(.01)</td>
<td>(.02)</td>
<td></td>
</tr>
<tr>
<td>Sad</td>
<td>.01</td>
<td>------</td>
<td>.04*</td>
<td>.05</td>
<td>.06**</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.08)</td>
<td>(.02)</td>
<td>(.01)</td>
<td></td>
</tr>
<tr>
<td>Anger</td>
<td>.02</td>
<td>.01</td>
<td>------</td>
<td>.02*</td>
<td>.03*</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td></td>
</tr>
<tr>
<td>Surprise</td>
<td>.01</td>
<td>.01</td>
<td>.02</td>
<td>------</td>
<td>.01</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td></td>
</tr>
<tr>
<td>Fear</td>
<td>.02*</td>
<td>.01</td>
<td>.02*</td>
<td>.02</td>
<td>------</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td></td>
</tr>
<tr>
<td>Disgust</td>
<td>.04*</td>
<td>.05*</td>
<td>.04*</td>
<td>.02</td>
<td>.05*</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.01)</td>
<td>(.02)</td>
<td></td>
</tr>
</tbody>
</table>

Note. One sample t-tests, criterion = 0.
*p ≤ 0.05. **p ≤ 0.001
Third, marked asymmetries were observed between pairs of emotions; significant response recovery was seen for pairs of emotions presented in one order, but not when the pairs were presented in the reverse order. Pairs of emotions that showed congruence in terms of statistical significance were response recovery to the change from happiness-sadness and response recovery to the change from sadness-happiness (both non-significant), surprise-fear and fear-surprise (both non-significant), disgust-surprise and surprise-disgust (both non-significant), happiness-fear and fear-happiness (both significant), and fear-anger and anger-fear (both significant). All other pairs: anger-happiness and happiness-anger, happiness-surprise and surprise-happiness, happiness-disgust and disgust-happiness, anger-sadness and sadness-anger, sadness-surprise and surprise-sadness, sadness-fear and fear-sadness, sadness-disgust and disgust-sadness, surprise-anger and anger-surprise, disgust-anger and anger-disgust, disgust-fear and fear-disgust, showed asymmetries in statistical significance dependent upon the order of presentation of the emotions (see Table 7).

In order to assess the degree of asymmetry between the emotion pairs, one-way ANOVA's were performed on the response recoveries to change in FEE for each set of emotion pairs. Of the fifteen sets of response pairs listed above, three showed significant differences in the degree of response recovery to the change in facial expression. The response recovery to sadness-surprise was significantly greater than the response recovery to surprise-sadness, $F(1,20) = 5.01, p = .03$ (.05 vs. .01, respectively). The magnitude of response recovery to sadness-anger was significantly greater than the magnitude of response recovery to anger-sadness, $F(1,19) = 4.04, p = .05$ (.04 vs. .01). Response recovery to happiness-surprise was significantly larger than the response recovery to surprise-happiness,
F(1,19) = 6.93, p = .01 (.09 vs. .01, respectively).

Magnitudes of response recovery for the change in identity and change in FEE for each stimulus triad were compared directly using two tailed paired samples t-tests. Of the thirty triads, four showed significant differences in the magnitude of response recovery to the change in identity versus the change in facial expression. In the triad; sadness, sadness, surprise, subjects showed greater response recovery to the change in FEE versus the change in identity, t(20) = -2.66, p = .02 (.04 vs. -.01, respectively). In the sadness, sadness, fear triad, subjects showed greater response recovery to the change in FEE than the change in identity, t(20) = -2.39, p = .03 (.06 vs . .02, respectively). In the sadness, sadness, disgust triad, subjects showed greater response recovery to the change in FEE than the change in identity, t(21) = 2.16, p = .04 (.05 vs . .02, respectively). In the happiness, happiness, surprise triad, subjects showed significantly greater response recovery to the change in FEE than the change in identity, t(21) = -3.24, p = .004 (.09 vs . .01, respectively).

Planned Comparisons Between Triads

In order to assess any global effects of the paradigm, most notably the overall degree of response recovery to changes in identity versus changes in FEE, all thirty triads were combined. Figure 2 shows the graph of responses over the experimental time line before the calculation of change scores, averaged across all triads. The zig-zag pattern of response change is characteristic of a habituation paradigm showing a response to the initial stimulus followed by habituation to that stimulus, followed by response recovery and subsequent habituation to a change in stimuli, followed by response recovery and habituation to another change in stimuli. This confirms the observation in the data reported by triad in Tables 2 - 6.
that the observed response changes were stimulus-linked, namely that increases in SCR were indicators of orienting to initial stimulus presentation or change, and decreases in SCR were indicators of habituation to repeated stimulus presentation (see Figure 2).

The magnitude of overall response recovery to changes in identity was assessed with a two tailed one sample t-test and found to be significantly greater than zero, $t(641) = 9.56, p = .000$. Similarly, the magnitude of overall response recovery to changes in facial expression was assessed with a two tailed one sample t-test and found to be significantly greater than zero, $t(641) = 10.45, p = .000$. When the degree of response recovery for changes in identity was directly compared to the degree of response recovery for changes in FEE with a two tailed paired samples t-test, the two did not differ significantly in terms of magnitude, $t(641) = 1.44, p = .15 (.033 \text{ vs. } .027, \text{ respectively})$. 
Mean autonomic lability over the experimental time line, averaged across triads.
Post hoc Comparisons Between Triads

In order to further examine the finding that no response recovery to identity occurred in the five triads where identity changed while happiness was constant, and the finding that no response recovery to the change in FEE was observed in any of the instances when subjects were initially habituated to surprise, data were grouped according to the FEE that was first presented. This was problematic, in that sometimes an FEE was presented first more than once to one group of subjects, creating differing degrees of freedom. However, presentation of a stimulus that has been primed by prior exposure may be less effective in producing dishabituation if used again in the same session (Siddle, 1985). Therefore, any biases created by this grouping should be in favour of the null hypothesis.

Because thirty-six post hoc comparisons were conducted, the conventional p value of .05 was adjusted with a Bonferroni correction to .001. The summary of changes in autonomic lability grouped by the facial expression first presented is shown in Table 8. Congruent with previous results, the data show the characteristic pattern of stimulus dependent increases and decreases associated with the habituation paradigm. However, two exceptions were notable that mirror results found in the analysis of data by triad. When identity changed while happiness was constant, no significant response recovery to the change in identity was observed; subjects generalized across identity when first habituated to a happy face. No significant response recovery to the change in FEE was observed when subjects were initially habituated to surprise, regardless of the emotion which followed. In other words, when subjects were first habituated to surprise, they appeared to generalize to all subsequent FEE’s.
### Table 8

Changes in autonomic lability (and SE’s of the mean) by emotion presented first, collapsed across emotion presented second

<table>
<thead>
<tr>
<th>Emotion presented first (N)</th>
<th>Initial Response *</th>
<th>Initial Habituation</th>
<th>Response to change in identity</th>
<th>Habitation to change in identity</th>
<th>Response to change in FEE</th>
<th>Habitation to change in FEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>happy (109)</td>
<td>.01 (.03)</td>
<td>-.05* (.01)</td>
<td>.01 (.01)</td>
<td>-.03* (.01)</td>
<td>.04* (.01)</td>
<td>-.04 (.01)</td>
</tr>
<tr>
<td>sad (108)</td>
<td>.07 (.03)</td>
<td>-.06* (.01)</td>
<td>.03* (.01)</td>
<td>.03* (.01)</td>
<td>.04* (.01)</td>
<td>-.03 (.01)</td>
</tr>
<tr>
<td>anger (108)</td>
<td>.10 (.04)</td>
<td>-.06* (.01)</td>
<td>.04* (.01)</td>
<td>-.04* (.01)</td>
<td>.02* (.01)</td>
<td>-.04* (.01)</td>
</tr>
<tr>
<td>surprise (107)</td>
<td>.07 (.03)</td>
<td>-.05* (.01)</td>
<td>.04* (.01)</td>
<td>-.04* (.01)</td>
<td>.01 (.01)</td>
<td>-.04* (.01)</td>
</tr>
<tr>
<td>fear (106)</td>
<td>.08 (.04)</td>
<td>-.05* (.01)</td>
<td>.03* (.01)</td>
<td>-.06* (.01)</td>
<td>.02* (.004)</td>
<td>-.03* (.01)</td>
</tr>
<tr>
<td>disgust (104)</td>
<td>.00 (.03)</td>
<td>-.07* (.01)</td>
<td>.05* (.01)</td>
<td>-.06* (.01)</td>
<td>.04* (.01)</td>
<td>-.04* (.01)</td>
</tr>
</tbody>
</table>

Note. One sample t-tests, criterion = 0.

* Response estimates are conservative; first second used as baseline for change scores.

* p≤0.001
CHAPTER FOUR

Discussion

This study provided initial evidence that a habituation paradigm using skin conductance as a dependent variable is suitable for the study of orienting to facial identity and facial expressions of emotion. One of the most prominent features of the data was the characteristic pattern of responses showing a response to the initial stimulus followed by habituation to that stimulus, followed by response recovery and subsequent habituation to stimulus change, followed by response recovery and habituation to another change in stimuli. This strongly suggests that observed response changes were stimulus-linked; increases in SCR were indicators of orienting to stimulus presentation or change, and decreases in SCR were indicators of habituation to repeated stimulus presentation. Given that the paradigm is viable, it is possible to make some tentative inferences regarding the relative salience of identity versus facial expression, as well as inferences regarding the nature of the processing of facial affect, and the nature of habituation.

Relative Salience of Identity Versus Expression

Changes in stimulus identity and FEE were both highly salient to subjects, evoking significant overall response recovery. However, significant differences in the degree of response recovery to identity versus facial affect occurred in only five of thirty triads. When compared directly, the degree of response recovery to the change in identity versus the change in FEE are equivalent. Because the orienting response recovers both when stimulus identity and stimulus FEE change, it can be concluded that attention was directed at both identity and facial expression (see Midgely, Wilkie, & Tees, 1988). According to Heinemann
and Chase (1987), the reinstatement of a response when both identity and expression are changed is characteristic of discrimination. This stimulus specificity may have occurred because changing expression elicits the same response as the first stimulus (an increase in SCR), but does not share the same synapses used by the habituating stimulus, in this case, identity (Davis & File, 1984). This is consistent with the results of studies that report a double dissociation between the processing of facial affect and facial identity; the two appear to be separate, parallel processes (Adolphs et al., 1994; Desimone, 1991; Hanaya, 1992; Harries & Perret, 1991; Prkachin & Prkachin, 1994; Sergent, Ohta & MacDonald, 1992).

The observation that the change in FEE evoked response recovery was equal to that of the change in identity is somewhat surprising. In this study, identity was always changed first, followed by the change in expression. Therefore, an order effect may have existed for the order of stimulus change. In other words, because identity was always changed first, this change may have been more salient to subjects than the change in FEE, thereby evoking a larger response due to novelty. Although this cannot be substantiated with this study, another study of this type changing FEE first, then changing identity, would be useful in order to determine whether the magnitudes of response recoveries for the change in identity and the change in FEE reported in this study are robust.

**Habituation and the Processing of Facial Affect**

Assuming that increased responding is indicative of stimulus discrimination, it is possible to make some tentative conclusions regarding the nature of processing of facial expressions of emotion. If the perception of facial affect is configural, response recovery to the change in facial expression should have been observed for all changes in FEE. However,
significant response recovery was not observed for all FEE changes, suggesting that the continuous information contained in blends of emotional expression are not transformed by the perceptual system into categorical information as concluded by Etcoff and Magee (1992). It is interesting to note that no response recovery to change in FEE occurred when subjects were initially habituated to surprise, regardless of which FEE followed. This observation suggests that the perception of surprise may prepare an individual to expect another facial expression and mirrors the conclusion made by Etcoff and Magee (1992) that surprise is different from other facial expressions of emotion and may be a “pre-emotion”.

If the perception of facial expressions of emotion is featural, response recovery to the change in FEE should have been dependent upon the degree of similarity of featural displacement for FEE’s. Surprise and fear are similar in terms of featural displacement (Yamada et al, 1993). Accordingly, no significant response recovery to change in FEE was observed between pairings of fear-surprise and surprise-fear. Anger, disgust, and sadness are also similar in terms of feature displacement (Yamada et al, 1993). No significant response recovery to the change in FEE was seen for the pairing of anger-disgust, but significant response recovery was observed for the pairing of disgust-anger. Similarly, no significant response recovery occurred for the pairings of anger-sadness and sadness-disgust, but significant response recovery was observed for the pairings of sadness-anger and disgust-sadness. Additionally, pairs of FEE’s that were dissimilar, for example, happiness-anger and disgust-surprise, did not show significant response recovery. Therefore, the results of this study do not support the featural hypothesis of the perception of facial affect. Response recovery was not predicted by the similarity of feature displacement of FEE’s.
Discrimination of Facial Expression

If the perception of facial affect is a combination of featural and configural processing dependent upon the particular facial expression to which the visual system is exposed, according to the theories of Kirita and Endo (1995), happy faces contain many low spatial frequency components and should therefore be processed configurally. Therefore, any facial expression paired with happiness, in any order, should produce response recovery. However, this was not observed. Of the ten possible FEE combinations including happiness, significant response recovery to change in FEE was observed in only five combinations. Sad faces are thought to be processed featurally (Kirita & Endo, 1995). Accordingly, some generalization should be seen between sad faces and faces similar in terms of featural displacement, for example, fear and anger. However, significant response recovery to change in FEE was observed for fear and anger after subjects were habituated to sadness. Response recovery to change in FEE was also observed for anger, after subjects were habituated to fear, and for fear, after subjects were habituated to anger. The results of this study do not support the mixed processing model proposed by Kirita and Endo (1995).

McKelvie’s (1994) mixed processing model states that surprise and happiness are processed categorically, while anger, disgust, fear and sadness are processed featurally. Therefore, any facial expression paired with happiness or surprise should produce response recovery. However, as noted above, significant response recovery was only observed in five out of ten FEE combinations containing happy faces. Significant response recovery to change in FEE was only observed for surprise after habituation to happiness and anger, and as mentioned earlier, no response recovery was observed for changes in FEE after subjects were habituated to surprise. Therefore, the results of this study do not support the mixed
processing model proposed by McKelvie (1994).

The errors commonly made in identifying and labelling facial expressions of emotion may also provide a clue to the nature of the processing of facial affect. If similar results are observed in the detection and discrimination of facial expression, then it may aid in understanding facial processing. Research has shown that anger and disgust are the most difficult emotions to detect (Prkachin & Prkachin, 1994) and are most often confused with each other (Ekman & Friesen, 1975, Ekman & Oster, 1982, McKelvie, 1994). Fear and surprise are also often confused (Ekman & Friesen, 1975, Ekman & Oster, 1982, McKelvie, 1994). Therefore, response generalization should be observed between fear-surprise, surprise-fear, anger-disgust, and disgust-anger combinations of facial expressions. These predictions are confirmed by the data, with one exception. Significant response recovery to change in FEE was observed for anger when subjects were first habituated to disgust. Nevertheless, the similarity between the results of this study and the errors commonly cited in the identification and labelling of facial affect suggests that the errors may be occurring at the level of detecting and discriminating the facial expression.

When results are compared to those found by Serrano, Iglesias, and Loeches (1992) in their visual fixation study with infants, some inconsistencies were found. Serrano et al (1992) observed significant response recovery for fear-anger, anger-fear, anger-surprise, surprise-anger, and surprise-fear. They did not observe response recovery for fear-surprise. The results of this study showed significant response recovery to the change in FEE for fear-anger, anger-fear, anger-surprise, but unlike Serrano et al. (1992), significant response recovery for fear-surprise. Contrary to the results reported by Serrano et al. (1992), in this study, response
recovery to change in FEE was not observed for either surprise-fear and surprise-anger. The results of this study show some resemblances to those of Serrano et al. (1992) observed in infants. At this point, although tempting, it is premature to conclude that discrepancies observed between the study conducted with infants and this study conducted with adults are due to maturation or learning. Nevertheless, the true complexity of the perception of emotion in the face is revealed when all possible combinations of the six basic facial expressions of emotion are used rather than three.

Habituation and the Role of Priming

One of the most interesting results of this study was the observation of asymmetries in significant response recovery dependent upon the order of presentation of stimuli. This asymmetry existed in ten of fifteen possible sets of stimulus pairs, although the degree of asymmetry was only significant in three of fifteen sets. This result was not predicted by any existing theories of facial affect processing which suggest that response recovery either should or should not be evident, irrespective of the order in which the stimuli are presented. The results of this study fail to support any of the existing theories regarding the nature of processing of facial affect. However, priming may have been responsible for the unusual pattern of results obtained in this study. Priming refers to the extent to which a stimulus is pre-represented in short term memory and is thought to occur by either prior presentation of the stimulus, or more importantly, the presentation of highly associated stimuli (Siddle & Spinks, 1992). Because priming can be associatively generated, the presentation of one stimulus may lead to the anticipation of another stimulus with which it is highly associated (Siddle & Spinks, 1992).
If priming has a role in habituation, there may have been priming effects due to the order of stimulus presentation. Because faces are biologically relevant stimuli and facial expressions of emotion naturally co-occur both within individuals and between individuals during the course of social communication, some combinations of FEE in particular orders may, through learning, come to be highly associated (i.e., surprise in one actor, followed by happiness in the same actor). Unprimed stimuli are processed more elaborately than primed stimuli, therefore, combinations of stimuli in unexpected orders may evoke large response recovery to the change in FEE while expected combinations would not.

The response recovery to the change in FEE in sadness-surprise was significantly greater than the response recovery to surprise-sadness, the response recovery from sadness-anger was significantly greater than the magnitude of response recovery to anger-sadness, and the response recovery to happiness-surprise was significantly larger than the response recovery to surprise-happiness. Although no hard evidence exists to suggest that emotion pairs showing significantly larger response recovery were unexpected combinations of emotion and those showing less response recovery were expected combinations, priming may explain this unexpected pattern of results. It is interesting to note that two of the three emotion pairs that showed significant asymmetry involved the emotion surprise.

Two other results are suggestive of a priming effect in this study. When identity changed while happiness was constant, no significant response recovery was observed. Subjects generalized across identity when first habituated to a happy face. This result may be indicative of a priming effect because happy faces often co-occur between individuals during the course of social communication. Also, no significant response recovery was observed.
when subjects were initially habituated to surprise, regardless of the emotion which followed. In other words, when subjects were first habituated to surprise, they appeared to generalize to all subsequent FEE's. These results may also be indicative of a priming effect because the presentation of a surprise face may prepare an individual to expect another facial expression.

Curiously, Serrano et al. (1992) reported significant response recovery for the emotion pairs surprise-fear and surprise-anger; however, in this study, response recovery to change in FEE was not observed for either surprise-fear and surprise-anger. If facial expressions of emotion become associated through experience and learning, it is possible that the four to six month old infants used in their study had not yet formed associations between surprise faces and other FEE's. However, it is possible that these associations between facial expressions had been learned in the adults who participated in the present study, resulting in the observed discrepancies between the two studies. It is important to note, that while results are suggestive of a priming effect, the role of priming in the processing of facial affect and in habituation is purely speculative. Research specifically tailored to address the issue of priming must be conducted before concluding that priming is a valid phenomenon in habituation research.

Limitations and Future Considerations

The results obtained in this study did not lend support for any of the theories of facial affect processing. Many possible explanations for these seemingly anomalous results exist in addition to priming effects. First, the use of a habituation paradigm using skin conductance as a dependent measure may not be appropriate for addressing these theories; the information necessary to properly address the question of the nature of facial processing may not be
contained in the data. Because no studies of this nature were found in the literature, it is uncertain as to whether the results obtained in this study are robust. Replication of this study is necessary to ensure that the results obtained here are not spurious. The exact parameters of this habituation paradigm may also be in need of some fine tuning, however, this remains speculative.

Caution must also be taken in the interpretation and generalization of the results. Standardized psychophysiologic experimentation in the laboratory, although having the advantages of comprehensive measurement and precise stimulus control, tends to be artificial and somewhat removed from the ongoing, continuous adjustments that occur in ordinary life (Schneiderman & McCabe, 1989). Given the dynamic and complex nature of social communication, of which facial expressions are a mere facet, it is likely that many factors influence the processing of facial affect. Potential influences may be gaze direction, head position, body posture, knowledge of the social context in which the emotional expression occurs, and knowledge of the actor performing the facial expression.

For example, this study used models, including the experimenter, who were known to many of the subjects. With such a small university population and such a limited number of FACS proficient individuals, this was unavoidable. However, it was observed during data collection that when the stimulus model was known to the subjects, large responses were observed for the presentation of the known identity. Therefore, response recoveries to change in identity may have been confounded by familiarity or recognition. This confound may have extended to response recoveries to change in expression. Given the importance of facial expressions of emotion in social communication, it is entirely possible that an FEE displayed
by a known individual may be more salient than an FEE displayed by someone unknown to
the subject. To illustrate, a sad face performed by an actor known to an individual should be
more salient than a sad face performed by an unknown actor. Ideally, this study would have
used models who were not known to any of the subjects.

Stimuli could have also been compared in terms of their respective rates of orientation
and habituation. Given that the primary purpose of this study was to establish the viability of
a habituation paradigm, a simple and robust treatment of the data was chosen. This study only
examined the magnitude of response recovery after stimulus change, however, random
variation in the two values used to estimate this change can have a profound effect on the
results. An examination of rates may have allowed for finer distinctions to be made between
facial expressions of emotion. Additionally, the examination of rates would have utilized
more of the data. Unfortunately, the examination of rates was not feasible this study, but may
be a useful method of analysis in future studies of this nature.

Another potential pitfall in this study was the inclusion of non-responsive subjects in
the final data set. During data collection, it was noticed that some subjects did not have skin
conductance responses to the stimuli. For these subjects, the average of the first six seconds
after the first stimulus presentation was used in lieu of an actual OR. The inclusion of these
subjects who did not show any response changes would have attenuated the calculated
magnitudes of response recovery. Any future studies should screen subjects for responsivity
before inclusion.

Conclusion

Despite its limitations, this study has merit in that it does attest to the viability of
using a habituation paradigm in the study of perceptual phenomena, in particular, the study of facial processing. A habituation paradigm may have much to offer in terms of resolving ongoing debates regarding the processing of facial expressions of emotion. Current theories of facial affect processing did not account for the data obtained in this study and the fact that significant response recovery seemed to be dependent upon the order of presentation of stimuli. These findings may have significant implications for our understanding of how emotion is perceived in the human face. Continued research with this paradigm is warranted in order to discover the extent of what it can offer in the understanding of facial processing.
REFERENCES


Discrimination of Facial Expression


Discrimination of Facial Expression

Review, 77, 406-418.


