DETERMINING SALIENCY LEVELS OF EMOTIONAL FACIAL EXPRESSIONS BY USING INSTRUCTED LYING PARADIGM

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MAY 2014

DETERMINING SALIENCY LEVELS OF EMOTIONAL FACIAL EXPRESSIONS BY USING INSTRUCTED LYING PARADIGM

A THESIS SUBMITTED TO

THE GRADUATE SCHOOL OF SOCIAL SCIENCES

OF

IZMIR UNIVERSITY OF ECONOMICS

BY

AYŞEGÜL AYDINLIK

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

THE DEGREE OF MASTER OF SCIENCE

IN

THE GRADUATE SCHOOL OF SOCIAL SCIENCES

MAY 2014

Approval of the Graduate School of Social Sciences

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

DETERMINING SALIENCY LEVELS OF EMOTIONAL FACIAL EXPRESSIONS BY USING INSTRUCTED LYING PARADIGM

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MS in Experimental Psychology, Department of Psychology

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May 2014, 170 pages

The current thesis investigates if emotional facial expressions with distinct saliency levels differ in terms of their resistance to the cognitive load that lying brings into as a function of their salience. In Study I, participants were asked to complete an emotion recognition task while response time and skin conductance measurements were being recorded in order to determine saliency levels of emotional facial expressions. In Study II, an instructed-lying paradigm was applied through an emotion recognition task to assess the resistance levels of facial expressions with distinct salience to the cognitive load lying produce. In Study III, in order to control if providing instruction to lie causes an overall change in the way facial expressions are processed, participants were asked to decide when to lie. Overall results indicate that distinct emotional facial expressions differ in terms of their saliency levels and salience of a facial expression makes it more resistant to lying. Also, analyses conducted on response time and skin conductance responses of distinct study groups indicate that lying is a more cognitively demanding task than telling the truth and may alter the way stimuli processed to be identified.

Keywords: Visual salience, instructed-lying paradigm, emotional facial expressions, facial expression processing

ÖZET

YÖNERGE-TEMELLİ YALAN SÖYLEME PARADİGMASI KULLANARAK DUYGUSAL YÜZ İFADELERİNDE BELİRGİNLİĞİN İNCELENMESI

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Tez Yöneticisi: Doç. Dr. Seda Dural

Mayıs 2014, 170 sayfa

Bu çalışmada farklı duygulara ait yüz ifadelerinin, görsel belirginlik düzeylerinin bir fonksiyonu olarak yalan söyleme eyleminin getirdiği bilişsel yüke dayanıklılıkları temelinde ayrışmaları incelenmiştir. Farklı duygulara ait yüz ifadelerinin görsel belirginlik düzeylerinin belirlenmesi amacıyla, Çalışma I'de katılımcılardan klasik bir duygu tanıma görevi tamamlamaları istenmiş, çalışma boyunca tepki süresi ve deri iletkenliği tepkisi ölçümleri alınmıştır. Farklı yüz ifadelerine ait duyguların yalan söyleme eyleminin getirdiği bilişsel yüke dayanıklılıklarının belirlenmesi amacıyla yürütülen Çalışma II'de yönerge-temelli yalan söyleme paradigmasının uygulandığı bir duygu tanıma görevini yerine getirmeleri istenmiştir. Yalan söyleme eyleminin uyarıcıların işlenmesine etkisini kontrol etmek amacıyla Çalışma III'te katılımcılara herhangi bir yalan söyleme yönergesi verilmemiş; ancak, katılımcılardan yalan söyleyecekleri zamana

kendilerinin karar vermesi istenmiştir. Genel olarak elde edilen sonuçlar, farklı duygulara ait yüz ifadelerinin görsel belirginlik düzeyleri bakımından ayrıştıkları ve yüksek görsel belirginlik düzeyinin ifadeleri yalan söylemeye karşı daha dayanıklı hale getirdiği yönündedir. Ayrıca, farklı çalışma gruplarından elde edilen tepki süreleri ve deri iletkenliği tepkisi ölçümleri, yalan söyleme eyleminin bilişsel yönden doğru söyleme eylemine göre daha yüklü bir eylem olduğuna ve uyarıcıların genel olarak nasıl işlendikleri üzerinde bir etkiye sahip olduğuna işaret etmektedir.

Anahtar sözcükler: Görsel belirginlik, yönerge-temelli yalan söyleme paradigması, duygulara ilişkin yüz ifadeleri, yüz ifadelerini işleme

ACKNOWLEDGEMENTS

When this thesis project was first proposed in 2011, I had no idea that I was just in the beginning of a journey through which I would have various chances to gain invaluable life experiences as well as to enrich my scientific knowledge. For this reason, I would like to thank Prof. Hakan Çetinkaya for starting Experimental Psychology Program and letting me be the member of our laboratory. I would also like to express my acknowledgements to Assoc. Prof. Seda Dural, my thesis supervisor, especially for her encouragements and faith in this thesis project that she presented with Prof. Hakan Çetinkaya since the very beginning of this project.

I had known that I am a member of a huge family; however, I was not aware of that my family is huger than I thought and filled with members who always inspired me with their attitudes towards life and their characteristics. For this reason I would like to express my gratitudes to Alp Giray Kaya, Baran Koç, Banu Değirmencioğlu, Deniz Küçüker, Emine Akman, Eymen Musluoğlu, Ezgi Gür, Ezgi Palaz, Nazlı Altınok, Peren Onaran and Yalçın Akın Duyan. I am glad to be a member of this family, knowing that we are always there for each other no matter how tied up we are.

Finally, I would like to thank my parents; Gülseren and Yılmaz Aydınlık, who are cursed with the unconditional love they have for their child, which being a parent brings into. Without your love and support, it was not possible to complete this thesis project.

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CHAPTER 1

INTRODUCTION

The main “cognitive architecture” assumption of neuropsychology holds the idea that sophisticated cognitive processes are composed of collaborative and interactive operation of various basic cognitive processes or subsystems, called modules, which are specialized to perform particular tasks (Bauer, Leritz, & Bowers, 2003). As Fodor (1983) states, whether these modules will operate, and if they will, what kind of function will be operated are determined by the type of input modules receive from a specific domain, which also indicates that type of input to trigger a module to function, and potential outputs that can be obtained as through the operation of that module is limited in its nature. Although experience and learning may have effects on characteristics and functioning of modules, modules are innately particularized, autonomous operators rather than being utterly reliant on experience or learning.

The main goal of neuropsychological research in general has been developing a better understanding of complex cognitive functions by disclosing the cognitive architecture of them, and unveiling cognitive structures that corresponds to the regions which should be operating a specific function as indicated in a model developed has always been a challenge that researchers have to face with. Processing emotional facial expressions is one of the sophisticated cognitive functions mentioned above. Emotions are defined as adaptive cognitive appraisal or perception, experienced feeling, autonomic and neural arousal, expressive behavior, and goal directed activities to an appropriately evocative stimulus (Plutchik, 1980), and it is first established by Darwin (1965/1872) that nonverbal communication of emotions via facial expressions is an adaptation which enhances survival and reproduction of an organism. In line with Darwin's establishment, Ekman and Freisen (1971) demonstrate that facial expressions of anger, disgust, fear, happiness, sadness, surprise are recognized universally as independent from the culture an individual grows up and lives in. Although Ekman and Friesen's research (1971) strengthen the view that perceiving emotion presented in a face as well as expressing an emotion via the face might be an adaptation, it also sparks the debate if emotions are entities of distinct categories and associated with unique neurophysiological activity patterns or they are continuous and neural activity of separate arousal and valence encoding systems lead them.

Although it is still not resolved if the emotional facial expressions are entities of distinct emotion categories or they are continuous, the question of how basic emotional facial expressions are processed in the brain has always been the center of attention for researchers across diverse disciplines as well as neuropsychologists and gave rise to distinguished, partly conflicting hypotheses which are (1) the right hemisphere hypothesis and (2) the valence hypothesis. In each emotion processing model, cortical lateralization of emotion processing is interpreted as a function of distinct characteristics of emotions. According to the right hemisphere hypothesis, all emotions are instances of one single category and are processed preferentially by the right cerebral hemisphere, whereas emotions are divided into distinct categories on the basis of their valence in the valence hypothesis, and it is proposed that each cerebral hemisphere is specialized to process a specific category of emotion.

Although there are findings on support for all these models in the literature, there is no consensus yet. On the other hand, there is a growing view that it may be the saliency levels of facial expressions rather than their valence characteristics that causes a hierarchy in processing of emotional facial expressions (Du, S., Martinez, A. M. 2013; Sweeny, Grabowecky, Paller, Suzuki, 2013; Tracy & Robins, 2008) which also indicates that it may be the pathways, which transmit the visual information to the cortices, rather than the cerebral hemispheres differed for distinct motional facial expressions. For this reason, in the present study, it was aimed to investigate whether emotional facial expressions could be grouped or ordered on the basis of their saliency level by using instructed lying paradigm in an emotion recognition task.

Prior to stating the hypotheses of the present study, each emotional processing hypothesis is presented by introducing the observations and research findings which contribute to emergence of that emotional processing hypothesis along with presenting affective processing findings that support the hypothesis introduced. Afterwards, the factors that may cause the contradictions among each hypothesis are discussed. Once the factors that make reaching a consensus difficult between different emotional facial expression processing hypotheses are discussed, findings regarding to that saliency levels of distinct emotional facial expressions give rise to hierarchical processing of emotional facial expressions are presented. In order to gain a full comprehension of how instructed lying paradigm could be used in order to determine saliency levels of emotional facial expressions, models developed in order to describe the cognitive processes that lie behind act of lying is introduced.

The Right Hemisphere Hypothesis

The right hemisphere hypothesis is the first cortical lateralization of emotion processing model developed on the basis of the observations that are made through emotion processing or emotion expression performance of patients with unilateral brain damage. It is proposed in the right hemisphere hypothesis that the right cerebral hemisphere is specialized in performing tasks that involve perception of emotional facial expressions, expression and experience of emotions regardless of their valence or other characteristic features (Borod, Cicero, Obler, Welkowitz, Erhan, Santschi, Grunwald, & Whalen, 1998).

The primary observations that display the link between the right cerebral hemisphere and emotion processing starts with Mills' examinations of a patient with unilateral right sided lesion (Mills, 1912). Pathological examination of the patient reveals that ventral portion of the dentate nucleus as well as the adjacent superior cerebellar peduncle, and the right nucleus ruber is smaller than the left, which are thought as the cause of patient's syndromes such as loss of control of the left leg and arm's movements, nerve deafness along with paralysis of emotional expression in the face (Mills, 1912). The additional cases conveyed by Mills, which belong to other patients with unilateral right sided lesions and who have uncontrollable laughter attacks after the lesion, arise the idea that emotional experience may be linked with functioning of the right cerebral hemisphere (Mills, 1912). In 1914, Babinski's (as cited in Alves, Fukusima, Aznar-Casanova, 2008) reports on the patients, who turn into manic or emotionally indifferent after a unilateral right sided lesion, strengthen Mills' proposition. Observations of both Mills and Babinski on the relationship between a unilateral right sided brain lesion and emotional behavioral changes in patients are the first remarks that point to the role of the right hemisphere in emotional processing, and the following systematic emotion processing studies with similar results give rise to the right hemisphere hypothesis (Cicone, Wapner, & Gardner, 1980; Etcoff, 1986; Gainotti, 1972; Gardner, 1975).

Although this hypothesis first established on the performances of patients with brain damage, data in support of this model is also attained through hemispheric specialization of emotion perception, emotion expression, and emotion experience studies conducted with healthy individuals.

The Right Hemisphere Hypothesis and Emotion Perception

The right hemisphere hypothesis and processing facial affect

Researches designed to investigate hemispheric specialization of emotion perception focus on facial affect, affective prosody, and lexical emotion channels of emotion communication. First indications of the right cerebral hemisphere's specialization in perception of emotional facial expressions are obtained through studies conducted with patients who have unilateral brain damages (Adolphs, Damasio, Tranel, & Damasio, 1996; Borod, Koff, Lorch, & Nicholas, 1986; Borod, et al., 1998; Cicone, Wapner, & Gardner, 1980; DeKosky, Heilman, Bowers, & Valenstein, 1980). These studies are traditionally carried out by comparing performances of patients who have lesions in different hemispheres or comparing performances of brain damaged patients with healthy individuals. The observed performance variations, like difference in number of correct responses and/or in speed of response times, among distinct groups are attributed to the dysfunction of the brain areas that are affected by the particular damage. Such performance comparisons reveal that right hemisphere damaged patients perform worse than left hemisphere damaged patients in tasks that require recognition of facial expression. For instance, Cicone, Wapner, and Gardner (1980) compare performances of 18 left brain patients, 21 right brain patients, and 13 frontal leucotomy patients who serve as control group along with 10 non-neurological patients through (1) recognition of identical faces, (2) recognition of identical emotional facial expressions presented by different individuals, (3) matching drawings that convey the same emotion, and (4) detecting similarities between verbally described situations in terms of the emotion they convey tasks. It is observed that right hemisphere patients perform worse than left hemisphere patients in face recognition, emotional expression recognition and matching drawings of the same emotion tasks, whereas these patient groups perform equally in matching verbally described situations on the basis of emotion they convey. Similarly, Adolphs and colleagues' (1996) study on the recognition of emotional facial expression reveals that patients with right hemisphere lesions are impaired in recognizing facial expressions that are different than the expression of happiness, whereas left hemisphere damaged patients do not represent such impairments. In 1998, Borod and colleagues report that right brain damaged patients perform worse both than left brain damaged patients and healthy individuals in identification of emotional facial expressions task, while performance of left brain damaged patients are as good as healthy individuals'.

Findings regarding to the right cerebral hemisphere's superiority for perceiving emotional facial expressions are also obtained through Benowitz and colleagues' (1983) research with patients who have undergone cerebral commissurotomy, who are also known as split brain patients. Cerebral commissurotomy is a procedure first applied by Van Wagenen in 1940 in order to treat incurable severe forms of epilepsy (Van Wagenen, & Herren, 1940), and involves separating all direct cortical connections between the two cerebral hemispheres by dividing corpus callosum, the anterior and hippocampal commissures, and the massa intermedia (See Figure 1.1). This separation ensures confinement the epileptic wave to one cerebral hemisphere, thereby either abates severity of seizures or ceases them. Although, neurological investigations of patients after surgery do not indicate any findings of neurological deficits, it is not until Gazzaniga and Sperry (Gazzaniga, Bogen, & Sperry, 1962) develop new investigation techniques, which involve restriction of stimuli presentations to one side of the sensory space, subtle deficits that patients suffer from are revealed and split brain patients are studied with in investigation of functional specialization of the cerebral hemispheres.

In Benowitz and colleagues' (1983) research, split brain patients, right hemisphere damaged patients, left hemisphere damaged patients and healthy individuals are presented voices and short videos which involve facial expressions or body movements of individuals, and participants are asked to identify the

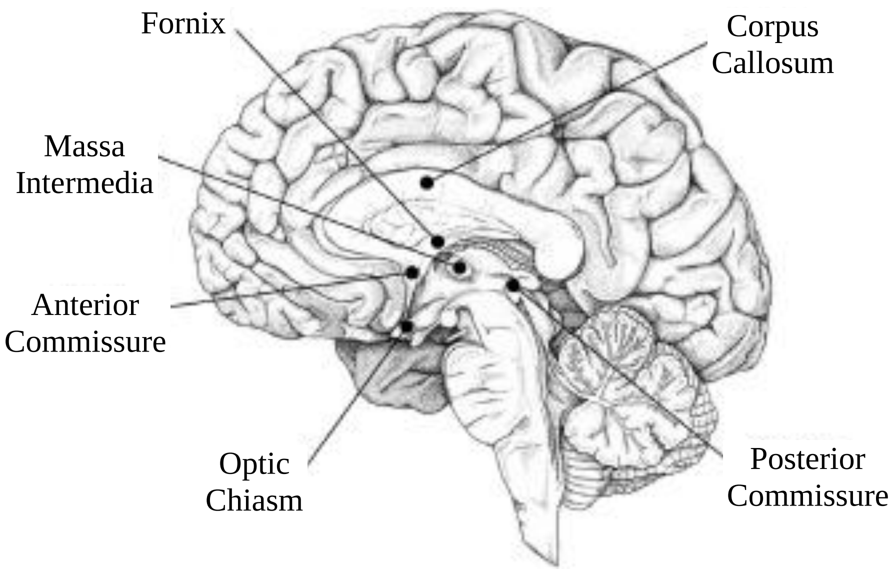

Figure 1.1. Cortical connections between the two cerebral hemispheres separated in cerebral commissurotomy. Reprinted from *Introduction to Neuropsychology, 2nd Edition* (p. 201), by J. G. Beaumont, 2008, New York, NY: The Guildford Press. Copyright [2008] by the The Guildford Press.

emotion each stimuli convey. Benowitz and colleagues (1983) report that in addition to right brain damaged patients' worse performance in evaluation of emotional facial expressions and body movements, split brain patients perform normally when emotional facial expressions are presented from the left visual field (to the right hemisphere), while they cannot recognize the emotion when stimuli are presented from the right visual field (to the left hemisphere).

The stimulus presentation technique developed by Gazzaniga and Sperry (Gazzaniga, Bogen, & Sperry, 1962) not only revealed the subtle deficits split brain patients suffer from, but also made studying functional specialization of the cerebral hemispheres with healthy individuals possible by giving rise to divided visual field technique. In individuals with intact brain, images fall on to retina are projected to both the left and the right occipital cortex in such a way that images received by the nasal hemiretina are transmitted to the contralateral hemisphere, while images received by the temporal hemiretina are transmitted to the ipsilateral hemisphere (See Figure 1.2). If a visual stimulus is presented in the left visual field, its image falls on to both nasal hemiretina of the left eye and temporal hemiretina of the right eye, which project the image to the right occipital cortex. Similarly, if a visual stimulus is presented in the right visual field, its image falls on to both nasal hemiretina of the right eye and temporal hemiretina of the left eye, which project the image to the left occipital cortex. By controlling the subject's fixation, it is possible to inject an image into particular hemisphere, therefore subject's accuracy of report or response time can be regarded as operation of the hemisphere the image presented to (Bourne, 2006). The crucial points to be taken into consideration in application of divided visual technique are the position

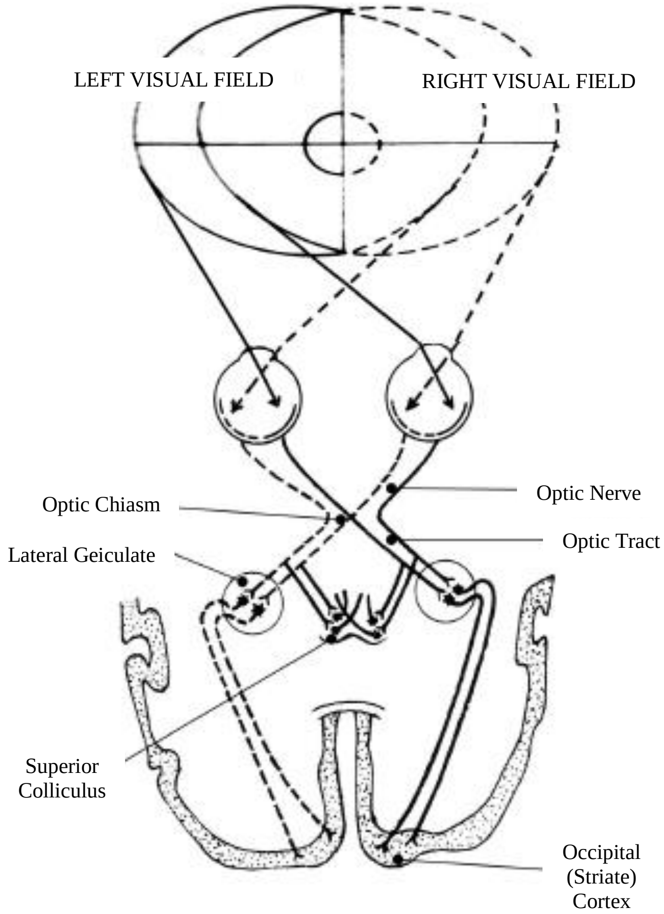

Figure 1.2. Visual pathways transmitting visual stimuli to visual cortices. An image presented from the left visual field is projected to the right occipital cortex, while visual stimuli presented from the right visual field is projected to the left occipital cortex. Reprinted from Introduction to Neuropsychology, 2nd Edition (p. 222), by J. G. Beaumont, 2008, New York, NY: The Guildford Press. Copyright [2008] by the The Guildford Press.

of the stimuli, and the duration of the stimulus presentation. Since the transmissions from nasal hemiretina and temporal hemiretina are not equally distributed and overlaps at splenium of the corpus callosum, it is advised to place lateralized stimuli with inside edge of three degrees from fixation in order to be ensure that stimulus is presented unilaterally. In order to preserve the fixation of subjects, and to avoid any saccadic or voluntary eye movement towards the stimuli presented, stimuli presentations are generally limited to 150msec or 180msec maximum.

Perception of facial affect studies conducted by using tachistoscopic stimulus presentation or divided visual field technique express left visual field advantage for distinguishing emotional facial expressions (Alves, Aznar-Casanova, & Fukusima, 2009; Landis, Assal, & Perret, 1979; Ley & Bryden, 1979; McKeever & Dixon, 1981; Schweinberger, Baird, Blümler, Kaufmann, & Mohr, 2003; Suberi & McKeever, 1977). For instance, in examination of utilization of associative matching by the right cerebral hemisphere Landis, Assal, and Perret (1979) design a tachistoscopic study, in which a target drawing is presented from the center of the screen, and participants are asked to decide whether the photograph presented from the right visual field or left visual field for 150msec has the same meaning with the target. The target presented from the center of the screen is either the drawing of a facial expression of anger, happiness or astonishment, or an object (corkscrew, key, or brush).

The rationale behind Landis, Assal and Perret’s research is that apperceptive and associative matching are two different visual processing strategies, which are thought to be favored by different cerebral hemispheres. Apperceptive matching is a processing in which objects are matched on the basis of their figural similarity, while this matching is performed on the basis of contextual or categorical similarities of objects in associative matching. Considering the visuospatial and language dependent functional asymmetries between two cerebral hemispheres, it is concluded that the right hemisphere benefits from apperceptive matching, whereas the left hemisphere favors associative matching. However, Landis, Assal, and Perret (1979) claims that if the right cerebral hemisphere is specialized to process emotional facial expressions, associative matching strategy should be favored by the right hemisphere, too, since conceptual matching plays an important role in decoding emotional facial expressions. Therefore, they propose that it may be expected to observe an improved right hemisphere performance in an associative matching task when emotional facial expressions are used as stimuli.

Observed shorter reaction times for matching facial expressions with target accurately when they are presented from the left visual field in comparison to presentations from right visual field, and shorter reaction times for matching objects with target accurately when they are presented from the left visual field in comparison to the object presentations from the right visual field support the claim that the right hemisphere is capable of utilizing associative matching strategy as well as indicating right hemisphere's role for processing emotional facial expressions.

However, in 1970s, the right cerebral hemisphere's superiority for recognizing and evaluating emotional facial expressions has been speculated as being arisen from its specialization in processing visuospatial tasks or from its superiority for recognizing faces. After Yin (1970) brought out that face recognition performance of patients with right posterior cerebral injuries is damaged while their object recognition ability remains intact, therefore, face recognition process may be carried out differently than object recognition, Suberi and McKeever (1977) conducted a study in order to address the question of whether recognition of emotional facial expression is dependent on face recognition. In their study, participants are asked to memorize photos of models posing either neutral facial expressions or emotional facial expressions, and then to decide whether the models presented from different visual fields have same identity with target models. It is observed that faces that are presented from the left side of the screen is matched with target faces faster than faces presented from the right side of the screen regardless of models' facial expressions. Although these results can be interpreted in terms of the right hemisphere's superiority for recognizing emotional facial expressions is rooted in its specialization in recognizing faces, it is also observed that this response time differences are greater among participants who memorized models with emotional facial expressions as target and participants who memorized models with neutral expressions as target, as the former group respond faster than the latter when faces are presented from the left side of the screen. Suberi and McKeever (1977) interpret these results as the indicator of "emotion storage" of the right cerebral hemisphere, which is independent of face recognition or spatial ability differences between cerebral hemispheres since left visual field superiority is attained for matching both neutral and emotional faces, however, emotional facial expressions recognized faster.

Findings regarding to the right cerebral hemisphere's superiority for processing and evaluating emotional facial expressions have also been obtained from electrophysiological recording and neuroimaging studies (Vanderploeg, Brown, & Marsh, 1987; Kestenbaum, & Nelson, 1992; Kayser, Tenke, Nordby, Hammerborg, Hugdahl, & Erdmann, 1997). For instance, in order to investigate emotional correlates of event related potentials (ERPs), Vonderploeg and colleagues (1987) present words and simple drawings of facial expressions to participants, and ask them to evaluate valence of each stimulus while EEG measurements are being recorded. It is observed that facial expression drawings that are classified as neutral cause larger amplitudes than drawings classified as emotionally laden in the left hemisphere, while emotionally laden expressions cause higher amplitudes than neutral facial expressions in the right hemisphere. Similarly, Kestenbaum and Nelson (1992) report that when adults and children are asked to decide if a presented facial expression is representing anger or happiness, a greater right hemisphere involvement is observed in adults.

Although ERP findings similar to Vanderploeg and colleagues' (1987) on the issue of differential processing of emotionally laden facial expressions are obtained through following ERP studies (Johnston, Miller, & Burleson, 1986; Johnston & Wang, 1991; Lang, Nelson, & Collins, 1990; Naumann, Bartussek, Diedrich, & Laufer, 1992), Kayser and his colleagues (1997) emphasize that ERP findings of affective processing should be interpreted carefully since tasks used in these studies generally require participants to press buttons or to make judgments orally, which also causes amplitude differences through distinct EEG channels as affective processing may cause. For this reason, in order to both diminish confounding effects of motor actions in EEG recordings, and to examine affective processing performance of each cerebral hemisphere individually, Kayser and his colleagues (1997) record ERPs in a divided visual field study, in which participants are asked to view face pairs that are presented from different sides of the screen simultaneously, without pressing any button. The face pairs are consisted of one face with a dermatological disease or a scar, and one after cosmetic surgery. The faces with dermatological disease are served as negative stimuli, whereas photographs of faces after surgery serve as neutral stimuli. Kayser and his colleagues (1997) report that while negative stimuli causes greater amplitude difference than neutral stimuli in general, these amplitude differences are enhanced by the visual field that the stimuli are presented from. Accordingly, photographs of faces with dermatological disease presented from the left side of the screen produce enhanced amplitudes of early components of ERP in right parietal regions.

In addition to divided visual field and ERP studies, evidences of right cerebral hemisphere’s superiority for processing facial affect are attained through functional magnetic resonance imaging (fMRI) studies conducted with healthy individuals. In 2001, Narumoto, Okada, Sadato, Fukui, and Yonekura present photographs of models posing either sad, happy, or fearful expressions which are framed with either rectangular or circular contour, and ask their participants to match the target photographs with one of the two photographs displayed subsequent to the target photograph presentations on the basis of (1) the frame of the photograph while disregarding the identity of the model or the facial affect they present, (2) the identity of the model while disregarding the contour of the photograph, and (3) the facial expression while disregarding the contour of the photograph or identity of the model. Identity matching task is observed to evoke stronger responses in left lateral fusiform gyrus (LFG), right superior temporal sulcus (STS), and left intraparietal sulcus (IPS) than matching contours of photographs elicits, whereas matching photographs of same facial affect evoke stronger responses only in right superior temporal sulcus. Similarly, Sato, Kochiyama, Yoshikawa, Naito, and Matsumura (2004) report observed activation in occipital and temporal cortices in the right cerebral hemisphere, involving foci of the inferior occipital gyri, middle temporal gyri, and fusiform gyri along with superior temporal sulcus, throughout viewing dynamic facial expressions of happiness and fear, which indicates greater involvement of the right cerebral hemisphere in facial affect processing.

The right hemisphere hypothesis and processing affective prosody

Apart from facial expressions, the other emotion channel that is being practiced on in investigation of hemispheric specialization of emotion perception is affective prosody. The term prosody refers to the vocal parameters – such as voice pitch, voice quality, loudness, and rhythm – of speech, and the idea that the vocalizers' affective states are reflected in their speech by means of distinct vocal parameters is first hypothesized by Darwin (1965/1872). Since the speech is transported via voice, it has been generally thought that affective states of the vocalizers are transmitted via the words used in the speech rather than the paralinguistic components of it. However, it is well established by Mehrabian and Weiner (1967) that when individuals are asked to determine the vocalizers' affective states by focusing on the vocal cues and disregarding the words pronounced, individuals perform equally well as the ones who focus both on the content of the speech and vocal cues at determining affective states of the vocalizers, which emphasizes that vocal parameters are as important as the content of speech in terms of both expressing an affective state and referring the vocalizers' (Banse, & Scherer, 1996).

However, researches indicate that right hemisphere damaged patients' ability to comprehend affective speech is disturbed (Denes, Caldognetto, Semenza, Vagges, & Zettin, 1984; Ehlers & Dalby, 1987; Heilman, Bowers, Speedie, & Coslett, 1984; Kent & Rosenbek, 1982; Ross, Thompson, & Yenkosky, 1997; Ross & Monnot, 2008; Tucker, Watson, & Heilman, 1977). For instance, Denes and colleagues (1984) present their participants pairs of vowels that are composed of [a] and [o] sounds each of which pronounced in a way to convey anger, disgust, fear, happiness or sadness. They report that patients with damages in posterior regions of the right cerebral hemisphere perform poorer both than left hemisphere damaged patients and patients with damages in anterior regions of the right cerebral hemisphere along with healthy individuals in determining whether the pronounced vowel pairs represent the same or different emotion states. Accordingly, performance of patients with damages in anterior regions of the right cerebral hemisphere is observed to be worse than left hemisphere damaged patients and healthy individuals. Additionally, when it is asked to participants to identify the emotion that the first vowel in vowel pairs convey, it is observed that right posterior region damaged, right anterior region damaged and left posterior region damaged patients make more errors than healthy control group.

Denes and colleagues (1984) also examine if utilization of acoustic and conceptual cues differentiate between patients with distinct brain damages by examining error patterns of each investigation groups. They claim that frequent confusion of sadness and disgust or anger and fear are indicators of deficiency in utilizing acoustic cues since emotions in these pairs have similar duration and fundamental pitches (sadness-disgust) or similar duration and energy (anger-fear). Similarly, confusing sadness and disgust can also be interpreted in terms of deficiency in utilization of conceptual cues since sadness and disgust are placed closely on the Plutchik's circular model that is proposed on the basis of relative polarity and semantic similarity of emotions (See Figure 1.3) (Plutchik, 1980). When the error pattern of each group is examined, healthy individuals and left hemisphere damaged patients are observed to have high tendency to confuse sadness with disgust, whereas right posterior region damaged patients do not exhibit any stable error pattern. Denes and colleagues (1984) interpret these confusion patterns as the indicators of right posterior region damaged patients' inability to use conceptual and acoustic cues, while left hemisphere damaged patients and healthy individuals capable of utilizing both of them.

In addition to examining perception of affective prosody with brain damaged patients, the lateralization of perceiving affective prosody is studied with healthy individuals via dichotic listening paradigm. Dichotic listening paradigm can be regarded as auditory version of divided visual field technique, and involves

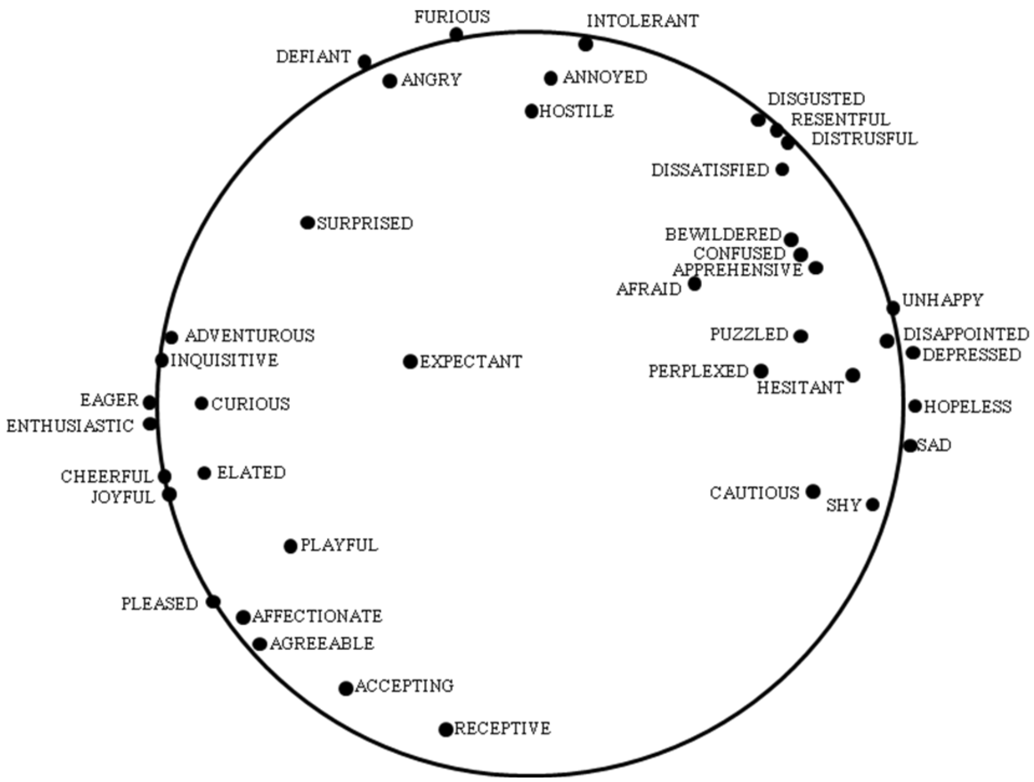

Figure 1.3. Plutchik's circular structure of similarity of emotions. Reprinted from Emotion: Theory, research, and experience: Vol. 1. Theories of emotion (p. 18), by R. Plutchik & H. Kellerman (Eds.), 1980, New York, NY: Academic Press. Copyright [1980] by Academic Press Inc.

presentation of two different auditory stimuli simultaneously. The stimuli presented can be short sentences as well as syllables or digits, and participants are asked to report what they heard after the stimuli presentation. Although both dichotic listening paradigm and divided visual field technique are based on lateral functionality of the neural system, primary injections of the visual and the auditory systems differ in terms of lateralization. Unlike the visual system, the primary projection of the auditory system is not completely lateralized. Both left and right ears have connections with the primary auditory cortices in temporal lobes of each cerebral hemisphere. The auditory information received by the left ear is transmitted to the left auditory cortex through ipsilateral pathways, and to the right auditory cortex via contralateral pathways. Similarly, the auditory information received by the right ear is transmitted to the right auditory cortex by means of ipsilateral pathways, and to the left auditory cortex through contralateral pathways (See Figure 1.4).

On the other hand, it has been established that information transmitted through the contralateral auditory pathways are more strongly presented in the brain than the ones the ipsilateral pathways transmit (Hugdahl, 2003; Kimura, 1967; Mononen, & Seitz, 1977). Therefore, the rate of participants' accurate reports of what they heard is interpreted in terms of *ear advantage*. Ear advantages are named on the basis of the ear from which the stimuli heard are reported more accurately, and they refer to the greater involvement of the contralateral cerebral hemisphere in processing those stimuli. For instance, if participants more accurately report the auditory stimuli they hear from the left ear than the stimuli

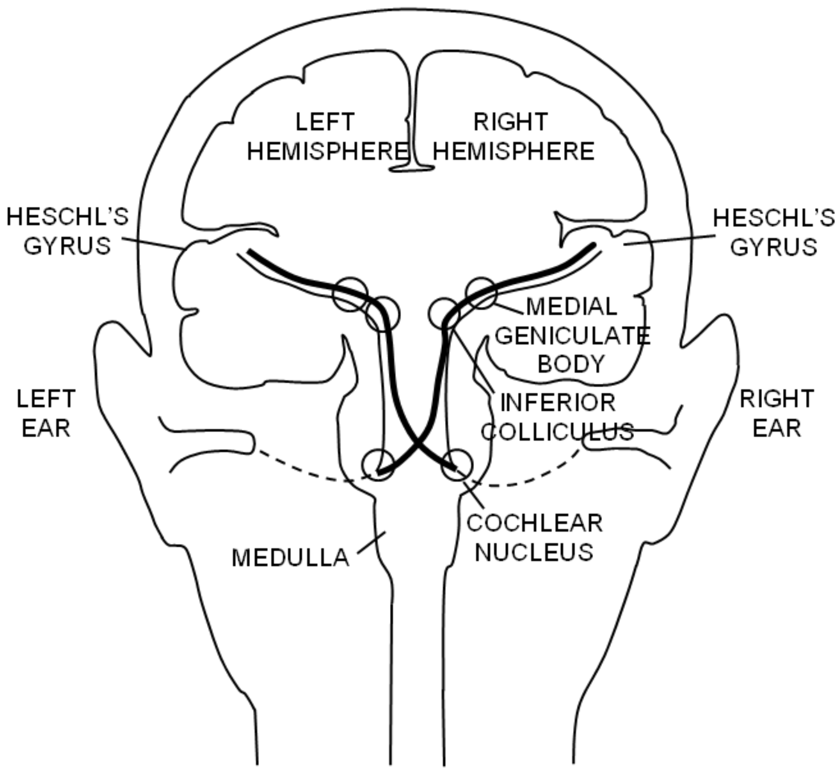

Figure 1.4. Pathways transmitting the audtory infomation received by easrs to auditory cortices. The auditory information received by the left ear is transmitted to the left auditory cortex through ipsilateral pathways, and to the right auditory cortex via contralateral pathways. (Kimura, D. (1973). The asymmetry of the human brain. Scientific American, 228(3), 70-78)

they hear from the right ear, it is described as, in simplest manner, a left ear advantage in processing those stimuli, which also refers to greater involvement of the right cerebral hemisphere. While in various dichotic listening studies right ear advantage is documented for processing speech-like and language related stimuli, left ear advantage is observed in processing non-verbal emotional component of speech, one of them which is affective prosody (Carmon, Nachshon, 1973; Haggard, Parkinson; 1971; Hatta, Ayetani, 1985; Herrero, Hilix, 1990; Saxby, Bryden, 1984; Shipley-Brown, Dingwall, 1988). For instance, Haggard and Parkinson (1971) present six short sentences – which are all vocalized once with angry, bored, happy or distressed tones – dichotically with a babbling crowd's sound, and ask their participants to identify the emotion that the vocal tone convey after participants report the sentence they heard. Haggard and Parkinson (1971) report that despite of not observing any difference between ears in terms of reporting sentences correctly; participants more accurately identify the emotional tone of the voice when sentences are heard from the left ear. Similarly, when Carmon and Nachshon (1973) ask their participants to match dichotically presented cry, shriek, and laugh of a child, a woman, and a man with representative drawings of each condition, participants are observed to perform slightly more accurate in matching voices heard from left ear with their representative drawings.

Dichotic listening paradigm is also used along with event related brain potential (ERP) measurements in investigation of functional specialization of the cerebral hemispheres in terms of processing affective prosody. In 1998, Erhan, Borod, Tenke and Bruder record event related brain potentials (ERPs) during dichotic listening paradigm, in which participants are presented emotionally pronounced nonsense syllables dichotically, and are asked to respond as quickly as possible when they heard the syllable pronounced in a specific tone that is declared to participants before the experimental session. Erhan and colleagues (1998) report left ear advantage regardless of the valence of intonation, however, they note that they did not observe ERP hemisphere asymmetries along with left ear advantage unlike previous dichotic listening studies (Haaland, 1974; Mononen, Seitz, 1977; Neville, 1974).

Along with dichotic listening researches and examination of brain damaged patients' performance in processing affective prosody, neuroimaging studies, too, indicate greater involvement of right hemisphere regions in perceiving affective prosody (Buchanan, Lutz, Mirzazade, Specht, Shah, Zilles, & Jäncke, 2000; Mitchell, Elliott, Barry, Cruttenden, & Woodruff, 2003; Sander, & Scheich, 2001; Wildgruber, Pihan, Ackermann, Erb, & Grodd, 2002). In order to investigate neural regions involved in processing emotional prosody and verbal component of spoken language, Buchanan and colleagues (2000) present their participants words pronounced in angry, happy, neutral or sad tones, and ask their participants (1) to detect specific words while disregarding the emotional tone they are pronounced in, and (2) to detect specific emotional tones while disregarding the words pronounced. They report that instructing participants to detect specific emotional intonation results in greater right inferior frontal lobe activation, whereas instructing participants to detect specific words cause greater left inferior temporal lobe activation. Wildgruber and colleagues' (2002) study on the effects of acoustic cues in detecting emotional states reveals that lateralization of neural activity in response to affective prosody is independent of acoustic structure and valence of the prosody. Similar to Buchanan and colleagues' findings, Mitchell and colleagues (2003) report that relatively right lateralized temporal lobe activation is observed when participants are asked to listen sentences spoken in different emotional tones, and sentences whose semantic components are not available but the tone they are vocalized in is clear. Additionally, they document that directing participants' attention to the semantics induces left lateralized neural activity, while paying attention to emotional prosody results in right lateralized neural activity.

The right hemisphere hypothesis and processing lexical emotion

Although facial expression and affective prosody channels of emotion have been studied intensely in terms of investigating neural regions and mechanisms that are involved in emotion processing, utilizing lexical channel of emotion in affective processing studies is relatively new. Researches indicate that right brain damaged patients perform differently than healthy individuals or left brain damaged patients in tasks that involve identification or discrimination of emotionally laden words (Borod, Andelman, Obler, Tweedy, & Welkowitz, 1992; Borod, Cicero, Obler, Welkowitz, Erhan, Santschi, Grunwald, & Whalen, 1998; Semenza, Passini, Zettin, Tonin, & Portolan, 1986). In order to examine brain damaged patients' performance on evaluating relatedness of emotion words, Semanza and colleagues (1986) present three emotion words simultaneously, and ask right brain damaged patients along with left brain damaged patients and neurologically healthy participants to choose two of the words that have similar meanings. They also repeat the same procedure by using bird and color names in order to control any linguistic or cognitive deficits' confounding effects. Semanza and colleagues conduct a cluster analysis and further compare clusters of emotion words with each other. They discuss that although right hemisphere damaged patients' and healthy individuals' performances on grouping bird and color categories yielded a significant correlation, grouping emotion words does not result in any significant correlation, and these performance differences are interpreted in terms of between right brain damaged patients and healthy individuals' differential processing of emotion words.

Similarly, Borod, Andelman, Obler, Tweedy, and Welkowitz (1992) compare right brain damaged and left brain damaged patients' performances of perceiving lexical emotion with each other and with healthy individuals' performances through (1) word-cluster identification, (2) sentence identification, and (3) word discrimination tasks. In word-cluster identification task, participants are presented word groups formed by three emotionally laden words, and asked to choose the emotion these words correspond to among happiness, pleasant surprise, interest, sadness, anger, fear, disgust written on a card, whereas in sentence identification participants are asked to choose the emotion that represents the emotion the sentence convey best. In word discrimination task, participants are asked to decide if the two words presented simultaneously belong to same emotion group. Borod and colleagues (1992) also create non-emotional version of these tasks by using "characteristics of people" instead of emotions. They characteristics used in this study are beauty strength, intelligence (positive characteristics), fatness, weakness, stupidity (negative characteristics), and hair color (neutral characteristic).

Borod and colleagues (1992) report that healthy participants performed more accurately than right brain damaged and left brain damaged patients through both emotional and non-emotional versions of word-cluster and sentence identification tasks, in addition to performing better than right brain damaged and left brain damaged patients on non-emotional version of word discrimination task. Moreover, right brain damaged patients perform better than left brain damaged patients on non-emotional version of sentence identification task, whereas left brain damaged patients perform more accurately than right brain damaged patients on emotional versions of both word-cluster task and word discrimination task. Additionally, it is noted that right brain damaged patients perform better on non-emotional versions of word-cluster task, sentence identification task, and word discrimination task than they do in emotional versions of all of these three tasks.

The Valence Hypothesis

The alternative emotion processing model introduced following the right hemisphere hypothesis is the valence hypothesis. Although emotional processing is formerly proposed to be associated with cortical structures in the right cerebral hemisphere, observations on emotional behavior changes of patients with unilateral left sided lesions raise the idea that the left cerebral hemisphere may be linked to emotion processing along with the right cerebral hemisphere. For instance, Goldstein (1939) reports that psychiatric patients with unilateral left sided damages have higher tendencies to present catastrophic-depressive reactions than psychiatric patients with unilateral right sided damages. Similarly, examination of several pathologic laughing and crying cases indicates that the two cerebral hemispheres may be specialized for positive and negative affect differentially, in a way that damages to the left cerebral hemisphere is related with depressive symptoms while damages to the right cerebral hemisphere is involved in pathological laughing (Sackeim, Weiman, Gur, Greenberg, Hungerbuhler, & Geschwind, 1982 as cited in Alves, Fukusima, Aznar-Casanova, 2008). These observations on behavioral changes of patients as dependent of which side of the brain is damaged bring forth the valence hypothesis.

In the valence hypothesis, it is stated that the two cerebral hemispheres are differentially specialized to process emotions as a function of their valence (Silberman & Weingartner, 1986). In this model of emotion processing, emotions are divided into two subgroups on the basis of their valence, as negative or unpleasant emotions (which involves anger, disgust, fear, sadness) and positive or pleasant emotions (which are happiness and surprise). Moreover, each subgroup is suggested to be primarily processed by a different cerebral hemisphere in a way that the left cerebral hemisphere is associated with positive emotions while the right cerebral hemisphere associated with processing negative emotions (Borod et al., 1992; Silberman & Weingartner, 1986).

Although the link between perception of negative emotions and the right cerebral hemisphere has been well established via studies conducted with brain damaged patients as well as healthy individuals, similar studies conducted with brain damaged patients result with diverse supports for the link between perception of positive emotions and the left cerebral hemisphere, which leads researchers to develop an alternative valence hypothesis. In the alternative valence hypothesis it is suggested that the left hemisphere is associated with expressing and experiencing positive emotions, while the right cerebral hemisphere is associated with expressing and experiencing negative emotions along with perceiving both positive and negative emotions (Borod, Koff, & Caron, 1983).

The Valence Hypothesis and Emotion Perception

Review of the literature related to the right hemisphere hypothesis and emotion perception reveals that researches investigating the link between emotion perception and the right cerebral hemisphere are carried out for all of the facial affect, affective prosody, and lexical emotion channels. Supporting evidence for the right hemisphere hypothesis in point of emotion perception is obtained through studies using diverse experimental paradigms such as divided visual field, dichotic listening, and semantic priming. On the contrary to the this variety of investigation domains in the literature of the right hemisphere hypothesis and emotion perception, researches designed to investigate hemispheric specialization of emotion perception as a function of the valence focus on facial affect channel of emotion communication. This restraint of investigation domain is unavoidable to some extent since differential specialization of emotion processing as a function of the valence of the emotion is first established through studies investigating emotional facial expression perception, and complementary evidences are not obtained consistently for affective prosody and lexical emotion channels.

The first known researchers who propose and explicitly investigate that the observed differential involvement of the two cerebral hemispheres in expressing and experiencing emotions laden with distinct valence may also apply to perception process are Reuter-Lorenz and Davidson (1981). They present facial expressions of anger, disgust, happiness, and sadness simultaneously with a neutral facial expression in a divided visual field study, and ask participants to designate the visual field from where the emotional face is presented while response time and accuracy score measurements are being taken. Despite of using the most obvious positive emotion and more than half of the negative emotions as stimuli, Reuter-Lorenz and Davidson are obliged to conduct statistical analysis only for facial expressions of happiness and sadness after finding out that facial expressions of negative emotions are posed rather than being photographs of simultaneous emotions. They report that although stimuli used for facial expression of sadness are among the posed facial expressions, they are the only posed stimuli which do not have any effect on recognition rates of the expression.

Reuter-Lorenz and Davidson (1981) state that the response time analyses give the first evidences of the two cerebral hemispheres being differentially involved in processing emotions with distinct valence in a way that the left cerebral hemisphere is associated with processing positive emotions, while the right cerebral hemisphere is associated with processing negative emotions. They report that participants detect the right visual field presentations of facial expressions of happiness faster than they detect the left visual field presentations of this facial expression. Conversely, facial expressions of sadness are observed to be detected faster when they were presented from the left visual field in comparison to the right visual field presentations. Moreover, it is reported that facial expressions of happiness are detected faster than the facial expressions of sadness when they are presented from the right visual field, whereas the facial expressions of sadness are observed to be detected faster than the facial expressions of happiness through left visual field presentations. Besides the observations related to the response time differences for detecting distinct emotional facial expressions through presentations from the left and right visual fields, Reuter-Lorenz and Davidson note that, although reported to be statistically insignificant, complementary accuracy rates are observed. They tentatively interpret their findings in terms of the differential lateralization of the cerebral hemispheres in construction of positive and negative emotions, and discuss that constructive and productive characteristics of perception may require involvement of motor processes, which in turn result in differential lateralization of the cerebral hemispheres in processing facial expressions as a function of their valence.

The idea behind the Reuter-Lorenz and Davidson's (1981) study is that if perceiving emotion presented in the face requires involvement of the motor process, then the cortical lateralization of processing emotional faces should present similar patterns as the expressing or experiencing emotions present. Therefore, they initially examine the extent to which the left cerebral hemisphere is associated with processing positive emotions and the right cerebral hemisphere is associated with processing negative emotions, and observe that cortical lateralization patterns of expressing and experiencing emotions seem to apply to the perception process. In 1983, in order to investigate whether perception requires motor processes, and if the motor processes involved in perception result in observed differential lateralization of the cerebral hemispheres in processing facial expressions, Reuter-Lorenz, Givis, and Moskovitch replicate Reuter-Lorenz and Davidson's (1981) study with right-handed, inverted left-handed, and non-inverted left-handed individuals. Reuter-Lorenz and colleagues (1983) claim that if motor processes are influential factors in differential specialization of the cerebral hemispheres to process emotional facial expressions, right handed and inverted-left handed participants are expected to present similar lateralization patterns, whereas the non-inverted left handed participants are expected to present this pattern in an opposite direction. Apart from investigating the involvement of motor processes in perception, another aim of this study is examining the effects of saliency levels of emotional facial expressions on the hemispheric specialization of perceiving emotional facial expressions. Therefore, facial expression of happiness is presented with photographs of models who express the emotion with closed or open mouth in order to have facial expressions with different saliency levels in this study.

The data obtained from right-handed individuals indicate that facial expression of happiness presented with open mouth is more accurately and more rapidly identified than happiness presented with closed mouth and facial expression of sadness, regardless of the visual field they are presented from. Additionally, it is reported that both expressions of happiness is identified more quickly than expression of sadness when they are presented from the right visual field. Furthermore, it is observed that inverted left-handed individuals detect expressions of happiness more quickly when they are presented from the right visual field in comparison to the left visual field presentations. Facial expression of sadness is reported to be detected more quickly than expressions of happiness when presented from the left visual field comparing to the right visual field presentations. Most strikingly, non-inverted left-handed individuals are observed to be presenting just the opposite pattern of response time analysis results obtained from right-handed individuals.

Although Reuter-Lorenz and her colleagues (1983) attribute the observed hemispheric specialization patterns of processing emotional facial expressions with distinct valence to the involvement of motor processes in perception, and present that handedness is an influential factor on the hemispheric specialization pattern of emotional expression processing, Natale, Gur and Gur (1983) fails to replicate that the expressions associated with the left and right cerebral hemispheres are reverse for left-handed and right-handed individuals. In order to investigate cortical lateralization of valence processing, Natale, Gur and Gur (1983) unilaterally present facial expressions of anger, disgust, fear, happiness, surprise along with sadness in a divided visual study, and ask right-handed, left-handed and inverted-left handed participants to evaluate the "happiness" levels of the expressions presented. Although they do not observe that the happiness ratings given by right-handed, left-handed, and inverted-left handed participants do not vary as dependent to the visual field the expressions presented from, it is observed that ratings given by participants differ among right-handed and left-handed individuals in a way that the overall ratings given by the right handed individuals are lower than the left handed individuals. Along with this observation, by considering that expressions presented from the left visual field are evaluated as less happy than the expressions presented from right visual field, Natale, Gur and Gur interpret their findings as the indicators of the bias of right cerebral hemisphere for negative emotions.

While the right visual field advantage is observed for processing positive emotional facial expressions in divided visual field studies, researches conducted with brain damaged patients do not provide consistent findings regarding to the link between the left cerebral hemisphere and positive emotions. In certain studies, perception of emotional facial expression performance of patients with damages to the right cerebral hemisphere has been observed to be damaged more than the facial expression recognition performance of patients with left cerebral hemisphere damages, regardless of the valence of the facial expression. Conversely, in other studies, right brain damaged patients' performance of perceiving negative emotional facial expression has been reported to be impaired more than left brain damaged patients, whereas left brain damaged patients are reported to perform worse than right brain damage patients in recognizing positive emotional facial expressions. For instance, Borod, Koff, Lorch and Nicholas (1986) report that when it is asked to name the emotion presented in a facial expression, right brain damaged patients is perform worse than both left brain damaged patients and healthy individuals. Additionally, although it has seen that negative and neutral emotions are perceived less accurately by right brain damaged patients in comparison to left brain damaged patients and healthy individuals; no performance difference is observed for perception of positive emotions among distinct participant groups. While right brain damaged patients emotion perception performance is reported to be worse for negative emotions in comparison to positive and neutral expressions, such a performance difference is not observed for left brain damaged patients.

On the other hand, Mandal, Tandon and Asthana (1991) compares performances of right brain damaged patients, left brain damaged patients and health individuals through (1) matching facial expressions of the same emotion and (2) verbally identifying the emotion presented in a facial expression tasks and report that both right brain damaged and left brain damaged patients perform worse than healthy control group, however, left brain damaged patients perform better than the right brain damaged patients over all. Right brain damaged patients are reported to be performing worse in identifying negative emotions in comparison to identifying positive emotions. Moreover, although left brain damaged patients are observed to perform better than right brain damaged patients in general, they perform worse than right brain damaged patients in identifying positive emotions, whereas recognition of negative emotions is more impaired for the right brain damaged patients in contrast to left brain damaged patients, which contradicts with Borod and colleagues (1986) findings.

By considering the inconsistent findings attained regarding to the valence hypothesis and the alternative valence hypothesis, Killgore and Yurgelun-Todd (2007) conduct an fMRI study by using backward stimulus masking technique, in which chimeric faces composed of either happy and neutral faces or sad and neutral faces, to investigate (1) global pattern of activity during presentations facial expressions of happiness and sadness, (2) specific activity patterns each visual field presentation for each affect trigger, and (3) specific activity patterns presentations of each affect within a particular visual field trigger.

By comparing the activation pattern observed throughout stimuli presentation with threshold, Killgore and Yurgelun-Todd say that a great right-lateralized activation pattern for all emotional expressions is observed as independent of the valence or the visual field that emotional facial expression presented from. The comparisons made between the left visual field and right visual field presentations present a greater involvement of the posterior right cerebral hemisphere, which is in line with the right hemisphere hypothesis. For instance, for happy expressions, middle temporal and fusiform gyri are observed to be greatly activated for left visual field presentations; and parahippocampal gyrus and fusiform gyrus of the left hemisphere, in addition to a large area within the right orbitofrontal cortex are observed to be greatly activated for right visual field presentations. Additionally, left visual field presentations of sad expressions yield in strongly right-lateralized activation in temporal lobes, parietal lobes, and occipital cortex, whereas right visual field presentations result in activity in left anterior hemisphere. On the other hand, comparisons made on the basis of the valence of facial expressions provide findings in accordance with the valence hypothesis. Presentation of sad faces from the left visual field yields in bilateral activity within the insular cortex, anterior cingulate gyrus, frontal cortex, temporal cortex, while facial expression of happiness presented from the left visual field, no regions with greater activation than presentation of sad faces is observed.

Killgore and Yurgelun-Todd (2007) propose on the basis of these observations that posterior right hemisphere is specialized to process emotional facial expressions as independent of the valence, along with specialized to process facial expressions with negative valance. It is also proposed that the posterior left hemisphere might be dependent on downstream processing in order to assess significance of the facial expression. According to this, sad facial expressions presented from the left visual field projected directly to the primary visual cortex. Since the right hemisphere is specialized to process negative emotional facial expressions sad faces presented from the left visual field will be processed more efficiently in comparison to sad faces presented from the right visual field, which are projected to the primary visual cortex of left hemisphere. In the left cerebral hemisphere, the expression projected is relayed to anterior regions for evaluation (See Figure 1.5).

Problems Regarding with the Techniques Used in Studies of Cortical Lateralization of Emotion Processing

Research on the cortical lateralization of emotional facial expression processing gives rise to two invaluable, strong hypotheses. However, as it is stated previously, there is no consensus reached on which emotion processing model explains best how emotional facial expressions are processed in the brain, and today, findings on the support of both the right hemisphere hypothesis and the valence hypothesis is being attained. Najt and his colleagues (2013) point out that dissimilarities among different studies in terms of the differences with regards to pre- and post operative neurological status among brain damaged individuals who served as participants, facial expressions used as stimuli, requirements of a task used and measurement techniques utilized to attain data related to performing a specific task along with approaches taken in data analysis are the facts that restrict making comparisons between findings of different studies, and therefore

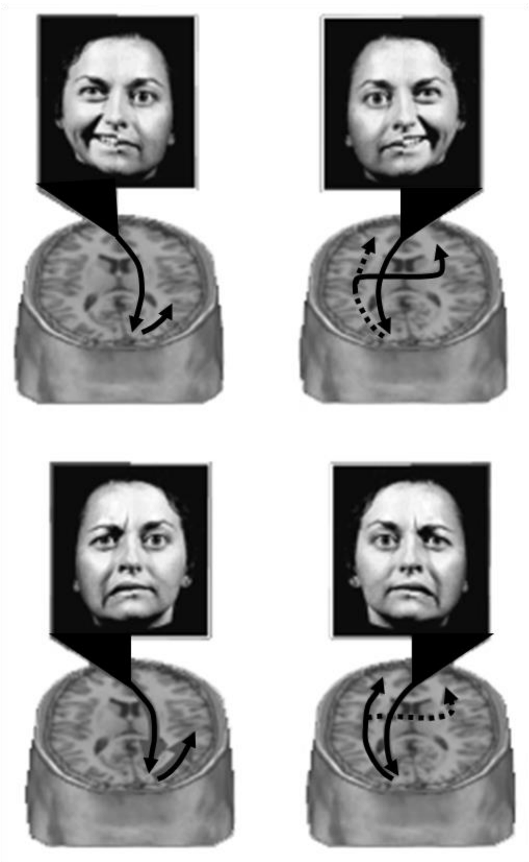

Figure 1.5. Killgore and Yurgelun-Todd’s model of emotional facial expression processing. According to this model, posterior right hemisphere is specialized to process emotional facial expressions, wheras computations related with significance of the facial expression is carried out at left cerebral hemisphere Killgore, W. D: S., & Yurgelun-Todd, D. A. (2007). The right-hemisphere and valence hypotheses: Could they both be right (and sometimes left?). *SCAN*, *2*, 240-250

not only resolving but also reducing the conflict between facial expression processing hypotheses are gradually growing difficult.

When the cognitive and neural structure of brain is considered, it would appear that modules are not distributed arbitrarily; instead, they are regionally localized throughout cortical and subcortical systems. The crucial point to be taken into account is that a complex cognitive process may result from collective performance of adjacent or closely located modules while other sophisticated cognitive processes, memory for instance, involve operation of distinct regions. Therefore, in order to thoroughly comprehend the operation of a complex cognitive process, it is crucial both to establish the modules this cognitive process is comprised of, and how these modules are combined to yield that particular cognitive process.

The oldest method used in neuropsychological research in order to uncover the cognitive architecture of complex cognitive processes, to build models (hypotheses) of cognitive architecture or revise the already developed models is the study of patients with lesions. It is thought that a lot of information can be acquired on the nature of normal functioning by studying dysfunction (Damasio & Damasio as cited in Bauer, Leritz, & Bowers, 2003) since damages to brain, as lesions, are thought to cause in specific performance impairments or deficits. Furthermore, since brain organization is uniform across all humans in a certain way in spite of inconsiderable differences between individuals in terms of cognitive abilities, information gathered on the nature of normal functioning from studies of dysfunction can be generalized to individuals without lesion. In a cognitive processing model developed by researchers in order to define how a complex cognitive function is formed, all modules, and elementary cognitive operations which constitute that particular cognitive processing are precisely itemized. In examination of patients with lesions, these models are regarded as guides since precisely itemization of subsystems involved in a cognitive functioning gives invaluable opportunity to identify and to localize the patients' shortages in terms of behavioral performance. Such behavioral data can be acquired from examination of a single patient as well as examinations of a group of patients with lesions at same anatomical localizations. At the end of the patients' examinations, observed behavioral performance differences on different tasks may help us to determine whether the same cognitive ability controls these tasks (association) or required cognitive abilities to perform one task differ from the others vital in terms of performing the other task (dissociation) (See Figure 1.6). However, these outcomes should be interpreted carefully, since these observed performance similarities may result from an unmeasured processing that occurs early in processing steps, or different task difficulties may cause differences in behavioral performance. As Teuber (1955) points out, only the observation of poor performance in one task (Task A) without any impairment in performing other task (Task B), and vice versa at the same time (double dissociation of symptoms) is the strongest indicator of specifity between lesions and behavioral performance. For instance, in order to be able to say that recognition of an emotion expressed in the face and face recognition are distinct cognitive functions, it should be established that emotion recognition performances of patients with

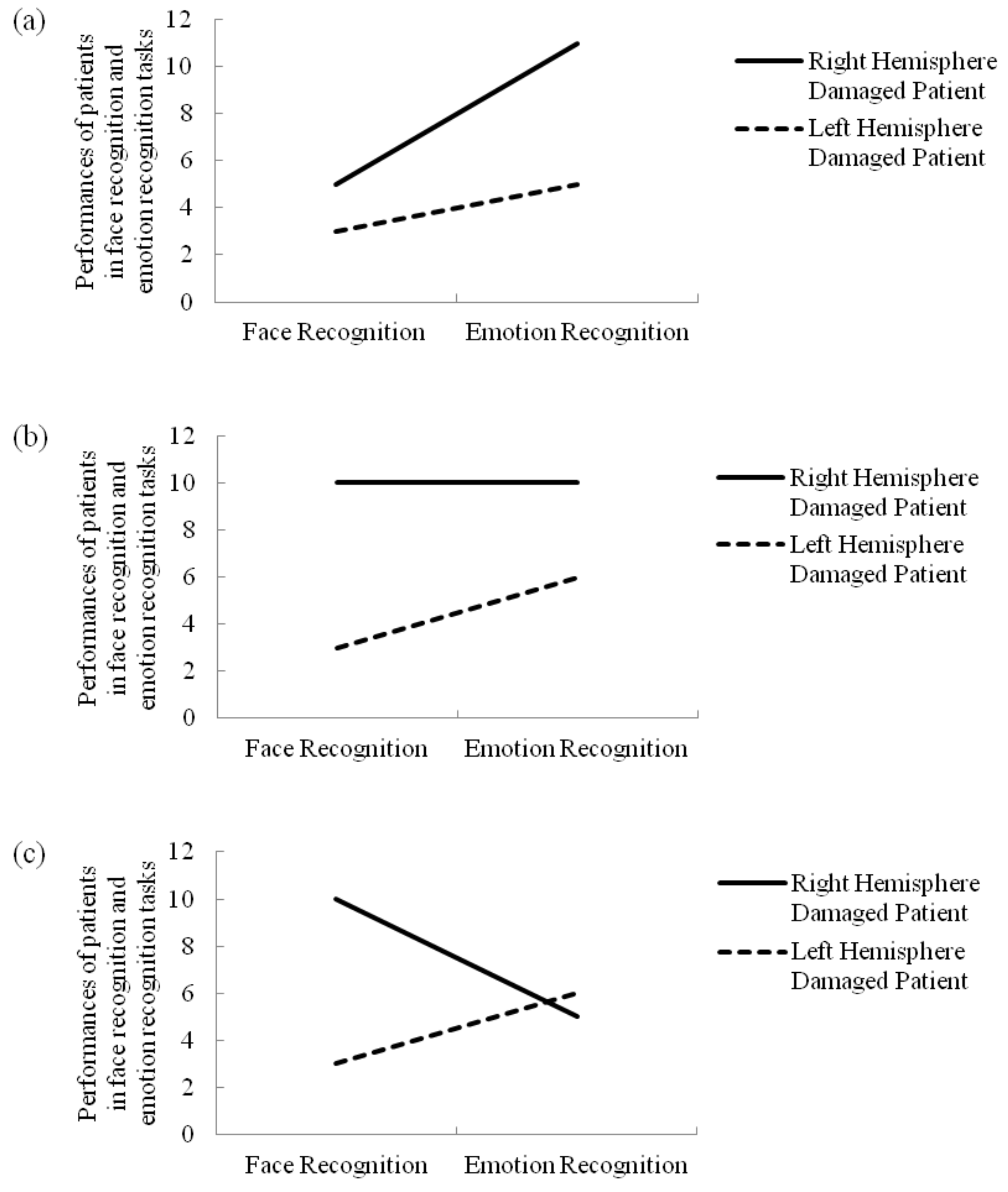

Figure 1.6. Instances of (a) association, (b) dissociation, and (c) double dissociation.

damages to the specific brain region decreases while their face recognition performance is not affected in addition to presenting that damages to different region in the brain affect face recognition of patients while emotion recognition performance remains intact.

Lesion studies provide precious information on the constituent subsystems of cognitive functions. However, one of the difficulties faced with while studying on the hemispheric specialization of a given cognitive function with patients with brain damages is finding functionally and anatomically corresponding regions in the cerebral hemispheres. In addition to that, while interpreting findings attained from performances of patients with lesions and generalizing them to individuals without lesion, it should be bear in the mind that these studies are conducted with patients who have *abnormal* brains, which means these patients' neurological histories are greatly different than healthy individuals.

Aside from the difficulties studying with patients with brain damages bring about, another factor that makes analyzing and contrasting the findings of different studies is the number of facial expressions used as stimuli through investigation of functional cerebral asymmetries in processing emotional facial expression. It has been observed that researchers have tendency to select two or three emotional facial expressions as the representative of an emotion category such as negative and positive emotions. Problem with this approach is that it is not always possible to be sure that the selected expression is the representative of the emotion category that is being studied. For instance, if a researcher uses expression of anger along with expression of happiness to study how positive and negative emotions are processed and finds out that processing these expressions are linked with different cerebral hemispheres, he may be actually finding that recognizing facial expressions of approach related emotions are associated with different cerebral hemispheres since anger is classified as an emotion that leads individuals towards the environment from the approach-withdrawal hypothesis' perspective (Davidson, 1995). Approach/Withdrawal Hypothesis categorizes anger as an approach tendency because it implies a goal blockage disruption (Depue & Zald, 1993). Therefore anger has crucial implications for differentiating between the two versions of the valence-specific hypothesis. Besides, these risks that disregarding the fact that emotions are categorized differently in distinct emotion processing hypotheses has last even the facial expressions of all of the six basic emotions are used as stimuli since statistical analyses are generally conducted by combining the measurements acquired for each emotion which are proposed to be the entities in an emotion category.

Last but not least, another important point that restricts making comparisons between findings of different studies is that the paradigms used in investigation of cortical lateralization of emotion processing vary from matching to target, emotion recognition to same-different tasks and giving ratings of *emotionality* to the presented facial expression. Stone and her colleagues (1996) states that giving the target emotion words before the presentation of facial expressions that are supposed to be judged if they represent the same emotion with the emotion words improves the performance of the left cerebral hemisphere. They discuss that even such a slight change improve the emotion recognition performance of the left cerebral hemisphere.

A New Dimension to Be Considered: Saliency

Although it has been traditionally investigated that valence of distinct emotional facial expressions might be influential on the way facial expressions are processed, there is a growing view that it may be the saliency levels of facial expressions rather than their valence characteristics that causes a hierarchy in processing of emotional facial expressions (Du & Martinez, 2013). Du and Martinez (2013) propose that although the brain areas that are specialized to process emotional facial expressions might be the same, the pathways through which these facial expressions are transmitted to that particular brain area might differ. Regarding to this suggestion, one of the prominent factors that has been introduced to determine through which pathway an emotional facial expression might be transmitted is its salience. Saliency is defined as “the quality of being salient”, which means “projecting beyond a … surface or level” and “standing out conspicuously” (Collins Dictionary) and although it has not been investigated if cerebral hemispheres of the brain are specialized to process emotional facial expression on the basis of their saliency levels yet, the effects of saliency levels of emotional facial expressions on the accuracy rates of categorizing facial expression in under high cognitive load (Tracy &Robins, 2008), response time takes to process them (Calvo & Lundqvist, 2008; Palermo & Coltheart, 2004), minimum exposure time sufficient to process a facial expression when presented through images with low resolutions (Du & Martinez, 2013).

It is known that identifying and recognizing facial expressions of emotions with high saliency levels takes shorter time than recognizing and categorizing emotional facial expressions with lower saliency (Calvo & Lundqvist, 2008; Palermo & Coltheart, 2004). For instance, Palermo and Coltheart (2004) present facial expressions of anger, disgust, fear, happiness, sadness and surprise in addition to a neutral expression, which are derived from various face stimulus sets, and ask participants to (1) identify the emotion presented in the face along with (2) rating the intensity of a given facial expression. It is observed that facial expressions with high salience are recognized both faster and more accurately than facial expressions of emotions with low salience. They report that facial expression of happiness is recognized faster than all of the other expressions, whereas fear is the slowest. In addition to findings of Palermo and Coltheart (2004), Calvo and Lundqvist (2008) report that along with being recognized more accurately and fast, facial expression with high saliency levels are recognized more correctly than expressions with low salience even for presentation durations as short as 25 msec. Moreover, Tracy and Robins (2008) report that highly salient facial expressions' feature of being recognized more accurately and fast is still preserved even under high cognitive load whereas recognition rates of facial expressions with low saliency levels impair. Tracy and Robins (2008) observe that when individuals are given a seven-digit number prior to an emotion recognition task and are told that this number will be asked at the end of the study, recognition rates of fear, sadness and surprise decreases in comparison to trials in which participants are provided enough time to process facial expressions and not given a seven-digit number to remember.

In 2013, Du and Martinez present the hierarchical processing of emotional facial expressions on the basis of their saliency levels in a more direct way than the examining only the differences in accuracy rates and response time between distinct facial expressions by altering both the resolutions of the images used for facial expressions of basic emotions and the presentation durations. Du and Martinez (2013) creates five different levels of visual saliency for each emotional expression by changing the resolution of the images (See Figure 1.7) and ask participants to identify the emotion presented in the face. In addition to varying resolutions of images, they also vary the stimulus presentation durations in a way that each misidentification of the emotion increases the stimulus presentation durations whereas the duration was decreased for each correct identification. Du and Martinez (2013) report that the accuracy rates of highly salient facial expressions such as happiness are recognized more accurately and require shorter presentation durations than facial expressions with low saliency levels across distinct resolution levels, which indicates that emotional facial expressions with high salience are more resistant to visual distortions than facial expressions with low salience.

Given such advantage of facial expressions with high saliency levels, it was aimed to investigate whether emotional facial expressions differs in terms of their resistance to the cognitive load that act of lying brings into by using instructed lying paradigm. Prior to stating the hypotheses, the literature regarding to the cognitive load that being engaged in deceptive acts will be presented through the following section.

Deception

The definition of deception in an unpretentious manner is that it is a

Figure 1.7. Different resolution levels for each emotional facial expression created by Du and Martinez. Reprinted from Du, S., Martinez, A. M. (2013). Wait, are you sad or angry? Large exposure time differences required for the categorization of facial expressions of emotion. *Journal of Vision,13*(4), 1-14

deliberate attempt to make someone believe something that is not true or intentionally withholding the truth from others in order to be able to mislead them, and gaining a specific benefit or reducing the size of possible risk or punishment are among the motives that generally lie behind the act of deception (Bhatt, Mbwana, Adeyemo, Sawyer, Hailu, & VanMeter, 2009).

Deception is one of the intricate behaviors that cannot be narrowed down to one or two specific practices, and is comprised of various forms like concealment, exaggeration or joking, of which possibly the most frequently observed deed is lying. Lying is an intentional attempt to mislead others by changing the information so that it is no longer true or correct. This plain description of lying connotes some of the cognitive processes involved in it as distinct from truth telling, which result inevitably in higher cognitive load, which are that a person who produces a lie should *know* what the “truth” is to successfully manipulate it, has to *inhibit* both the truth itself and the activated memory related to it and *produce* plausible alternatives to increase its persuasiveness (Ekman; Vrij & Mann, 2001 as cited in Gombos, 2006; Walczyk, Roper, Seeman, & Humphrey, 2003).

Attempts to uncover the behavioral indicators of the cognitive load lying brings to give rise to four distinguished theories, which are (1) Zuckerman et al.’s (1981) Four-Factor Theory of deception, (2) Lane and Wegner’s Preoccupation Model of Secrecy (1995), (3) Walczyk et al.’s Activation-Decision-Construction Model (2003) and (4) Mohamed et al.’s neurological model of deception (2006).

Four Factor Theory

Miron Zuckerman and his colleagues' (1981) Four Factor Theory of deception is the first comprehensive theory on the behavioral correlates of deceptive acts, which was founded upon the findings derived from various preceding studies conducted, in which behavioral correlates of lying are examined by using different levels of physiological and behavioral measurements. By bringing together the findings of these studies, Zuckerman and his colleagues reached the conclusion that although it is impracticable to associate lying with certain verbal or nonverbal expressions as in the manner specific emotions are associated with specific facial expressions, act of lying has an effect on behaviors since it is comprised diverse processes or factors that produce effect on behavior. These factors are (1) the control attempt of the deceiver, (2) the arousal caused by the act of lying, (3) affects aroused because of engaging in deception, and (4) the cognitive factors in deception.

Zuckerman and his colleagues adopt the definition of lying developed by Krauss and his colleagues (1976) in which lying is construed as an intentional act to promote an idea or belief, that is regarded as false by deceiver, in another person. The important characteristic of lying indicated in this definition is its dual nature, which refers to active participation of both the deceiver and the perceiver through the communication of lying. In order to enhance plausibility and cogency of the false message deceiver transmitted, he has to manage his self-representation well, while the perceiver judges the deceiver's sincerity and evaluates what can be deduced from the message he received.

The most frequently used means concerning maintenance of plausibility and cogency of the transmitted message are composed of the attempts made by deceivers to control their verbal and nonverbal behaviors. However, ironically, these control attempts generally turn into deception or leakage cues as referred to by Ekman and Friesen (1969). It is believed that control of verbal communication channels requires less effort than control of nonverbal communication channels such as facial expressions, body movements, vocal tone or having eye contact require, however, researches indicate that certain nonverbal communication channels are as restrainable as verbal communication channels. The degree to which a communication channel is controllable is determined by (1) the amount of distinguished messages that can be delivered through that channel in addition to the degree that channel is attended by addressees (sending capacity), (2) the degree of comprehensiveness of addressees' responses (external feedback), and (3) the degree of self awareness of one's own expressions (internal feedback) (Ekman and Friesen 1969).

Considering the factors that determine to what extent a communication channel is controllable, facial expressions can be regarded as having high levels of controllability than other nonverbal communication channels, especially than body movements, since face has higher sending capacity, people with whom deceiver communicates highly attend to the information transmitted through face, and people are more aware of their facial expressions than they are aware of their body movements. However, despite having high levels of controllability, facial expressions still leak deception because of very brief muscular movements in the face called microexpressions. Microexpressions are considered as the remainders of the concealed expressions which aroused immediately, however, their appearance is interrupted by person taking control and switching them with another expression (Ekman and Friesen, 1969). Haggard and Isaac's (1966) observations of clinical interviewees' facial expressions conflict with the previous or following facial expressions throughout denial statements or verbal blockings is one of the supportive evidences of that microexpressions uncontrollably leak deception cues.

This hierarchy between facial expressions and body movements in terms of controllability leads researchers to investigate whether such a hierarchy exists between other communication channels, and the findings indicate another controllability order between verbal content of the speech and tone of voice (Weitz, 1972; Bugental, Love, 1976). Tone of voice is a communication channel with high sending capacity as verbal content, on the other hand, the extent it avails of internal and external feedback is not as clear as verbal content does. Weitz's (1972) study on whites' friendly attitudes toward blacks indicates that friendly attitudes present high positive correlations with the friendliness interpreted from the tone of voice whereas they are negatively correlated with the friendliness deduced from the content. Another study whose findings indicate vocal tone is less controllable than content of speech is Bugental and Love's (1976) study conducted with mothers of children who either have problems at school or do not. If a mother feels confident or unconfident about controlling her children is disclosed by whether she uses confident tone while making verbal comments with either neutral or affective content. Apart from these findings, Zuckerman and his colleagues' (1981) observations on differences among people's ability in terms of modifying facial expressions and vocal tone, and the accuracy rates of people's predictions on what kind of messages can be derived from either their facial expressions or vocal tones set forth a hierarchy between facial expressions and vocal tone by presenting facial expressions are more controllable than latter communication channel.

In order to transmit a lie without being caught, the deceiver should control his nonverbal communication channels as well as verbal communication channels to prevent any leakage or deception cues. However, since the number of channels to be controlled simultaneously is numerous and there are control hierarchies between different communication channels, Zuckerman and his colleagues (1981) conclude that any attempt of deceiver to control his behavior may result in planned or rehearsed self-representation of the deceiver, speech disturbances or in development of discrepancies between different channels, such as between face and body, face and vocal tone, or microexpressions may transmit different messages to addressees.

The second factor proposed by Zuckerman and his colleagues as an effector of behavior that being engaging in deceptive acts causes is arousal (1981). This assumption bases on the findings of psychophysiological detection of lying studies (Hemsley, 1977; Lykken, 1974; Orne, Thackray, & Paskewitz, 1972; Podlesny & Raskin, 1977; Waid & Orne, 1981), in which it is found that deems of truth telling and lying generate different autonomic response, the latter one induces higher levels of arousal. Davis (1961) proposes that the underlying processes that cause act of lying to generate high levels of autonomic responses can be interpreted from the view of three theories; the conditioned response theory, the conflict theory, and the punishment theory. The idea underlying the conditioned response theory is the assumption that the question which directs someone to lie is associated with a dishonest, consequently, a traumatic experience. In conditioned response theory, this association is regarded as the reason for higher autonomic responses. Zuckerman, variously, approaches the association from a different standpoint and claims that the association may not be necessarily established between the question and a traumatic experience, instead, lying itself may be associated with past lying experiences resulted in troublesome outcomes. Conflict theory, on the other hand, introduces being torn between two incompatible acts, telling truth and lying, as the rationale for the enhanced responsivity throughout lying. Besides the explanations provided by both the conditioned response theory and conflict theory, punishment theory refers to deceiver's apprehension of punishment he may get when he is caught while lying as the source of higher responsivity. As distinguished from Davis's theories on how lying evokes enhanced autonomic responses than truth telling, three additional approaches, having the specific information (guilty knowledge) (Lykken, 1959, 1960), deceiver's incentive to succeed in misleading others (Gustafson & Orne, 1963, 1965), and differential habituation curves shaped by truth telling and lying stimuli (Lieblich, Kugelmass, & Ben-Shakhar, 1970; Ben-Shakhar, Lieblich, & Kugelmass, 1975) are presented in literature of psychophysiological studies of deception. In these approaches, higher autonomic responses lying causes are attributed to either the motivation the deceiver has or the characteristics of stimulants.

It is well documented that arousal producing stimuli cause observable behavioral changes, such as changes in pupil dilation, frequency of eye blinks, rise in voice pitch, and speech disturbances. It is proposed by Hemsley (1977) that since lying is an instance of the arousal producing situations, therefore arousal related behavioral changes may be observed in people involved in deceptive acts. The essential point to be taken into consideration is, yet, distinguishing the rationale underlying the behavioral changes since affects involved in being engaged in deceptive acts is another factor that causes behavioral changes as well as arousal producing stimuli do, which leads us to the third factor of Zuckerman and his colleagues' Four Factor Theory – affects aroused because of engaging in deception.

The most frequently felt sentiments throughout the act of lying are noted as guilt because of being engaged in deceptive acts and anxiety triggered by the idea of being caught or having his lie unmasked. In accordance with the motivation of the deceiver to succeed in misleading others, Ekman (1980) adds the joy of deceiving others ("duping delight") among the emotions aroused by being involved in deceptive acts. Although these emotions may cause higher autonomic responses, they may influence behavior in a way apart from higher arousal levels alter behavior. For instance, negative emotions experienced because of being involved in lying may result in expressing less pleasant facial and vocal behaviors, or even withdrawal which is an attempt of detaching oneself from the deceptive message he transmits in order to reduce the negative affects experienced. Withdrawal attempts are generally accompanied by decrease in bodily gestures, frequency and duration of eye contact and increased efforts to change the conversation topic.

The last and least detailed component of lying that is put forward by Zuckerman and his colleagues as the cause of behavioral changes is the cognitive factors involved in it. The single argument propounded by Zuckerman is that creating a lie is much more difficult and more complex task than truth telling since a deceiver should minimize the logical inconsistencies or has to consider the information perceiver already has, which results in higher response times in consistency with other cognitively complex tasks. In addition to longer response latencies, speech disturbances like speech pauses and hesitations are frequently observed.

Although Zuckerman and his colleagues' Four Factor Theory of deception is the first comprehensive theory on the behavioral associates of lying, it falls short of providing a detailed explanation on the cognitive processes underlying the act of lying. Theories regarding the cognitive processes act of lying is comprised of increases after Four Factor Theory, first of whom the Preoccupation Model of Secrecy proposed by Lane and Wegner (1995).

The Preoccupation Model of Secrecy

The Preoccupation Model of Secrecy is one of the models that draw attention to the cognitive processes that lie behind the act of deception, rather than behavioral correlates of it. Developers of the Preoccupation Model of Secrecy, Lane and Wegner, propound that behavioral changes observed in an individual throughout engaging in deceptive acts, such as increased skin conductance levels as observed in Pennebaker and Chew's study (1985, as cited in Lane & Wegner, 1995), are indicators of the mental effort required to perform deceitful acts, however, observations on behavioral changes provide only a partial explanation on the nature of deceitful behaviors. In order to get a solid grasp of why deception is such a hard deed to accomplish, it is crucial to examine and understand the cognitive processes taking place in such acts and their interactions with each other.

The Preoccupation Model of Secrecy is primarily developed to shed light on the question of which cognitive mechanisms that keeping a secret brings into and how these mechanisms interact with each other. Keeping a secret, or secrecy, is consisted of attempts that are made to keep someone from recognizing something one believes to be true, and does not involve producing any plausible alternative of the truth on the contrary of lying. This difference between secrecy and lying may lead people to think that the insight gained about the operation of cognitive mechanisms via this model may not be applied to the functioning principles of the cognitive processes involved in lying. However, this model still provides invaluable insight into the operation of fundamental cognitive mechanisms of lying, since cognitive processes these two deeds have are highly resemble when producing plausible alternatives is excluded.

In Preoccupation Model of Secrecy, it is proposed that the first cognitive mechanism triggered by the existence of a secret to be kept is suppression. Suppressing the secret itself and the activated memory or information related to that secret is one of the frequently used strategies in order to avoid any accidental disclosure. However, Lane and Wegner state that these suppression attempts made by the secret bearer engender in secret gaining more accessibility to the consciousness than it had before by means of the intrusive thinking that suppression causes, which means that regardless of the cognitive load one has, the secret comes to mind unexpectedly and more quickly without any conscious search for it. Lane and Weger explain this “hyperaccessibility” in terms of the unconscious, automatic search processes suppression initiates. The hyperaccessibility secret gained and the introduction of intrusive thoughts because of suppression may result in secret bearer to concern about an inadvertent revelation, which produce renewed suppression attempts in order to discard these intrusive thoughts. Lane and Wegner emphasize that the relationship between intrusive thinking and renewed suppression attempt may easily turn into a cyclic relationship since each suppression attempt may result in new hyperaccessible, intrusive thoughts that require being suppressed in order to remove the displeasure and distress they cause.

In order to test the suppression brings into hyperaccessibility of the secret assumption of their model, Lane and Wegner designs a study in which they ask participants to complete a two color Stroop task while they are keeping either a two digit or nine digit number in their minds. The rationale behind using numbers with two different kinds of digit is creating either lower or higher cognitive load for participants. Earlier on participants start to Stroop task, a target word assigned to each participant and they are asked to either keep researcher watching participants throughout the experimental session from extracting the target word by observing participants reactions or to reply the questions related to their target word that can be addressed by the researcher. The word lists used in the Stroop task are comprised of a target word that is assigned to participants before they start to experimental procedure, words that are related to target word and words that are irrelevant of the target word. It is hypothesized that if suppression causes hyperaccessibility of the information that is being kept in secret, participants who are in high cognitive load condition and who are asked to keep their target word in secret should have the slowest response times in two color Stroop task. The findings of this study revealed that response times of participants in higher cognitive load condition are higher that the participants in low cognitive load condition. Additionally, it is observed that participants in high cognitive load condition react to target word slower if they are asked to keep it in secret in comparison to participants who do not make such attempts. Moreover, such a response time-secrecy relationship is partially observed for target word related words, while this relationship is not observed for target irrelevant words, which serves as evidence for the hyperaccessibility assumption of Preoccupation Model of Secrecy.

The Preoccupation Model of Secrecy makes helpful contributions to uncovering the cognitive processes involved in secrecy. Although lying and keeping secret seems as different processes in terms of the cognitive mechanisms they are built on, the information acquired on the relationship between suppression and intrusive thinking via this model may be applicable for act of lying. However, the relationship between the processes of producing plausible alternatives of the truth that lying involves and intrusive thinking is still needed to be examined.

Activation-Decision-Construction Model

The Activation - Decision - Construction Model developed by Walczyk and his colleagues (2003) in order to shed light on the processes that lie behind the increased response times lying causes is the first model which presents cognitive processes such as information encoding, activation of information stored in long term memory, spread of activation among respective cognitive networks, and information transmission from long term memory to working memory for consideration. In this model, act of lying is described in terms of activation of semantic and episodic memory related to truth in addition to the truth itself, deciding either to respond honestly or to lie and construction of the lie in case of deciding to deceive phases.

According to the Activation - Decision - Construction Model, when a question is directed to the addressee, each word, that forms the question in combination, activates the semantic and episodic information related to it, and the activation of truth arises after the complete processing of the question. The full question fills the temporary storage system of the verbal short term memory, called articulatory loop. The activated truth and the information related to it are transferred from long term memory to working memory automatically.

Deciding to lie is a resolution reached at after a person considers the social context and his or her self-interest. These considerations are one of the reasons that decision phase adds to response times. The following processes initiated immediately after reaching a decision to lie are inhibition of both the truth active in articulatory loop in order to prevent a disclosure, and implausible lies that can be generated via using the activated truth-related information. Residuary information of such screening and inhibition processes are used in construction of lie and finally the constructed lie is transmitted to the audience.

In order to test if decision and construction phases add to response time as it is proposed in their model, Walczyk and his colleagues design a study in which participants are asked to answer number of open ended and yes-no questions which vary in terms of their embarrassment level. Whether participants lie or tell the truth is dependent on the experimental group they are assigned to. Walczyk and his colleagues assert that one of the factors that may influence lie construction agility of participants is their verbal efficiency. For this reason, participants are asked to complete three tasks in which they are asked to read the words presented, decide if the presented word pair belongs to same category, and generate verbs related to the words presented before they start to receive questions and reply them either truthfully or deceitfully. Participants in lie telling group are asked whether the truth and truth relevant information activated in their memory, if they tried to think about implausible responses other than the truth immediately after they lied. This probe is made in order to examine the activation phase of their model via having feedback about the task difficulty and personal experience.

Findings of this study indicates that material used in such studies do have effect on response times. It is noted that responding to yes/no questions take much shorter time than responding to open-ended question takes. Although there is such a response time difference between different types of questions, this difference is not sufficient to eliminate the response time differences between truth telling and lie telling. Walczyk and his colleagues (2003) report that regardless of the question type addressed to the participants, it takes longer response time to generate lies that truth telling, and verbal efficiency levels of participants only correlate with lie telling response times.

Feedbacks gathered from participants after they answered each question reveals that the question addressed to participants do activate the truth and truth related memory first, and these activated memories are used in lie construction. Participants in lie telling group describe the plan they followed for replying yes/no questions as saying “yes” if the actual answer is no, and saying “no” if the answer is yes. Although this plan may seem very automatic and effortless, it still requires the activation of the true answer. Feedbacks received for open-ended questions, on the other hand, indicate that participants first thought about truth and relevant knowledge is activated in their mind. Additionally, participants report that they intentionally inhibit the truth to avoid a disclosure and then make up their lies instead of the truth.

Although findings of their study is in line with the predictions of their model, Walczyk and his colleagues note that this model still needed to be improved. Questions used throughout the study are generally related to close memories, and the Activation - Decision - Construction Model should be tested by using remote memory related questions to probe the effects of allocation of control processes on response times.

Neurological Model of Deception

Being engaged in deceptive acts has been associated with changes in various physiological responses for a long time, and researchers have used one or more of these physiological response changes as base in their attempts to develop a systematic measurement technique for detection of deception. For instance, in late 19th century, Lombrosso’s observations on the relationship between changes in blood volume and deception lead him to claim that drop in blood pressure is associated with guilty deeds. Yet, he reveals innocence of a suspect, who is accused of stealing money, by using his technique while interrogating the suspect and it is disclosed that the suspect is guilty for stealing some documents but not for stealing money (Grubin, Madsen, 2005). In early 20th century, researchers start to use multiple physiological channels in their detection of deception studies. Benussi observes changes in blood pressure, pulse, and breathing rate in his detection of deception studies, and these measurements guide him to conclude that act of lying is associated with variation in the rate of exhaling to inhaling, a notion that is also known as “Benussi ratio” (Grubin, Madsen, 2005). Although another researcher Munsterberg’s writings on the physiological correlates of lying is not supported by European scientists under the guise of not being scientific, his student Marston’s claims on finding “specific lie response”, which is based on his observations regarding the correlation between systolic blood pressure and lying, is given credit and is being discussed if “systolic blood pressure deception test” is applicable in courts (Grubin, Madsen, 2005).

Even though the relationship between various physiological responses and lying is established by many researchers at different times, the invention of deception detection device polygraph, which is widely used nowadays, did not actualize until Larson succeeds recording three physiological measurement channels - blood pressure, pulse rate, and respiration - simultaneously in 1921, and in 1939, Keeler goes a step further, and adds galvanic skin response measurement to Larson’s invention. Since Keeler is more interested in marketing of this invention rather than its accuracy, he starts first polygraph school regardless of the

Larson's doubts on his invention, which results in establishment of rival polygraph schools, and extensive usage of polygraph in criminal interrogations.

The accuracy of the physiological response recordings is not the only issue that preoccupies researchers. Using polygraph with interrogations bring about another questions directly related to the questioning technique used during interrogation, and new questioning techniques are developed to reduce the problems previous questioning technique brings about, which results in development of the Relevant/Irrelevant Technique, Control Question Test, the Directed Lie Test, and the Guilty Knowledge Test to be used throughout interrogations.

The Relevant/Irrelevant Technique is the oldest method that is developed by Larson in 1932, and involves addressing crime-relevant and crime-irrelevant questions to examinees. Crime-relevant questions are the ones that are directly related with the crime under investigation (e.g. "Did you murder the victim?", "Did you steal the money?"), on the other hand, crime-irrelevant questions are the ones whom can be replied honestly without having any concern of being accused of committing the crime, and whose answers are known by both the examiner and the examinee (e.g. "Is today Monday?", "How old were you 5 years ago?"). This technique bases on the assumption that although innocent and guilty examinees give similar responses to crime-related questions, crime-related questions will result in higher arousal levels than crime-irrelevant questions in guilty examinees, whereas such arousal differences for different type of questions is not observed in innocent examinees. Although the rationale behind this technique seems plausible at first glance, this technique severely suffers from taking into consideration the fact that crime-relevant questions may be more arousal evoking than crime-irrelevant questions in general. Additionally, this technique is seriously lacking in explaining if the arousal is because of the anxiety triggered by committing the crime and fear of being caught or because of being afraid of not being believed. These obstacles that the Relevant/Irrelevant Technique RIT has endanger its applicability.

Another questioning technique developed to resolve the problems that RIT brings into is the Control Question Test, also known as Comparison Question Test, in which control questions that are formed by the examiner are used instead of low arousal evoking crime-irrelevant questions used in the Relevant/Irrelevant Technique, together with crime-related questions along the examination. Control questions are the ones that are general, ambiguous in nature and are asked to deliberately embarrass the examinee so that examinee feels that he should deceive the examiner by responding the question with denial. For instance, if the crime under investigation is homicide, a crime-related question may be asking if the examinee murdered the victim, whereas possible control question is asking to the examinee if he has ever hurt someone before. The rationale behind asking potentially embarrassing questions and forcing examinees reply with denial is the assumption that control questions will give rise to higher arousal levels in innocent participant than they do in guilty participants, because the emphasis put on control questions by the examiner leads examinees to falsely think that their answers to these questions may direct the examiner to draw a conclusion that the crime is committed by them since previous practices of the examinee may be interpreted as indicators of future practices. Another assumption behind the expectation that control questions give rise to higher arousal levels in innocent examinees bases on is that innocent examinees know that they are lying about control questions, whereas they reply the crime-relevant questions honestly, on the contrary of guilty participants who are supposed to lie all the questions throughout the investigation. Although this technique is developed to reduce the validity and reliability issues that appear with the Relevant/Irrelevant Technique, it is still insufficient to explain the source of anxiety which causes higher arousal levels, as the Relevant/Irrelevant Technique is, in addition to using unstandardised control questions formed by the examiners and which are entirely dependent on the examiners question forming skills.

In order to solve the using unstandardised control question during investigation problem, another test model, the Directed Lie Test is developed. In this test, examiners direct the same standardized control questions that are formed before the investigation is conducted to all examinees, and directs examinees to reply these questions with denial. However, Directed Lie Test is not more preferable and applicable than any other previously developed tests since the rationale behind it is same with the rationale behind Control Question Test and Directed Lie Test still lacks reducing serious validity and reliability problems other tests have.

The last developed investigation technique the Guilty Knowledge Test, which is also known as the Concealed Information Test, is designed to find out whether examinees have specific information about the crime under investigation.

In order to reveal the information the examinee has the investigator addresses crime relevant questions to examinees step by step while the examinee is under polygraphic measurement. For instance, if the crime is homicide and the murder weapon is known, examiner asks if the examinee knows where the body of the victim is found. While questioning the crime scene, examiners ask about every room of a house (such as kitchen, bathroom, and living room) one by one. The next questioning may be related to how victim is murdered, and examiner asks by counting all murder weapons one by one in a similar fashion with asking about crime scene. The assumption behind the Guilty Knowledge Test is that although guilty and innocent examinees will respond to the questions verbally in similar ways, the arousal will be higher in guilty examinees when the right crime scene and right crime weapon is asked since they know where or how they committed the crime.

Although the Guilty Knowledge Test is theoretically more sound than previously developed investigation techniques, there are some issues under discussion, which indicates that applicability of this technique may not be without any restriction. The first discussion carried out on the applicability of the Guilty Knowledge Test is related to the amount of information required to conduct the investigation. If the investigation is carried out in order to reveal the perpetrator of a crime, it is proposed that all details related to the crime (e.g. crime scene, crime weapon, the extent of the damage etc.) should be known accurately by the investigation authorities; however, it is not always possible to reach all crime related details immediately. Additionally, the time required to uncover all necessary information may cause longer time intervals between perpetration and the investigation. As a result of that guilty examinees may forget about the details or vividness of memories related to the crime may diminish, which may result in lower arousal levels in a guilty examinee than expected to observe, or similar arousal patterns between guilty and innocent examinees. Another factor that should be taken into consideration is the extent of crime related information known by innocent examinees. It is discussed that autonomic responses of innocent examinees may be affected by the extent of the information they have about the crime. Although they did not perpetrate the crime, if an innocent examinee knows where the crime has taken place for instance, they may autonomic responses may be heightened. Although they did not perpetrate the crime, questions addressed during the polygraph investigation that the examinee knows the answer may heighten their autonomic responses. The last factor introduced to restrict the applicability of the Guilty Knowledge Test is the information or the experience the examinee has in general. It is offered that an innocent examinee may has a weapon they have never used it to commit a crime but is similar to the crime weapons shown and asked about during the investigation, or has a traumatic experience in one of the asked crime scenes, which may heighten their autonomic responses to these places or weapons when asked. Therefore, it is suggested that previous experiences and the information an examinee has have to be known by the investigator and they should be considered while interpreting the autonomic responses of examinees. However, since it is not always possible to know all the previous information and experience of examinees before the investigation, this issue is regarded as one of the factors that restrict the applicability of the Guilty Knowledge Test.

Since the polygraph is a technique that bases on the measurement of the sympathetic nervous system responses, Mohamed et al. (2006) discuss that these responses might be related to other emotional states as well as act related to deception, and polygraph may not be a sufficient technique to determine the complex cognitive processing that involved in truth telling and lying. In order to reduce the problems caused by insufficiency of polygraph to monitor the cognitive functions, and to minimize the effects of the subjectivity of the examiner in interpreting polygraph charts, they develop neurological model of deception. While developing their neurological model of deception, Mohamed et al. (2006) itemize each cognitive function that may be involved in act of deception and truth telling, and the brain area related to that function in an order on the basis of the previous fMRI studies conducted to investigate neural correlates of deception.

If a lie is generated as a response to a question, the activation process starts with receiving the question. Therefore, activation in corresponding auditory or visual cortex - depending on the means of question is addressed - along with the perception of question is expected. Since the question is needed to be fully comprehended in order to be answered, the activation of auditory or visual cortex is followed by the activation of Wernicke's Area. After the addressee of the question fully comprehend it, he may need to retrieve question related events and facts from memory, which results in activation of areas in prefrontal cortex.

Mohamed et al. (2006) note that an area of the brain related to emotions such as fear and anxiety is the amygdala, therefore, any activation in this area should be interpreted carefully. If a question is related to an anxiety triggering event, stimulation of the amygdala can be observed even the addressee replies the question truthfully as well as it is possible to observe this stimulation when someone lies since lying may bring into fear of being caught. According to Mohamed et al. (2006) one of the cognitive processings that polygraph measuring may come short of is distinguishing the anxiety that is caused by act of lying from anxiety of being accused of lying because of being a technique based on the changes in sympathetic nervous system responses

In order to produce a response for a question, the examinee has to plan and construct his answer regardless of the truthfulness or deceitfulness of the answer. Therefore, the next step following recall of the related events from memory is the planning of answer sentences, which is the step Mohamed et al. (2006) expect truthful and deceitful answers to separate from each other in terms of the brain areas activated or activation patterns of these areas. They propose that act of producing deceitful answers involve inhibition of the truth as different from responding truthfully, therefore deceitful and truthful answers can be separated from each other by examining activation of areas in prefrontal cortex, anterior cingulate cortex, and areas of right hemisphere. Mohamed et al.'s neurological model ends with the release of the answer that requires activation of the motor system in the frontal lobe.

In the study Mohamed et al. (2006) conducted in order to test their model, they assign participants to guilty and nonguilty study groups. Guilty subjects are given the scenario that they have been chosen to fire a gun in the hospital and the only one knows this is the researcher who gives the gun to the participants, and an expert will interview with them since they are regarded as suspects. Additional to this scenario, guilty subjects are trained about gun safety and are asked to actually make a few shots with empty bullets. This experience let participants in guilty condition to form memories on shooting a gun. On the other hand, participants in nonguilty condition are told that a gun is shot in hospital that day and they are going to be interviewed as suspects. (Mohamed et al., 2006).

All participants are interrogated both in fMRI scanner, and with polygraph. Before going into interrogations, participants are asked to follow one of two possible strategies - lie-only strategy and telling the truth-only strategy - during examination. All participants are interrogated via Control Question Test while they are in scanner, and under polygraph test. Subjective lie and subjective truth answers of the participants are compared to known truth or known lie control questions.

Results of Mohamed et al.'s (2006) study indicate that polygraph examination is highly accurate in detecting guilty participants (92% accuracy), however, this accuracy falls to 70% for nonguilty subjects, which means 28% of nonguilty subjects may be falsely charged of committing the crime. The fMRI scanning of participants, on the other hand, display that activation of specific areas in frontal, temporal, occipital lobes and anterior cingulate cortex (ACC), right fusiform gyrus, right sublobar insula differs between guilty and nonguilty participants during fMRI scanning, which can be interpreted as fMRI scanning is more sound technique in terms of detecting guilty participants than a sympathetic nervous system response dependent polygraph.

Summary of Deception Theories

Attempts to uncover the behavioral indicators of the cognitive load lying brings to give rise to distinguished theories, which are (1) Zuckerman et al.'s (1981) Four-Factor Theory of deception, (2) Lane and Wegner's Preoccupation Model of Secrecy (1995), (3) Walczyk et al.'s Activation-Decision-Construction Model (2003) and (4) Mohamed et al.'s neurological model of deception (2006). In each theory, the factors that cause lying to have higher cognitive load than truth telling are discusses in terms of distinct cognitive processes. For instance, Zuckerman and his colleagues (1981) reached the conclusion that although it is impracticable to associate lying with certain verbal or nonverbal expressions as in the manner specific emotions are associated with specific facial expressions, act of lying has an effect on behaviors since it is comprised diverse processes or factors that produce effect on behavior. These factors are (1) the control attempt of the deceiver, (2) the arousal caused by the act of lying, (3) affects aroused because of engaging in deception, and (4) the cognitive factors in deception. As an alternative, in the Preoccupation Model of Secrecy, it is proposed that the first cognitive mechanism triggered by the existence of a secret to be kept is suppression. Suppressing the secret itself and the activated memory or information related to that secret is one of the frequently used strategies in order to avoid any accidental disclosure. Similar to Activation-Decision-Construction Model, Mohamed and colleagues (2006) propose that if a lie is generated as a response to a question, the activation process starts with receiving the question. In order to produce a response for a question, individuals have to plan and construct their answer regardless of the truthfulness or deceitfulness of the answer and in this stage of lying process, truthful and deceitful answers can be distinguished since lying involves suppression of the truth.

Aims of the Present Study

In the present study, it was initially aimed to investigate if the response time required for successful identification of an emotional facial expression varies for distinct facial expressions as a function of the emotion presented in the face. Studies examining the hierarchical structure of the computations carried out in the semantic analysis of an image indicate that the duration of the stimulus presentation that is sufficient to accurately classify a facial expression varies for different emotional facial expressions. On that account, in Study I participants were asked to complete an emotion recognition task, while response time measurements were being recorded. Emotional facial expressions that trigger a response faster than others were expected to be the ones with higher saliency levels.

In the second place, it was aimed to investigate if the instructed lying paradigm used in this study produce results consistent with the previous findings that are related with the effects of lying on response time durations and skin conductance responses. Previous findings indicate that being engaged in lying causes slower response times than truth telling since lying involves more complex cognitive processes and higher cognitive load than truth telling, in addition to higher skin conductance responses. Therefore, in order to examine whether being instructed to lie about emotional facial expressions requires slower response times and higher skin conductance responses than responding truthfully regardless of the emotion presented in the face, participants in Study II were asked to complete an emotion recognition task as the participants in Study I. However, differently from the participants in Study I, participants in Study II were presented with an instruction either to lie or tell the truth about the facial expression they see, prior to the presentation of the emotional facial expressions.

The third aim of this study was to investigate whether lying about emotional facial expressions that are recognized faster than others, and therefore more salient than others, require slower reaction times than lying about slowly recognized emotional facial expressions. It is proposed in the neurological models of lying that the act of lying involves retrieval of the truth and the memory related to it as truth telling involves. However, differently from truth telling, lying also requires suppression of the truth and producing a plausible alternative instead of it. On the other hand, it is expected to observe that since facial expressions with higher saliency levels capture attention, producing plausible alternatives instead of the presented emotional facial expressions should be more difficult for highly salient facial expressions in comparison to facial expressions with lower salience. Therefore, it was aimed to examine if recognizing a facial expression rapidly lead to slower response times in lying trials by increasing the amount of preoccupation with the truth. Additionally, when the effects of suppression on the preoccupation with the truth was considered, it was expected to observe that emotions with higher cognitive availability levels should decrease the amount of time spent in producing an alternative instead of the truth, which fasten lying about a facial expression.

Another aim of this study was investigating whether being instructed to lie and deciding when to lie differs in terms of the response times. In Activation-Decision-Construction Model of lying, it is proposed that making decision on whether to lie or to tell the truth, in addition to suppressing the truth itself and the memory related to, is another process which causes lying process to take longer time than truth telling. Therefore, it the response times of participants in Study III and Study II were compared in order to investigate the effects of decision making process on lying trials.

CHAPTER 2

EXPERIMENTS

Within the scope of this thesis project, three main studies were conducted in order to (1) investigate if distinct emotional facial expressions differ in terms of their saliency levels, (2) if the effort required to lie about emotional facial expressions differ between distinct facial expressions as a function of their saliency levels, and (3) if providing instruction to lie or decide to lie cause an overall change in cognitive processes of both identifying the emotional facial expressions correctly and lying about them. Although similar procedures were followed for these studies, they have been differed on the basis of the instructions provided prior to the main trials. In order to make following the differences between studies easier, the presentation flow regarding to the studies conducted under this thesis project was presented in Figure 2.1.

Pilot Study

A pilot study was conducted by using photographs of emotional facial expressions drawn from NimStim Face Stimulus Set (Tottenham et al., 2009) in order to determine facial expressions for each of the six universal emotions, which will serve as stimuli throughout the main experiments. In pilot study, it was aimed to determine the photographs of facial expressions, which are recognized accurately and have similar perceptual thresholds.

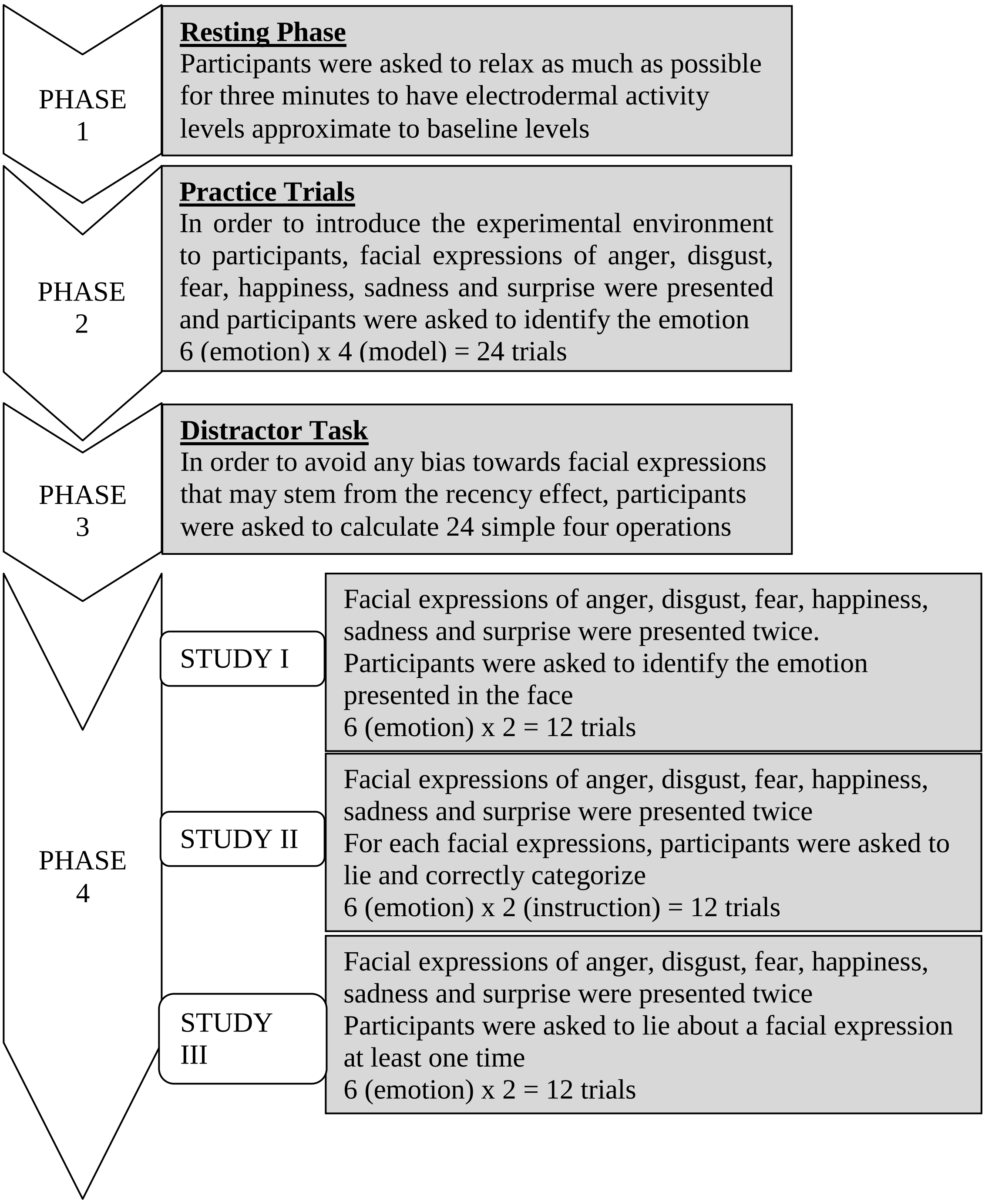

Figure 2.1. Phases and procedures followed through each phase of Study I, Study II and Study III

Method

Participants

Seventeen male and 15 female undergraduate students, whose ages vary between 18 and 27 years old (*M* = 21.31, *SD* = 2.26), from Izmir University of Economics served as participants in pilot study. All participants were accessed to be right-handed via Edinburgh Handedness Inventory (Oldfield, 1971), had normal or corrected-to-normal visual acuity, had normal levels of state and trait anxiety as accessed via standardized Turkish version of Beck Anxiety Inventory (Ulusoy et al., 1998), and had not reported any psychological or neurological disorder history. This research was conducted on the voluntary basis. Although it was reminded to participants that they had right to leave the study, there wasn't any participants who did not complete the session.

Stimuli, Apparatus, Material

Stimuli

Pictures of facial expressions of anger, disgust, fear, happiness, sadness and surprise drawn from the NimStim Face Stimulus Set (Tottenham et al., 2009) were used. The NimStim Face Stimulus Set contains pictures of 44 models displaying facial expressions of anger, calm, disgust, fear, happiness, sadness, surprise and a neutral expression with different densities. Density of a facial expression is altered by mouth opening. According to this, there are three different levels of densities which are represented with close mouth, open mouth, and widely open mouth. In this stimulus set, number of emotional expressions presented by a model is equal across models; however, levels of densities differ across emotions presented.

Facial expressions of anger, fear, disgust, sadness are presented with two different levels of densities (close mouth/open mouth), and happiness is presented with three levels of densities (close mouth/open mouth/widely open mouth), whereas surprise is only presented with open mouth for each model. The pictures are color photographs, and ethnicities of models vary between European American, Latino American, African American, and Asian American.

In order to minimize the effects of cognitive load or boredom that evaluating excessive amount of stimuli may have on response time measurements, out of the large NimStim Face Stimulus Set (44 models x 6 expressions), a final sample of 48 face stimuli were selected through a preliminary screening. First, it was decided to use pictures of European American models in order to avoid potential distractor effects of presenting pictures of models with distinct ethnicities within the same experimental block. Additionally, pictures of over- or underexposed expressions which appear to not clearly representing the intended emotional expression were removed from the stimuli list.

For the pilot study, faces drawn from the original NimStim Face Stimulus Set were grayscaled and stimulus size was set to 138 pixel in height and 217 pixels in height by using Adobe Photoshop ™ CS 2.0. Distracting parts of the stimuli, such as hair and neck, were removed since they do not bear information related with the expression presented in the face.

Participant Evaluation and Informed Consent Forms

A participant evaluation form was developed (See Appendix A) in order to assess participants' handedness, visual acuity, state and trait anxiety levels as well as to gain information about participants' previous and current psychological and neurological wellbeing, being on medication status, participation history in previous experiments in addition to examine their current knowledge regarding to what the six basic emotions that can be presented in the face are. This evaluation form was comprised of Edinburgh Handedness Inventory (Oldfield, 1971), standardized Turkish version of Beck Anxiety Inventory (Ulusoy et al., 1998) and questions related to visual acuity (e. g. Do you have myopia, hyperopia, astigmatism?), previous and current psychological/neurological wellbeing of participants (e. g. Were you diagnosed with any psychological/neurological disorder?) as well as their history of participation in previous studies conducted in the laboratory (e. g. Did you participate in any other experiment?), along with according to participants which emotions can be presented in the face (e. g. Please write down the emotions which you think that can be associated with distinct facial expressions).

An informed consent form was provided to participants in order to inform participants about the aim of the study and the procedure that would be followed, and to explain their rights as participants in addition to gain their permission to use data acquired from them for scientific purposes (See Appendix B).

Stimulus Presentation Program

Presentation and randomization of stimuli for the emotion recognition task that was carried out through the pilot study were designed and controlled by means of a stimulus presentation program which was written via SuperLab^{TM} 4.5 (Cedrus Corporation) and was run on a standard PC with a Pentium D 2.8 processor and a

17″ LCD monitor (Vestel, Flatron L1750S). Each trial started with presentation of a fixation cross in the center of the computer screen for 800msec. Following to the presentation of the fixation cross, facial expression of an emotion was displayed in the center of the screen for 1000msec in a random order, and participants were asked to identify the emotion presented in the face utmost in 4000msec. After each response of the participants, researcher moved to next trial by left clicking on a mouse connected to the PC. The inter-trial-interval was 1500msec.

Data Acquisition

Throughout the pilot study, participants indicated the emotion presented in a given facial expression verbally, and response time measurements along with the categorization responses of participants for each stimulus were recorded. It was observed in previous pilot studies, through which participants' verbal responses were collected via a microphone set connected to the computer and voice key responses triggered the presentation of the following trials, that microphone failed to pick up the actual response due to the sounds that participants made while thinking (e.g. Hmmm, aaaa), which in turn would cause loss of excessive amount of data. Therefore, participants' verbal responses were recorded via Olympus VN-8600PC digital voice recorder in order to avoid such loss of data. However, even though both researcher and participants performed carefully throughout the evaluation of facial stimuli, because of technical problems as mouse click was not received by the computer punctually, response times were not recorded precisely by the experimental program. In order to eliminate such technical problems and acquire exact response time of participants for each stimulus, participants' voice recordings were analyzed with a sound wave analyzing program called Audacity (http://audacity.sourceforge.net/) (See Figure 2.2).

Additionally, participants' responses regarding to the categorization of the facial expression were obtained through listening and decoding the voice recordings of each participant.

Procedure

Throughout the whole study, all participants were accompanied by the researcher. Individuals who accepted to participate in the study were brought to the sound-isolated room where they completed the session. In the sound-isolated test room, the aim of the study and the tasks that participants would be asked to complete were explained the participants verbally by the researcher. Following these explanations, participants were given the Participant Evaluation Form (See Appendix A) in addition to Informed Consent Form (See Appendix B). Participants who declare being currently diagnosed with any neurological or psychological disorder, being on medication, history of participation in previous experiments that were conducted by using similar facial expression stimuli, scored higher than 15 in the standardized Turkish version of Beck Anxiety Inventory (Ulusoy et al., 1998), and scored lower than 48 in the Edinburgh Handedness Inventory (Oldfield, 1971) were not allowed to proceed.

In the final part of the Participant Evaluation Form, it was given to the participants that there were universally shared emotions which were independent of the culture people were living in and especially six of them had their own unique facial expressions. After that information it was asked to participants to

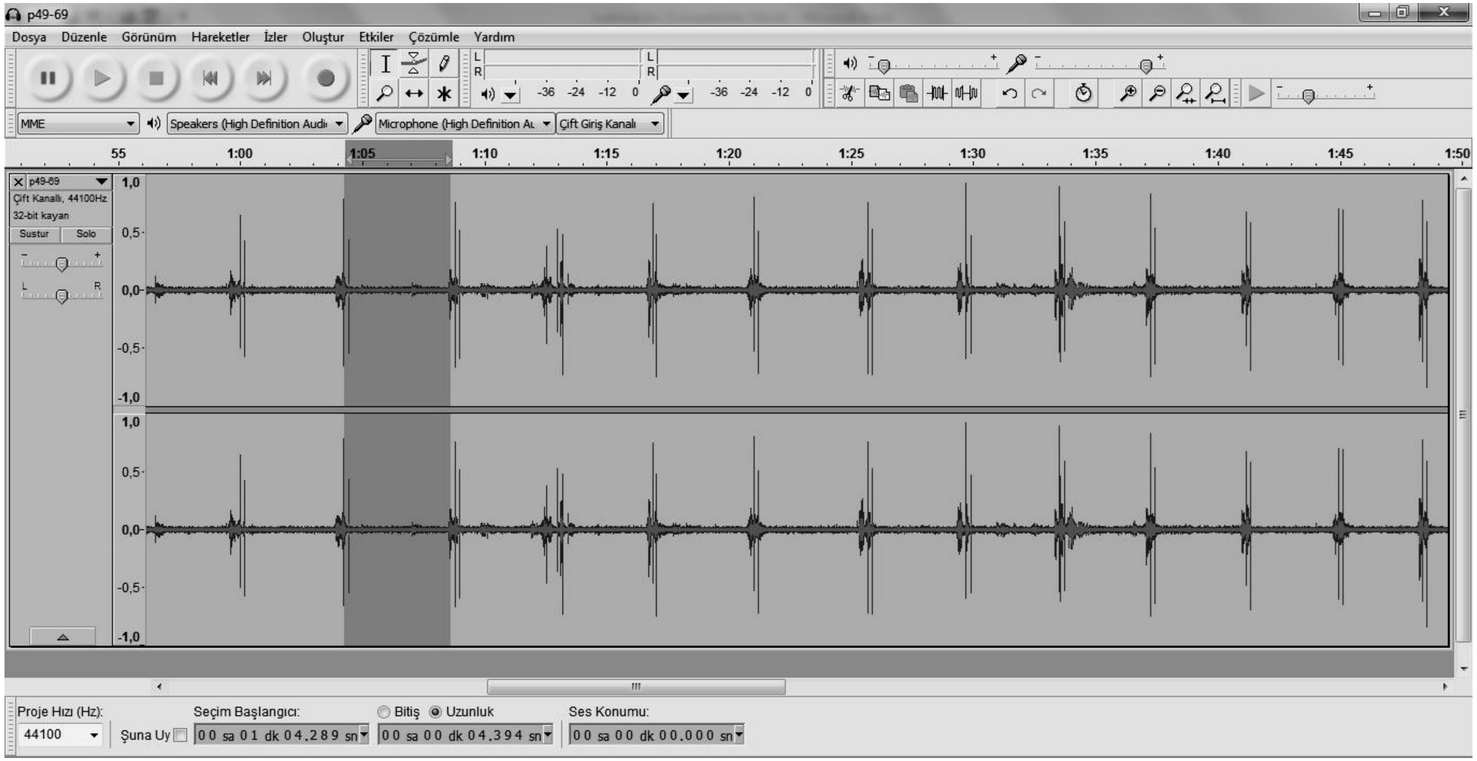

*Figure 2.2.*An example of sound file analysis with Audacity. Huge sound waves indicate participant's verbal responses whereas thin lines within huge sound waves indicate left mouse click of researcher.

write down the name of emotions, which could be presented in the face, as much as they could remember out of the six universal emotions in an order as they remember. The aim of this exercise was examining the number of universal emotions that participants have already known. In this part of the study, responses – e.g. excitement, shame, worry, crying, smiling/laughing, depression, joy, cheerfulness, anxiety, panic or jealousy – written instead of disgust, anger, fear, happiness, surprise and sadness were told to participants that these feelings were not examined in this study and were corrected to the universal emotions by the researcher. The paper on which corrected answers were written was left near the participant to make them have a look in case of need.

Before the stimulus presentation program was started, it was reminded to participants that they should indicate the emotion that facial expression represented verbally as fast and as correct as possible. While their responses were being recorded by digital voice recorder, researcher would press the left mouse button in order to start the next trial. Therefore, participants were warned to not to make any irrelevant comments loudly but to say only the emotion that the facial expression represents to not to confuse the researcher.

As it is presented in Figure 2.3, participants were asked to complete an emotion recognition task in the pilot study, which was consisted of random presentation of a total 48 emotional facial expressions. Prior to presentation of each facial expression, a fixation cross appeared for 800msec. Participants were given 4000msec at most to identify the emotion presented in the face. If the response time of participants took longer than 4000msec, a warning was presented

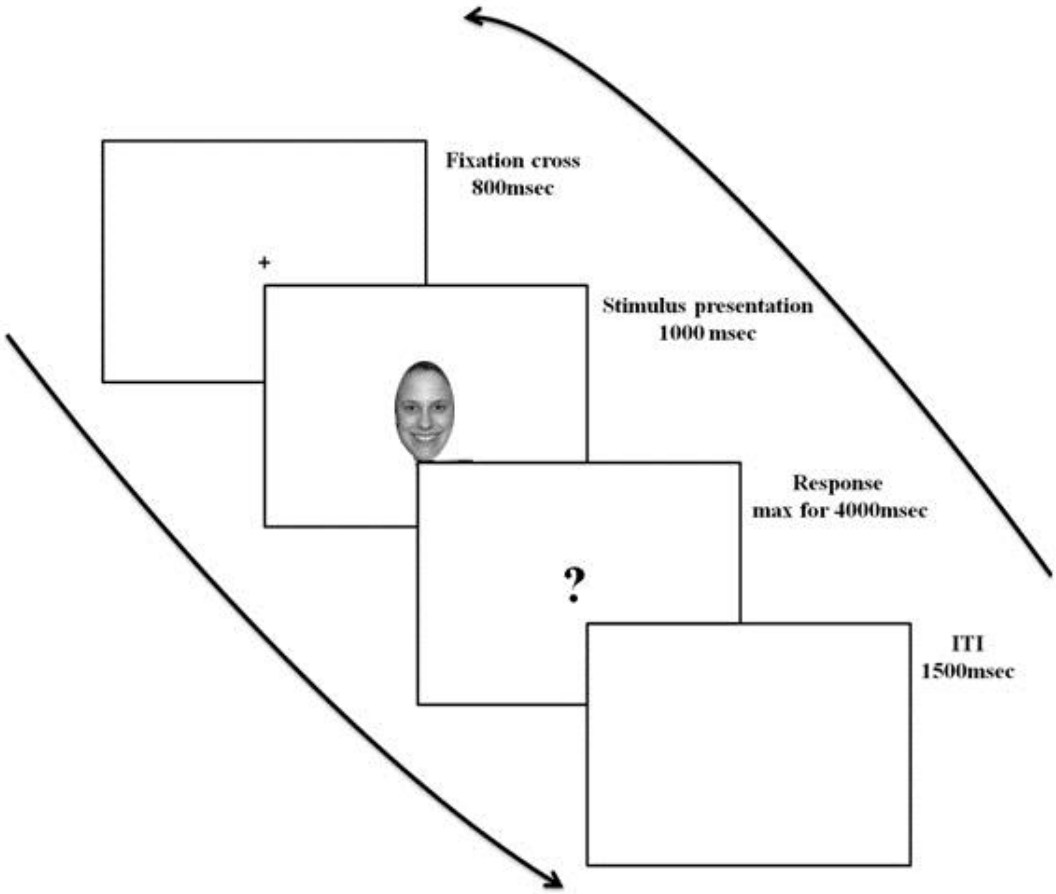

Figure 2.3. Stimulus presentation flow of pilot study

in the screen to respond faster and participants' responses for such trials were excluded from further analysis. It was proceeded to the next trial following to 1500msec inter-trial-interval. This procedure was applied for all of 48 trials. Correct responses and response times of participants for each emotional facial expression were recorded.

Results

Correct Response Analysis

In order to determine the photographs of facial expressions of anger, disgust, fear, happiness, sadness and surprise, - which are recognized accurately - correct responses given by participants were analyzed for each stimulus. It has been observed that although there were stimuli which were identified 100% correctly for facial expression of happiness and sadness, correct identification rate for expressions of disgust, anger and surprise were 90%, whereas fear was correctly identified with 80% accuracy rate maximum. For this reason, the later analysis was conducted with participants only who identified fear 100% correctly. This elimination raised the identification rate of disgust to 100%, however, identification rates of anger and surprise remained in 90%. Therefore, second data selection was made on the basis of the participants who identified fear, anger and surprise with 100% accuracy. After this elimination, it was observed that there was at least one stimulus for expression of fear, anger, surprise, disgust and sadness whereas there were eight stimuli for expression of happiness with 100% accuracy rate.

Response Time Analysis

In order to determine pictures of facial expressions with similar perceptual thresholds, response time analysis for accurately identified stimuli was conducted. Precise response time calculation was conducted via Audacity. First, the area starting from the thin mouse click – which started the next trial – to the beginning of the huge sound wave was selected and the length of this area in terms of milliseconds was recorded (See Figure 2.2). Then, the duration of inter-stimulus-interval (1500msec) and fixation cross presentation time (800msec) were subtracted from the selected area.

Kolmogorov-Smirnov test revealed that the response time measurement for facial expression of happiness (skewness of 2.09, SE = .41, kurtosis of 6.39, SE = .81, $D(32) = .17$, $p < .05$), sadness (skewness of .80, SE = .41, kurtosis of .50, SE = .50, $D(32) = .20$, $p < .05$), and surprise (skewness of 2.90, SE = .41, kurtosis of 8.49, SE = .81, $D(32) = .28$, $p < .05$) deviate from normal distribution, whereas facial expression of anger (skewness of 1.19, SE = .41, kurtosis of 1.03, SE = .81, $D(32) = .15$, $p > .05$), disgust (skewness of 2.0, SE = .41, kurtosis of 7.07, SE = .81, $D(32) = .13$, $p > .05$) and fear (skewness of .77, SE = .41, kurtosis of .50, SE = .81, $D(32) = .12$, $p > .05$) did not. Therefore, in order to examine if stimuli for each emotional facial expression trigger responses in similar response times Friedman's test was applied. The test results indicated that the Friedman χ^2 statistic was not significant at .01 significance level ($\chi^2(5) = 12.32$, $p > .01$) for a stimuli set consisted of facial expression of female model #5 with closed mouth for anger (M = 1524.44, SE = 102.76), facial expression of male model #37 with closed mouth for disgust (M = 1213.78, SE = 53.66), facial expression of male model #42 with open mouth for fear (M = 1640.33, SE = 125.72), facial expression of female model #8 with closed mouth for happiness (M = 1357.89, SE = 121.82), facial expression of female model #3 with closed mouth for sadness (M = 1475.50, SE = 102.14), and facial expression of male model #24 with open mouth for surprise (M = 1589.50, SE = 210.02)[1].

In this way, photographs with similar accuracy rates and response times are determined for each emotional facial expression, which will serve as stimuli throughout the main studies.

Study I

In order to determine if emotional facial expressions differ on the basis of the response time required to correctly identify them, a simple emotion recognition task was conducted. In addition to collecting response time measurements, skin conductance responses of the participants were recorded in order to investigate the physiological responses that each emotional facial expression induces. It was hypothesized that identification of salient facial expressions would require shorter response times than identification of less salient facial expressions require.

[1] Due to the restrictions put on the publication of the images from the NimStim Face Stimulus Set, selected images could not be offered here.

Method

Participants

Thirteen male and 17 female undergraduate and graduate students, whose ages vary between 18 and 26 years old (M = 21.37, SD = 1.81), from Izmir University of Economics served as participants in the study. Nine participants (4 male, 5 female), who could not recognize accurately more than half of the emotional facial expressions through main trials, were eliminated. It was assessed with Participant Evaluation Form (See Appendix A) that all participants were right handed, had normal or corrected-to-normal visual acuity, had normal levels of state and trait anxiety and had not reported any psychological or neurological disorder history. Some undergraduate students participated in the study to receive bonus points for the Quantitative Methods in Psychology-I class, whereas other participants attended to the study voluntarily.

Stimuli, Apparatus, Material

Stimuli

Stimuli used for main trials were consisted of the pictures of facial expressions of the six emotions (anger, disgust, fear, happiness, sadness, surprise), which were determined through pilot study to have high accuracy rates and have similar perceptual thresholds. In addition to stimuli used for main trials, three pictures with high accuracy rates were selected for each emotion and were used as stimuli in practice trials. The stimuli used in practice trials were male models #20, #36, #37 with close mouth for anger; female models #6, #8 with close mouth and male model #34 with open mouth for disgust; male models #30 with open mouth,

#33 with close mouth, and female model #19 with open mouth for fear; male models #20, #30 with close mouth and female model #7 with open mouth for happiness; female models #2, #7 and male model #27 with close mouth for sadness; female models #2, #7, #8 for surprise. All pictures of facial expressions were grayscaled and distracting parts of the stimuli, such as hair and neck, were removed. Stimulus size was set to 138 pixel in height and 217 pixels in height.

In addition to emotional facial expressions used in practice and main trials, 24 simple four operations (e. g. 5 - 1, 4 x 3, 9 + 3, 8 / 2) were used as distractor stimuli between practice trial blocks and main trials block.

Participant Evaluation and Informed Consent Forms

In order to assess participants' handedness, visual acuity, state and trait anxiety levels, as well as to gain information about their neurological and psychological wellbeing, being on medication status, and to examine their current knowledge regarding to what six basic emotions that can be presented in the face are, Participant Evaluation Form (See Appendix A) used in pilot study was applied to participants prior to the study.

An informed consent form was provided to participants prior to the study in order to inform participants about the aim of the study and the procedure that would be followed, and to explain their rights as participants in addition to gain their permission to use data acquired from them for scientific purposes (See Appendix B).

Stimulus Presentation Program

Presentation and randomization of facial expression stimuli were designed and controlled by means of a stimulus presentation program which was written via SuperLab^{TM} 4.5 (Cedrus Corporation) and was run on a standard PC with a Pentium D 2.8 processor and a 17″ LCD monitor (Vestel, Flatron L1750S). The stimulus presentation program consisted of four phases; which were (1) resting phase, (2) practice phase, (3) distractor task, and (4) presentation of main trials. In the first phase, participants were presented a countdown clock which indicates the time remained to start the presentation of facial expressions, and were asked to relax as much as possible for three minutes to have electrodermal activity levels approximate to baseline levels. Following this resting phase, 24 practice trials were presented in a random order throughout the second phase in order to introduce the experimental environment to participants. Prior to starting main trials, a distractor task - in which participants were asked to make total of 24 randomly presented simple summation, subtraction, multiplication, and division operations - was carried out in order to avoid any bias towards facial expressions that may stem from the recency effect. The distractor task was followed by presentation of 12 main trials in a similar fashion to the practice trials, in which each emotional facial expression presented twice in a random order and participants were asked to identify the emotion presented in the each facial expression as fast and as correct as possible.

Data Acquisition

Throughout the study, participants' verbal responses were recorded via Olympus VN-8600PC digital voice recorder and exact response time measurements of participants for each facial expression stimulus were calculated as in the pilot study via Audacity (http:/audacity.sourceforge.net/).

Skin conductance response resulted from electrodermal activity was measured with two BIOPAC TSD203 Ag-AgCl non-polarizable electrodes that were filled with isotonic gel and were placed between distal (first) and medial phalanges of ring finger and index finger of the left hand. Before electrodes were attached, participants' ring finger and index finger were cleaned with ethyl alcohol. Skin conductance was recorded using a BIOPAC GSR100C and the signal was sampled at 200 Hz by a BIOPAC MP150 (Biopac Systems,) system connected to a data-acquisition computer running the AcqKnowledge^{TM} 4.2 (BIOPAC Systems, Inc.) software package.

Procedure

As similar to the pilot study, all participants were accompanied by the researcher during study. Individuals who accepted to participate in the study were brought to the sound-isolated room where they would receive the experimental session. In the sound-isolated test room, participants were given the Informed Consent Form (See Appendix B) in addition to the Participant Evaluation Form (See Appendix). After participants finished filling forms, final warnings regarding to the task were reminded to participants by the researcher, and participants were started to be prepared for dependent measurement recordings.

In order to record changes in skin conductance response, two reusable electrodes filled with isotonic gel placed between distal (first) and medial phalanges of ring finger and index finger of the left hand after the skin was cleaned with ethyl alcohol. Following to the replacement of the electrodes, researcher moved to the control room, which was next to the test room, and started AcqKnowledge^{TM} 4.2 (BIOPAC Systems, Inc.) software to initiate and control the electrodermal activity recording. In order to control if changes in electrodermal activity was being recorded properly, researcher asked participants to take three deep breathes, which reliably results in observable skin conductance response. After being sure that skin conductance responses were being recorded properly, researcher moved to the test room and started the digital voice recorder in order to record verbal responses of a given participant.

Following to completion of preparations of dependent measurement recording devices, the stimulus presentation program was started. As seen in Figure 2.4, for the first three minutes of the study, a countdown clock which indicates the time remained to start the practice trials was presented to participants. Participants were asked to relax as much as possible throughout this resting phase in order to reduce the already present effects of body movements and increased pulse rate on electrodermal activity and approximate electrodermal activity levels to the baseline level.

Following the end of a 3-minute rest period, block of practice trials started. Throughout the practice trials, participants were presented four pictures for each one of the six emotional facial expressions in a random order and were asked to

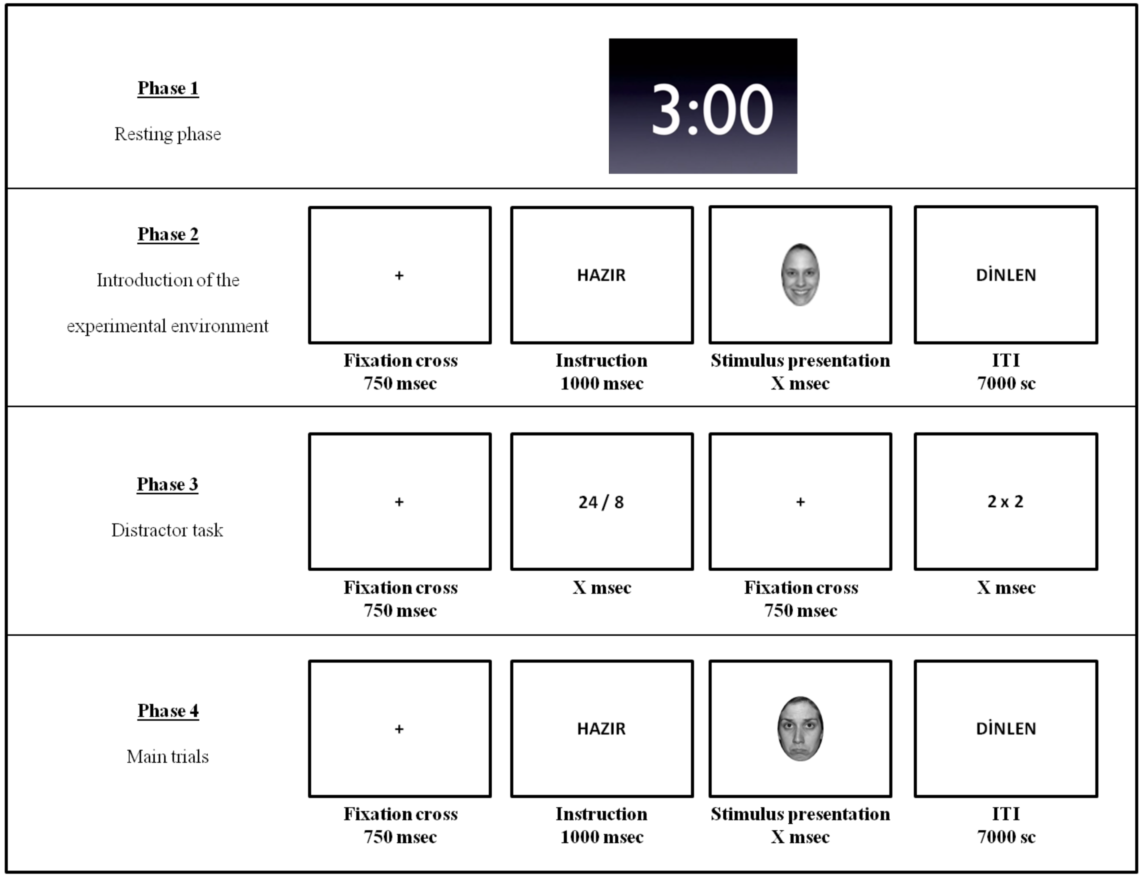

Figure 2. 4. Phases of Study I

identify the emotion presented in the face. Each practice trial started with the presentation of a fixation cross for 750msec. Subsequent to presentation of fixation cross, the instruction “READY” was presented in the center of the computer screen to bring to participants’ attention that an emotional facial expression would be presented. Emotional facial expressions presented in the center of the computer screen remained until participants identify the emotion presented in the screen verbally. After each response of the participants, researcher moved to next trial by left clicking on a mouse connected to the PC. In case of participants misidentified the facial expression, researcher corrected the mistake, and explained the facial cues which participants should pay attention. The next trial started after 7000msec interval.

In order to avoid any bias towards facial expressions that may stem from the recency effect, a distractor task consisted of 24 simple summation, subtraction, multiplication, and division operations was carried out prior to starting main trials. Each operation was presented subsequently to the presentation of a fixation cross for 750msec, and remained on the screen until participants respond.

The distractor task was followed by presentation of main trials which were identical with practice trials in terms of the task requirements and stimuli presentation durations. During the main trials, each emotional facial expression presented twice in a random order and participants’ response time and electrodermal activity measurements were recorded. As indicated before, data belong to participants who misidentified more than half of the facial expressions were excluded from further analyses.

Results

Response Time Analysis

In order to investigate if the response time required for successful identification of an emotional facial expression varies for distinct facial expressions as a function of the emotion presented in the face, response time measurements of participants for each emotional facial expression were compared. A repeated measures ANOVA with Greenhouse-Geisser correction for sphericity determined that mean response time required for correct identification of an emotional facial expression differed significantly between distinct emotional facial expressions, $F(3.40, 67.96) = 4.99$, $p < .05$, $\eta^2 = .20$. Post-hoc tests using the Bonferroni correction revealed that although response time required for identification of facial expressions of anger (M = 1088.62, SE = 73.00) and happiness (M = 904.29, SE = 65.33) did not differ statistically, identification of facial expression of happiness took shorter response times (M = 904.29, SE = 65.33) than identification of disgust (M = 1107.43, SE = 88.03), sadness (M = 1319.29, SE = 129.18), fear (M = 1338.24, SE = 125.99), and surprise (M = 1436.48, SE = 152.01), whereas identification of anger (M = 1088.62, SE = 73.00) requires similar response times to identification of disgust (M = 1107.43, SE = 88.03), sadness (M = 1319.29, SE = 129.18), fear (M = 1338.24, SE = 125.99), and surprise (M = 1436.48, SE = 152.01) (See Figure 2.5).

Skin Conductance Response Analysis

In order to examine if skin conductance response given for each facial expression differ as dependent of the emotion presented in the face, skin

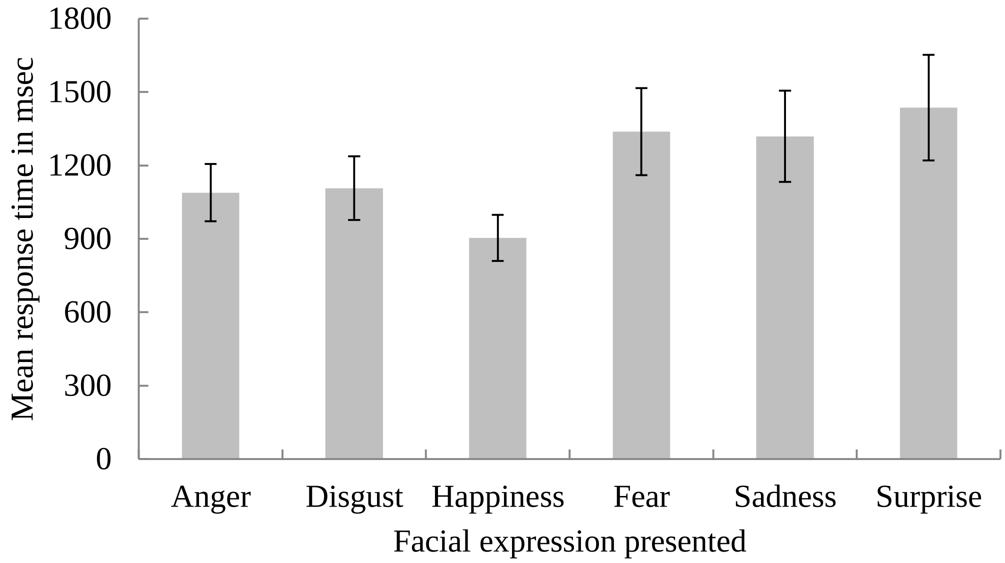

Figure 2.5. Mean (with 95% *CI*) response time by the emotional facial expression presented

conductance value for each stimulus was calculated by subtracting peak microsiemens value from the base microsiemens value in the time interval of 1000msec prior and 3000msec after the onset of stimulus (Figure 2.6). Then, square root transformation was applied to normalize distribution for values obtained from this calculation, since amplitude variable has a negatively skewed distribution in general (Boucsein, 2012). Since each emotional facial expression was presented twice, these square rooted values were averaged.

A repeated measures ANOVA indicated that the mean skin conductance response did not vary between facial expressions, $F(5, 100) = .69$, $p > .05$. According to this result, skin conductance response for facial expressions of anger ($M = .43$, $SE = .07$), disgust ($M = .38$, $SE = .06$), fear ($M = .37$, $SE = .06$), happiness ($M = .32$, $SE = .06$), sadness ($M = .35$, $SE = .08$) and surprise ($M = .35$, $SE = .07$) was found to be similar (See Figure 2.7).

Study II

As it was indicated in the Study I, facial expression of happiness was identified faster than facial expressions of disgust, fear, sadness, and surprise. It was observed that the only facial expression which has comparable levels of response time requirement to be correctly identified was anger. On the other hand, anger was also observed to have similar response time requirement with facial expressions of disgust, fear, sadness, and surprise. These findings may indicate that facial expression of happiness has the highest saliency, whereas facial expressions of disgust, fear, sadness, and surprise have lower saliency levels in comparison to happiness. Facial expression of anger, at this point, may be regarded

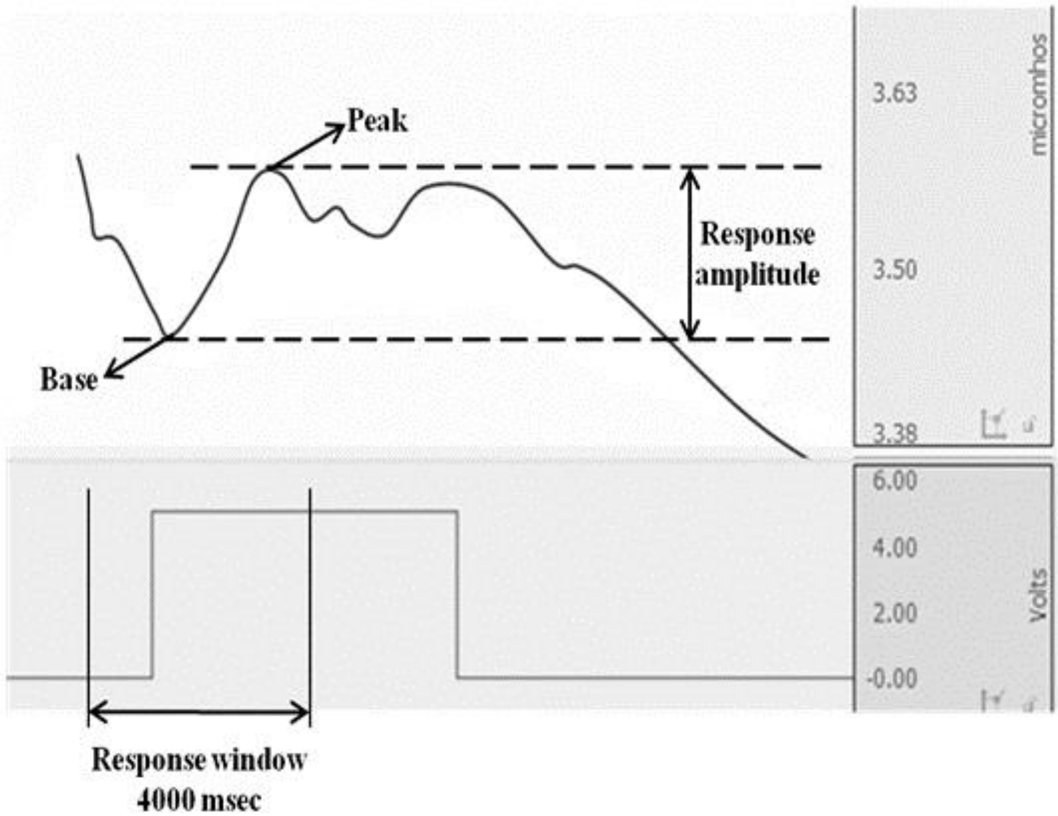

Figure 2.6. Measurement of skin conductance response given to single facial expression

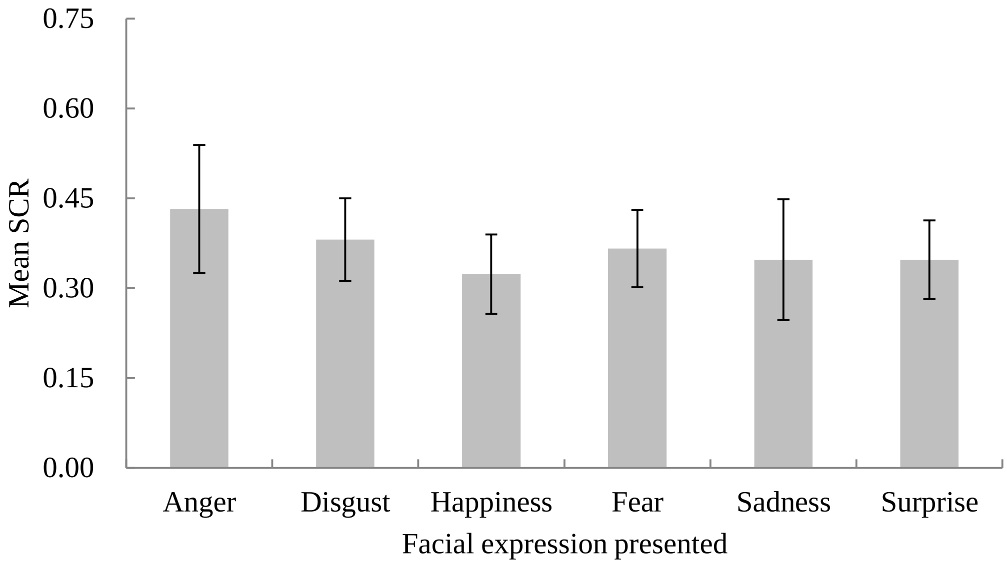

Figure 2.7. Mean (with 95% *CI*) skin conductance response by the emotional facial expression presented

as transition point between these expressions with high saliency and low saliency.

In the light of these observations, Study II was designed in order to investigate the resistance of the facial expressions to the cognitive load that lying about them brings to. It was hypothesized that lying about facial expression of happiness took longer time than lying about the facial expressions of disgust, fear, sadness, and surprise, whereas response time required for lying about facial expression of anger would be in between. It was also expected to observe that trials, in which participants were asked to lie about the emotion presented in the face yield in higher skin conductance response than trials through which participants did not lie.

Method

Participants

Twenty male and 31 female undergraduate students, whose ages vary between 18 and 32 years old (*M* = 22.51, *SD* = 2.90), from Izmir University of Economics took part in pilot study. All participants were right handed, had normal or corrected-to-normal visual acuity, had normal levels of state and trait anxiety, and had not reported any psychological or neurological disorder history.

Throughout the Study II, participants were asked to lie about the emotional facial expression presented in the center of the screen in trials which were presented with an instruction to lie prior to the presentation of the facial expression. Following to participants’ verbal responses, what the genuine facial expression was also asked to participants in order to be sure that participants processed the expression, and individuals who could not correctly identify the genuine expression were excluded from further analyses, in addition to participants who misidentified more than half of the facial expressions through correctly responding trials. These selection criteria applied to participants resulted in elimination of 30 participants (8 male, 22 female).

Stimuli, Apparatus, Material

The stimuli, participant evaluation and informed consent forms used in Study II and the procedure followed was the same with the stimuli, forms and procedure of Study I, except that during the main trials of the experimental program, participants were instructed to identify the emotion in the face displayed on the screen; however, as it was cued, they would be needed to lie about the emotion presented in the face as quickly as possible. Throughout the main trials block, stimuli for each emotional facial expression were presented twice, and participants were asked to lie about and correctly identify once each facial expression. Both the presentation of the facial expressions and the instructions to lie or to correctly identify the facial expression were carried out in a random order.

Procedure

The procedure followed throughout Study II (See Figure 2.8) was identical to the procedure followed in Study I. However, at the end of the distractor task, participants were presented the following instruction before starting to main trials block:

> "In this stage of the study, you will be presented - in a similar fashion to the first stage - photographs of individuals presenting various emotional facial expressions. As in the first stage, you are asked to identify the emotion presented in the face. However, as different from the first stage, for some trials, an instruction to lie

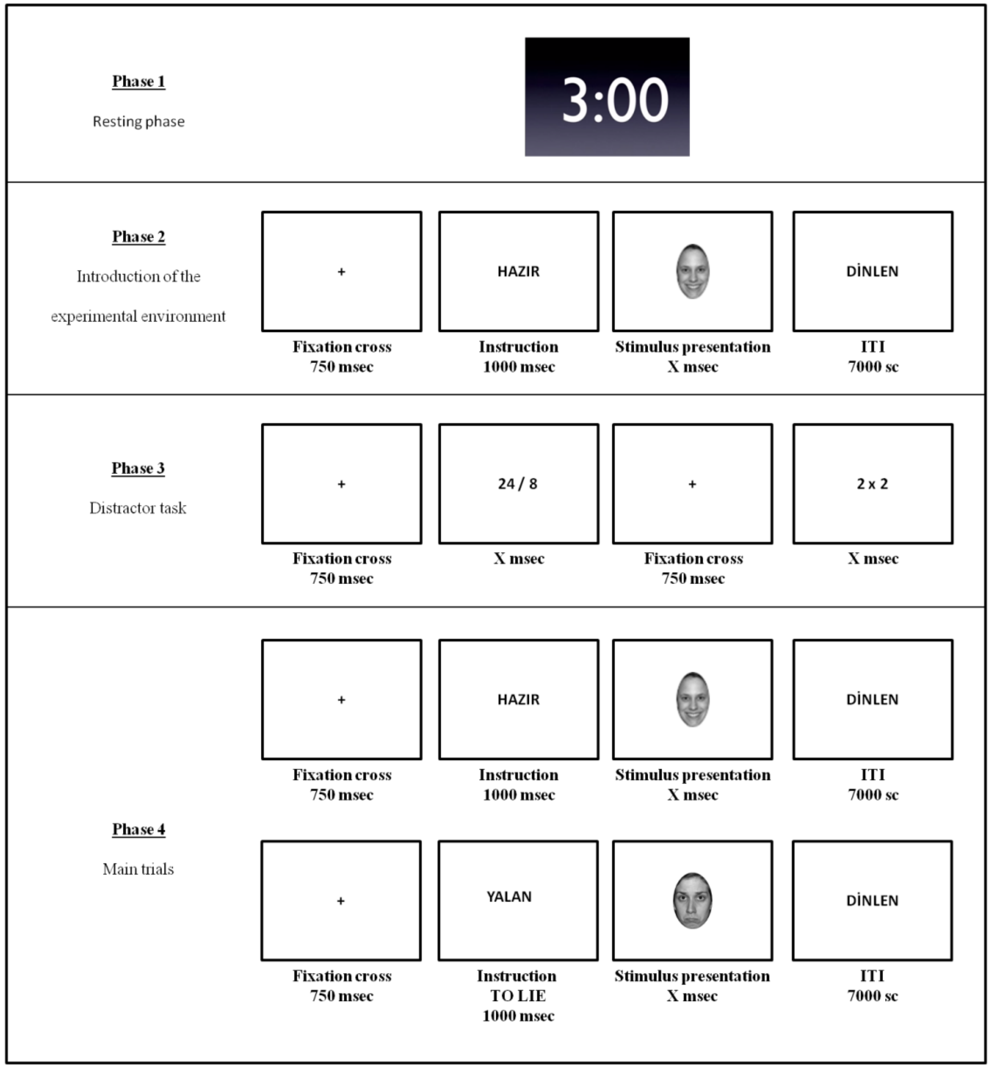

Figure 2.8. Phases of Study

about the emotion presented in the expression will be given prior to the presentation of the facial expression. What you are expected to do for such trials is saying an emotion other than the facial expression you see represents. For instance, if you are instructed to lie and presented an angry face, you are expected to say an emotion other than anger. An important point you should keep in mind that facial expression will disappear after you produced the lie, and following to your response, researcher will also ask you to identify the genuine emotion. Therefore, it is crucial for you to produce the lie after you have identified the genuine emotion. Additionally, you should bear in mind that you are expected to not to tell the same lie constantly for all lying trials."

Results

Response Time Analysis

In order to investigate if response time for different emotional facial expressions varies as a function of the instruction (lying, and truthfully identifying), response time measurements acquired from participants through instructed-to-lie and instructed to respond truthfully trials were compared for each emotional facial expression. A 2 (instruction: lie and truth) x 6 (emotion: anger, disgust, fear, happiness, sadness, surprise) repeated measures ANOVA with Greenhouse-Geisser correction for sphericity was conducted on the mean response times of participants. Results indicated that there was a significant main effect of the instruction on the mean response time, $F(1, 24) = 13.25$, $p < .01$, $\eta^2 = .36$. Instruction to lie about the facial expression presented was observed to yield in slower response time ($M = 3246.20$, $SE = 86.48$), than instruction to respond truthfully ($M = 2358.60$, $SE = 260.90$) (See Figure 2.9). Similarly, main effect of the emotion presented in the face on the mean response time was significant, $F(3.74, 89.86) = 4.55$, $p < .01$, $\eta^2 = .159$. It was observed that participants respond happiness ($M = 2129.60$, $SE = 139.99$) faster than surprise ($M = 2782.40$, $SE =$

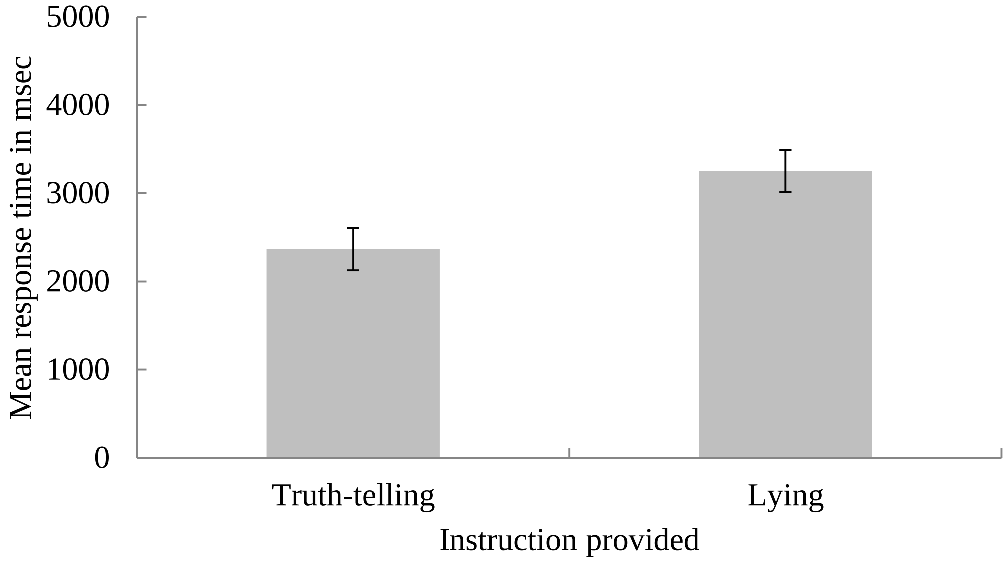

Figure 2.9. Mean (with 95% *CI*) response time by the instruction provided

190.04), disgust (M = 2930.50, SE = 218.27), fear (M = 2934, SE = 191.36), sadness (M = 2971.40, SE = 265.20), and anger (M = 3066.50, SE = 236.25) (See Figure 2.10). On the other hand, instruction*emotion interaction effect on response time was not found to be significant, $F(3.33, 79.89) = 1.29$, $p > .05$. However, when the figure presenting the instruction*emotion interaction was scrutinized (See Figure 2.11), it was observed that error bars of anger, happiness, and sadness among different instructions were not overlapping. Therefore, in order to avoid falling for Type II error, it was decided to conduct follow up analyses by conducting dependent t-test analyses for each emotional facial expression. Bonferroni correction was applied by dividing significance value of .05 to 6, and significance level was determined to be .008. It was observed that response time varies as a function of the instruction for facial expressions of anger ($t(24) = 3.04$, $p < .008$, $r = .53$), happiness ($t(24) = 3.94$, $p < .008$, $r = .63$), and sadness ($t(24) = 4.14$, $p < .008$, $r = .65$); whereas it did not vary for facial expressions of fear ($t(24) = 1.68$, $p > .008$), disgust ($t(24) = 2.12$, $p > .008$), and surprise ($t(24) = 1.71$, $p > .008$). According to this, lying about facial expression of anger (M = 3694, SE = 337.58), happiness (M = 2497.8, SE = 206.8), and sadness (M = 3617.8, SE = 402.71) took longer time than correctly categorize anger (M = 2439, SE = 127.92), happiness (M = 1761.4, SE = 117.76), and sadness (M = 2325, SE = 164.75).

Skin Conductance Response Analysis

In order to investigate if the skin conductance response for different emotional facial expressions varies as a function of the instruction, skin conductance response acquired from participants through instructed-to-lie and

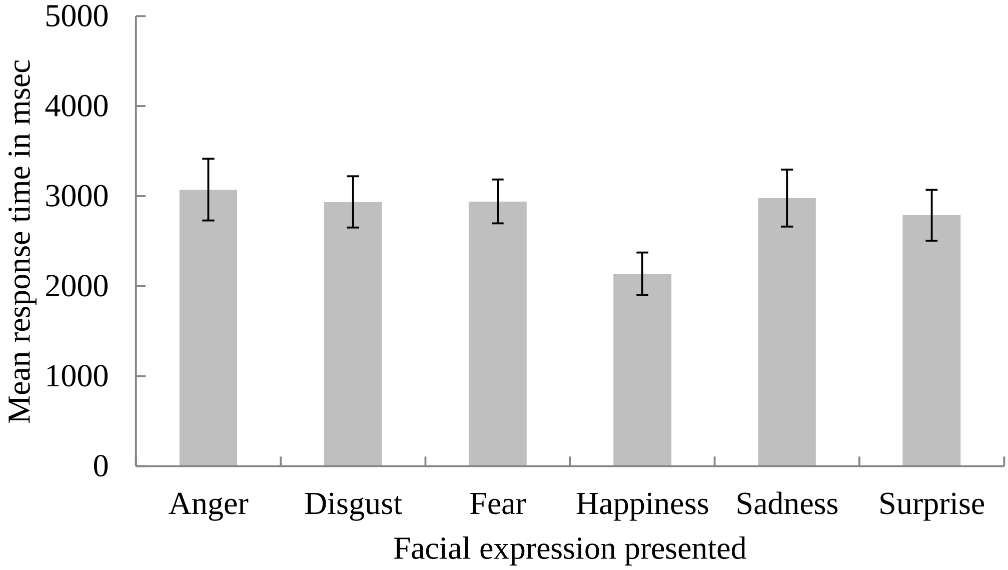

Figure 2.10. Mean (with 95% *CI*) response time by the emotional acial expression presented

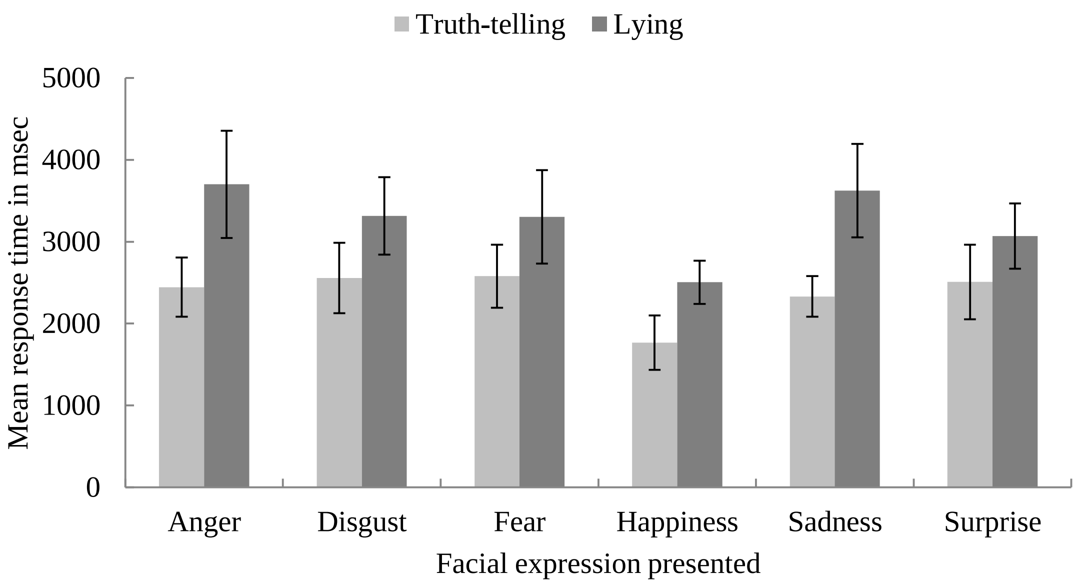

Figure 2.11. Mean (with 95% *CI*) response time as a function of instruction provided and facial expression presented.

instructed to respond truthfully trials were compared for each emotional facial expression. A 2 (instruction: lie and truth) x 6 (emotion: anger, disgust, fear, happiness, sadness, surprise) repeated measures ANOVA was conducted on skin conductance responses of participants. Results indicated that there was significant main effect of the instruction provided for either to tell lie or to respond truthfully on skin conductance responses, $F(1, 24) = 22.86$, $p < .05$, $\eta^2 = .49$. Instruction to lie about the facial expression presented was observed to yield in higher skin conductance responses ($M = .51$, $SE = .04$), than instruction to respond truthfully ($M =.37$, $SE = .05$) (See Figure 2.12). On the other hand, main effect of the emotion presented in the face on skin conductance responses was not significant, $F(5, 120) = 1.49$, $p > .05$. It was observed that differences between skin conductance responses of participants for facial expression of anger ($M = .05$, $SE = .05$), disgust ($M = .48$, $SE = .05$), fear ($M = .45$, $SE = .05$), happiness ($M = .43$, $SE = .05$), sadness ($M = .43$, $SE = .05$), and surprise ($M = .37$, $SE = .05$) were not statistically significant (See Figure 2.13). Similarly, instruction*emotion interaction effect on response time was not found to be significant, $F(5, 120) = 1.99$, $p > .05$ (See Figure 2.14). However, when the figure presenting the instruction*emotion interaction was scrutinized, it was observed that error bars of anger and happiness for different instructions were not overlapping. Therefore, similar to response time analysis, it was decided to conduct follow up analyses by conducting dependent t-test analyses for each emotional facial expression. Bonferroni correction was applied by dividing significance value of .05 to 6, and significance level was determined to be .008. It was observed that skin conductance response varies as a function of the instruction for facial expressions

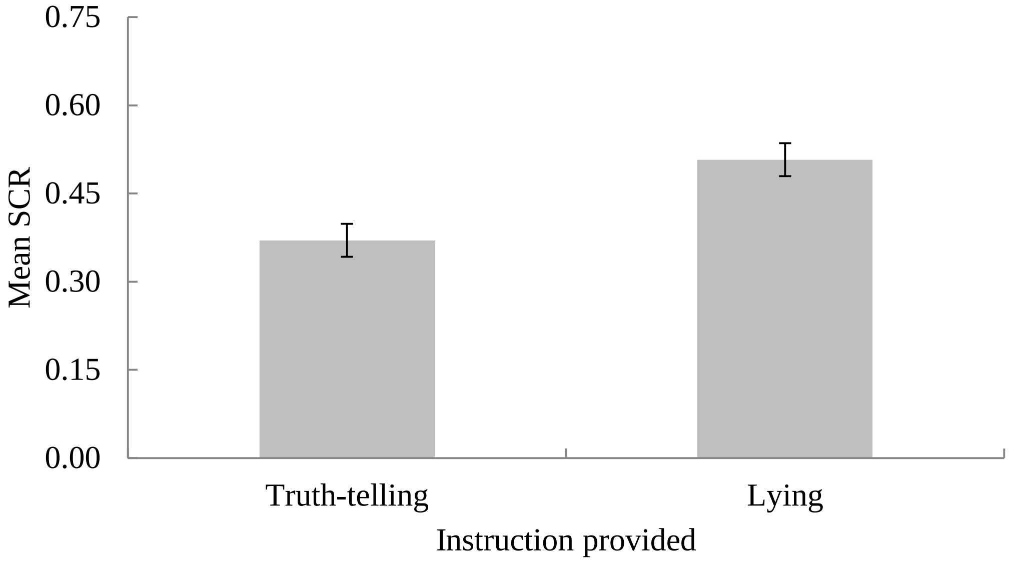

Figure 2.12. Mean (with 95% *CI*) skin conductance response by the instruction provided

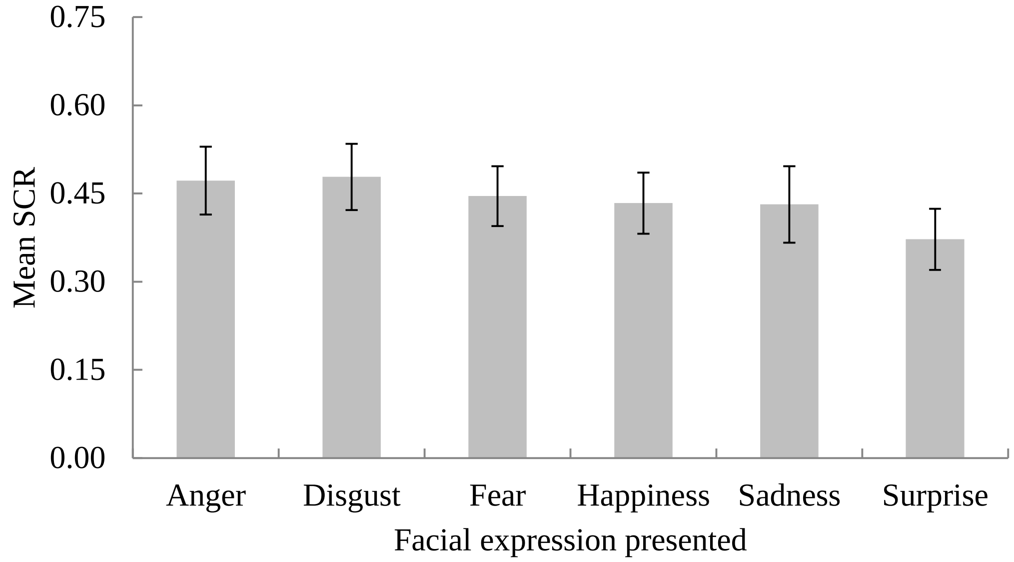

Figure 2.13. Mean (with 95% *CI*) skin conductance response by the emotional facial expression presented

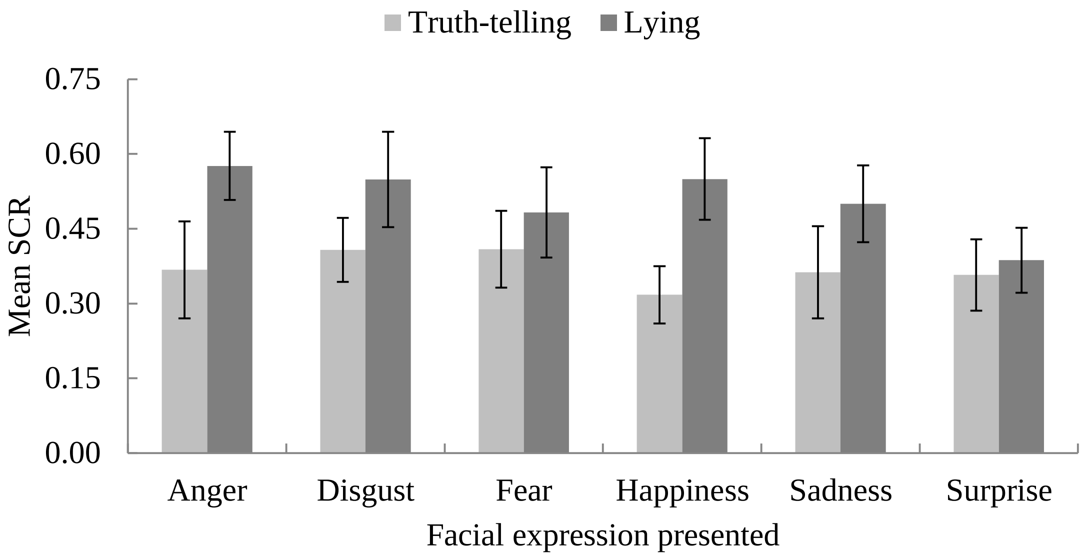

Figure 2.14. Mean (with 95% *CI*) skin conductance response as a function of instruction provided and facial expression presented.

of anger ($t(24) = 3.32$, $p < .008$, $r = .56$) and happiness ($t(24) = 4.71$, $p <.008$, $r = .69$), whereas it did not vary for facial expressions of fear ($t(24) = 1.09$, $p > .008$), sadness ($t(24) = 2.44$, $p > .008$); disgust ($t(24) = 2.36$, $p > .008$), and surprise ($t(24) = .65$, $p > .008$). According to this, lying about facial expression of anger ($M = .58$, $SE = .05$) and happiness ($M = .55$, $SE = .05$) yielded in higher skin conductance response than correctly categorizing anger ($M = .37$, $SE = .06$) and happiness ($M = .32$, $SE = .05$).

Facial expression presented and lie preferences

In order to examine the relationship between the emotional facial expression presented and lie preferences of participants, it was decided to conduct a 6 (facial expression presented) x 6 (lie preferences) chi-square test of independence. However, since the number of cases whose expected value was lower than 5 were higher than 20%, it was required to conduct Fischer's exact test. Since the design of this study was larger than 2 x 2, Fisher's exact test value was derived via Monte-Carlo simulation of SPSS 18 based on 10.000 randomly chosen tables, as it was suggested by Freeman and Halton (1951). Applying Fisher's exact test revealed that the relationship between the emotions presented and emotions used as lies for given facial expressions was significant. As seen in Table 2.1, while happiness was the most frequently preferred emotion as the lie for facial expressions of anger and fear, the most frequently preferred emotion as the lie for the facial expression of disgust was anger. Additionally, it was observed that the most frequently used emotion as the lie, being independent of the emotional facial expression presented, was happiness, χ^2 (5) = 38.87, $p < .05$. However, emotion preferred as a lie was observed to be related with the emotional facial expression

Table 2.1. *Distribution of lies for a given emotional facial expression for Study II*

	Facial expression presented					
	Anger	**Disgust**	**Fear**	**Happiness**	**Sadness**	**Surprise**
Lie preferences	**%**	**%**	**%**	**%**	**%**	**%**
Anger	0	36	0	40	20	16
Disgust	16.7	0	21.1	28	16	16
Fear	16.7	12	0	0	12	20
Happiness	50	32	57.9	0	44	24
Sadness	8.3	4	5.3	20	0	24
Surprise	8.3	16	15.8	12	8	0
Total % of lies used for a facial expression	100	100	100	100	100	100

presented and happiness was the most frequently used lie, neither response time (χ^2 (5) = 10.45, p > .05) nor skin conductance response (χ^2 (5) = 3.72, p > .05) varies as a function of the lie used.

Study III

It was indicated in Study II that lying is more cognitively demanding task than telling the truth, and lying about facial expressions of happiness, anger, and sadness require longer response times than lying about other facial expressions with lower saliency levels. Although these observations seem in line with the hypothesis that lying about salient emotional facial expressions would take longer time than lying about less salient emotional facial expressions, observing facial expression of sadness requiring longer response time to be lied about contradicts with the expected observations, since it was determined to have lower saliency than happiness and anger in Study I. Therefore, in order to examine if these observed differences arise from providing instruction to lie; Study III was designed in which the facial expression(s) participants would lie about was decided by participants themselves.

Method

Participants

Thirteen male and 12 female undergraduate students, whose ages vary between 19 and 24 years old (M = 21.65, SD = 1.32), from Izmir University of Economics took part in the study. All participants were right handed, had normal or corrected-to-normal visual acuity, had normal levels of state and trait anxiety, and had not reported any psychological or neurological disorder history as accessed with Participant Evaluation Form (See Appendix A). Eight participants (4 male, 4 female), who could not recognize accurately more than half of the emotional facial expressions or misidentify if they lied or correctly identified the facial expression were eliminated.

Stimuli, Apparatus, Material

The stimuli used in Study III and the procedure followed was the same with the stimuli and procedure of Study I, except that during the main trials of the experimental program, participants were instructed to identify the emotion in the face displayed on the screen; however, they were also asked to lie as quickly as possible about at least one facial expression of their choice. Participants were not limited in terms of the maximum number of lies they could tell. Throughout the main trials block, stimuli for each emotional facial expression were presented twice.

Procedure

The procedure followed throughout Study III (See Figure 2.15) was identical to the procedure followed in Study I. However, at the end of the distractor task, participants were presented the following instruction before starting to main trials block:

> "In this stage of the study, you will be presented - in a similar fashion to the first stage - photographs of individuals presenting various emotional facial expressions. As in the first stage, you are asked to identify the emotion presented in the face. However, as different from the first stage, this time you are asked to lie about <u>at least one</u> facial expression of your choice. Although you are asked to lie at least for one time, the maximum number of lies you could tell is not limited.

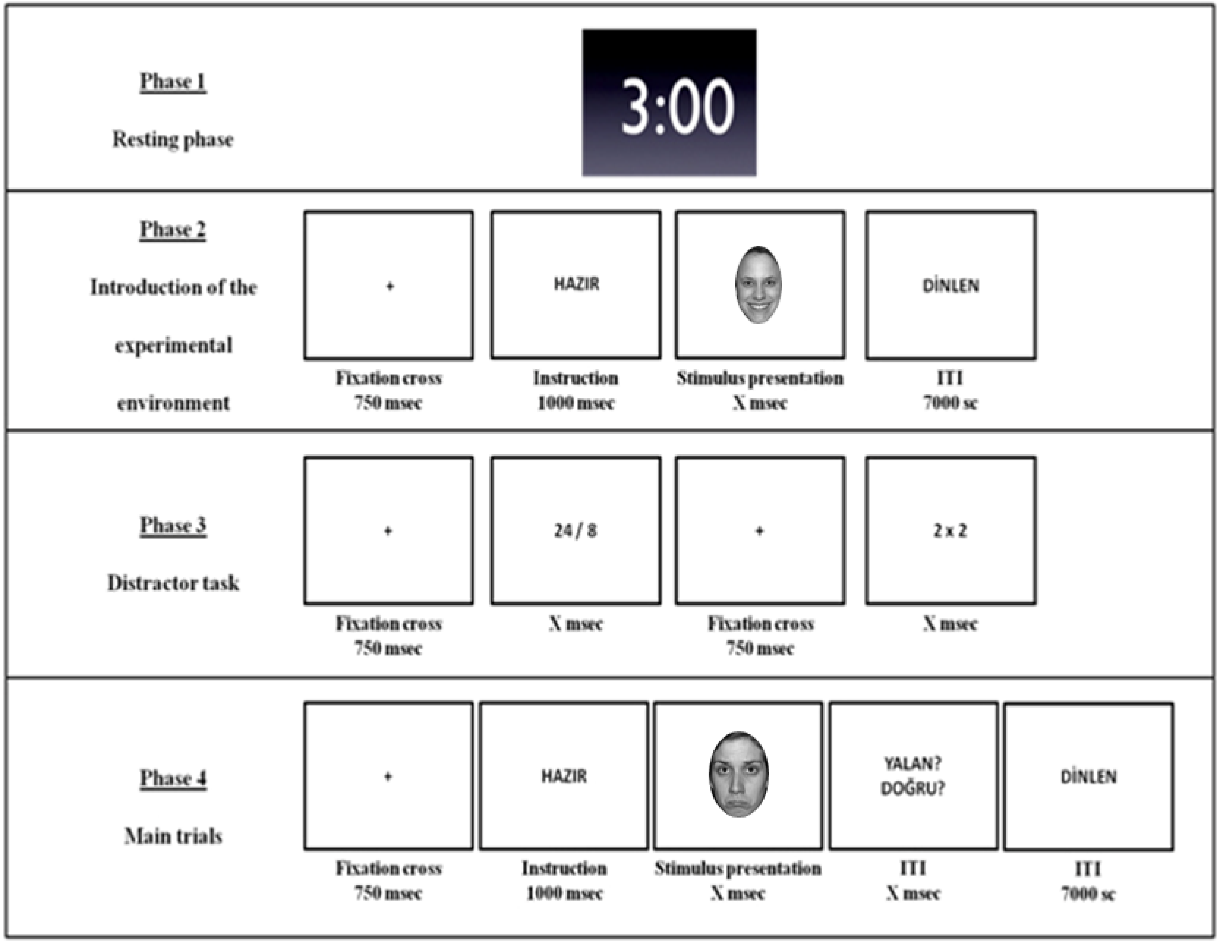

Figure 2.15. Phases of Study III

> Once you have decided to lie about the facial expression you see, you are expected to do for such trial(s) is saying an emotion other than the facial expression you see respresents. For instance, if you decide to lie about an angry face, you are expected to say an emotion other than anger. However, the important point you should consider about lying is that you should not tell the same lie constantly for all lying trials.
>
> You should keep in mind that following to your response about a facial expression, facial expression will be removed from the screen. Before moving to the next trial, you will also be asked to indicate if you lied about the facial expression, or correctly identified it. If you indicate that you have lied about the facial expression, researcher will also ask you to identify the genuine emotion. Therefore, it is crucial for you to produce the lie after you have identified the genuine emotion."

Results

As it can be seen in Table 2.2, number of emotions preferred as lie for each facial expression was not sufficient to conduct analyses regarding to the response time and skin conductance response differences between facial expressions since some emotions were not preferred as frequently as others as lie. For this reason, it was initially aimed to investigate if some emotions were preferred as lie more frequently than others as independent of the facial expression presented. A chi-square test of independence revealed that the relationship between the emotion and being used as lie was not significant, χ^2 (5) = 6.97, p > .05. Additionally, it was observed that the relationship between facial expression presented and being preferred to lie about as independent of the emotion used as lie was not statistically significant, χ^2 (5) = 7.17, p > .05.

Although in scope of Study III response time and skin conductance response measurements obtained from participants could not be compared across

Table 2.2. *Response time and skin conductance response distribution by a given emotional facial expression and the lie produced*

Facial Expression Presented

Lying/truth telling choices	**Anger**				**Disgust**				**Fear**				**Happiness**				**Sadness**				**Surprise**			
	N		Mean	SD	N		Mean	SD	N		Mean	SD	N		Mean	SD	N		Mean	SD	N		Mean	SD
Anger	17	RT	3073.65	672.74	4	RT	1512.25	254.02	1	RT	2335.00	-	1	RT	2923.00	-	1	RT	2297.00	-	4	RT	1889.00	280.60
		SCR	0.26	0.08		SCR	0.29	0.16		SCR	0.75	-		SCR	0.17	-		SCR	0.51	-		SCR	0.42	0.19
Disgust	2	RT	3225.50	1638.50	26	RT	2119.19	180.94	2	RT	6301.00	3510.00	-	RT			2	RT	2106.00	1096.00	-	RT	-	-
		SCR	0.74	0.16		SCR	0.30	0.05		SCR	0.44	0.16		SCR				SCR	0.46	0.46		SCR	-	-
Fear	4	RT	6190.25	2140.57	2	RT	1980.50	223.50	20	RT	1911.05	151.64	2	RT	1466.50	344.50	2	RT	2704.00	982.00	1	RT	1855.00	-
		SCR	1550.00	0.10		SCR	0.27	0.27		SCR	0.27	0.04		SCR	-	-		SCR	0.85	0.06		SCR	0.28	-
Hapiness	4	RT	1567.75	236.66	1	RT	1427.00	-	2	RT	1583.00	46.00	23	RT	1620.52	129.43	2	RT	2534.50	1139.50	1	RT	1696.00	-
		SCR	0.55	0.28		SCR		-		SCR	0.34	0.34		SCR	0.38	0.05		SCR	0.35	0.20		SCR	-	-
Sadness	2	RT	1111.00	88.00	-	RT	-	-	1	RT	3293.00	-	2	RT	1667.50	545.50	25	RT	2129.16	196.76	-	RT	-	-
		SCR	0.26	0.05		SCR	-	-		SCR	-	-		SCR	0.43	0.17		SCR	0.23	0.05		SCR	-	-
Surprise	4	RT	2460.75	930.15	1	RT	3450.00	-	6	RT	3510.67	613.10	2	RT	1883.50	338.50	2	RT	2451.00	154.00	27	RT	1857.15	98.84
		SCR	0.34	0.05		SCR	0.00	0.00		SCR	0.50	0.11		SCR	0.28	0.04		SCR	0.51	0.03		SCR	0.27	0.05

distinct emotional facial expressions either on the basis of the facial expression presented or the lies produced, the collected response time and skin conductance response data still provided invaluable information about the changes that might be occurring in cognitive processing through being engaged in lying. Therefore, it was initially decided to compare the performances of participants in Study II and Study III in terms of the response time and skin conductance measurements to investigate if the effects of providing instruction to lie or asking participants to decide to lie on the cognitive load that lying brings into differ as a function of the instruction. Additionally, it was aimed to examine the changes in response times of identifying the stimulus correctly that providing different instructions about lying causes by comparing the response time and skin conductance measurements of participants in Study I, Study II, and Study III.

Analyses between Study II and Study III

Response Time Analysis

In order to investigate if response time for lying about different emotional facial expressions varies as a function of the instruction provided (lying, and decide-to-lie), response time measurements acquired through lying trials of participants from Study II and Study III were compared. A 2 (Study II, Study III) x 6 (emotion used as lie) factorial ANOVA revealed that there was a main effect of the group on response time, $F(1, 195) = 3.72$, $p = .055$, $\eta^2 = .02$. According to this, participants in Study III, who were asked to decide when to lie, lied about a facial expression faster (M = 2623.41, SE = 248.83) than participants in Study II, who were provided instructions to lie (M = 3194.66, SE = 160.75) (See Figure 2.16).

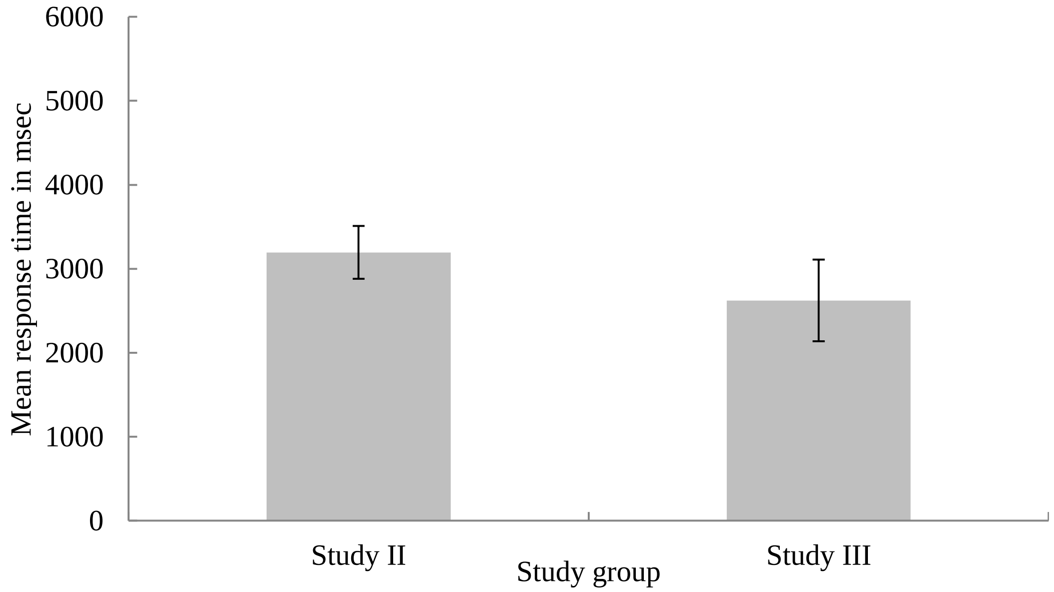

Figure 2.16. Mean (with 95% *CI*) response time by the study group that participants were in

Similarly, there was a main effect of the emotion used as the lie on response time, $F(5, 195) = 2.96$, $p < .05$, $\eta^2 = .07$. It was observed that using disgust (M = 3886.79, SE = 404.65) as a lie yield in slower response time than using sadness (M = 1999.33, SE = 455.83). On the other hand, effects of using happiness (M = 2393.69, SE = 306.84), anger (M = 2747.70, SE = 306.19), fear (M = 3105.17, SE = 350.40), and surprise (M = 3321.52, SE = 328.03) as the lie were not differed statistically. In addition to that, effects of using neither disgust (M = 3886.79, SE = 404.65) nor sadness (M = 1999.33, SE = 455.83) as the lie on response time was differed than using happiness (M = 2393.69, SE = 306.84), anger (M = 2747.70, SE = 306.19), fear (M = 3105.17, SE = 350.40), and surprise (M = 3321.52, SE = 328.03) (See Figure 2.17). Moreover, there was not a significant emotion*group interaction, $F(5, 195) = 1.82$, $p > .05$. According to this response times of using sadness (M = 2228.67, SE = 455.83), fear (M = 2672.33, SE = 455.83), happiness (M = 3024.48, SE = 254.82),anger (M = 3571.77, SE = 302.77), surprise (M = 3774.64, SE = 471.83), and disgust (M = 3896.09, SE = 368.12) as the lie in Study II did not differ than using happiness (M = 1762.90, SE = 558.28), sadness (M = 1770.00, SE = 789.52), anger (M = 1923.64, SE = 532.30), surprise (M = 2868.40, SE = 455.83), fear (M = 3538.00, SE = 532.30), and disgust (M = 3877.50, SE = 720.73) as the lie in Study III (See Figure 2.18).

Skin Conductance Response Analysis

In order to investigate if skin conductance response for lying about different emotional facial expressions varies as a function of the instruction provided (lying, and decide-to-lie), skin conductance response measurements acquired through lying trials of participants from Study II and Study III were

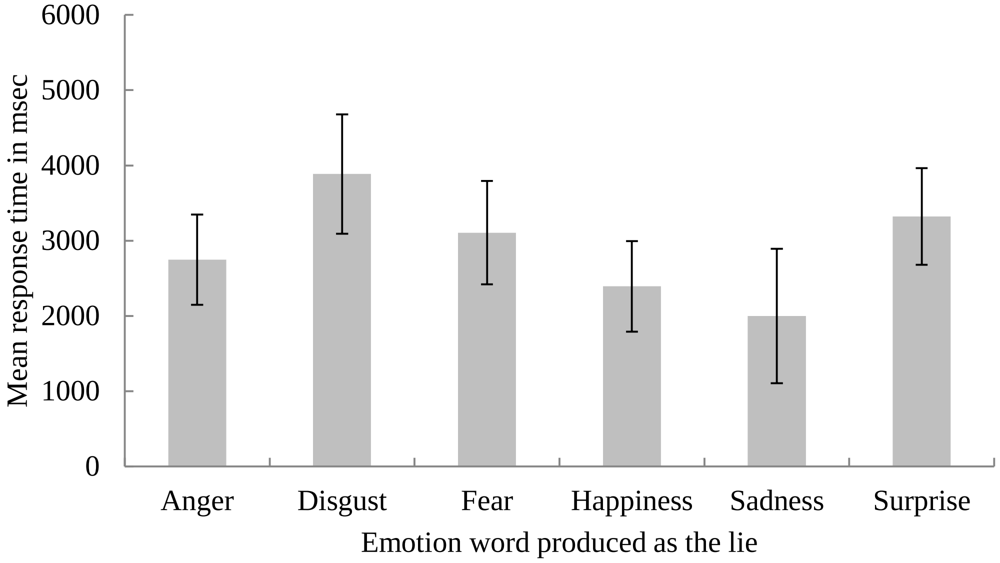

Figure 2.17. Mean (with 95% *CI*) response time by the emotion word produced as the lie

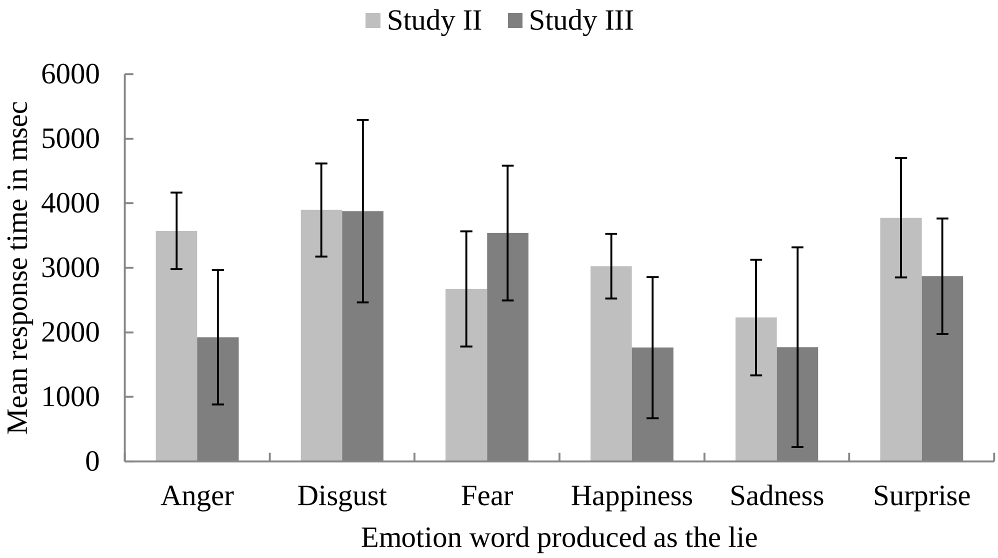

Figure 2.18. Mean (with 95% *CI*) response time as a function of the study group participants were in by the emotion word produced as the lie

compared. A 2 (Study II, Study III) x 6 (emotion used as lie) factorial ANOVA revealed that there was not a main effect of the group on skin conductance response, $F(1, 195) = .804$, $p > .05$. According to this, participants in Study III, who were asked to decide when to lie has similar skin conductance responses ($M = .51$, $SE = .03$) to the skin conductance responses of participants' in Study II, who were provided instructions to lie ($M = .46$, $SE = .04$) (See Figure 2.19). Similarly, there was not a main effect of the emotion used as the lie on skin conductance response, $F(5, 195) = 1.31$, $p > .05$. It was observed that using sadness ($M = .39$, $SE = .07$) as a lie yield in similar skin conductance responses with using fear ($M = .43$, $SE = .06$), surprise ($M = .48$, $SE = .05$), anger ($M = .49$, $SE = .05$), happiness ($M = .55$, $SE = .05$) and disgust ($M = .58$, $SE = .06$) (See Figure 2.20). Moreover, there was not a significant emotion*group interaction, $F(5, 195) = 1.27$, $p > .05$. According to this skin conductance response of using a fear ($M = .43$, $SE = .07$), anger ($M = .48$, $SE = .05$), sadness ($M = .49$, $SE = .07$), disgust ($M = .52$, $SE = .06$), happiness ($M = .53$, $SE = .04$), and surprise ($M = .58$, $SE = .07$) as a lie in Study II did not differ than using sadness ($M = .28$, $SE = .12$), surprise ($M = .38$, $SE = .07$), fear ($M = .43$, $SE =.08$), anger ($M = .50$, $SE = .08$), happiness ($M = .57$, $SE = .09$), and disgust ($M = .63$, $SE = .11$), as a lie in Study III (See Figure 2.21).

Analyses regarding to the effects of providing different instructions on correctly identifying the emotional facial expression

Response Time Analysis

In order to investigate if instruction provided has an effect on response time required for correctly identifying emotional facial expressions, the mean response

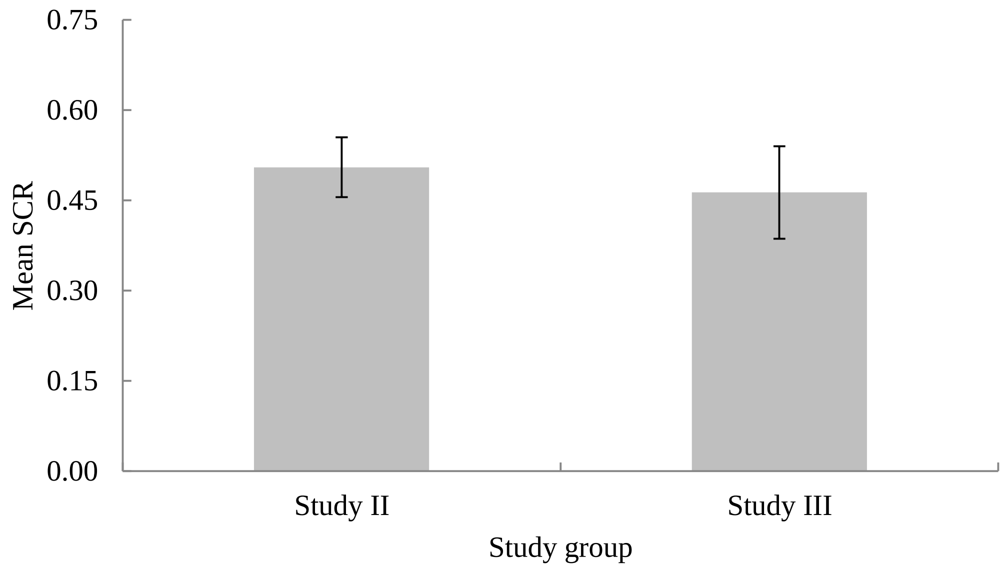

Figure 2.19. Mean (with 95% *CI*) skin conductance response by the study group participants were in

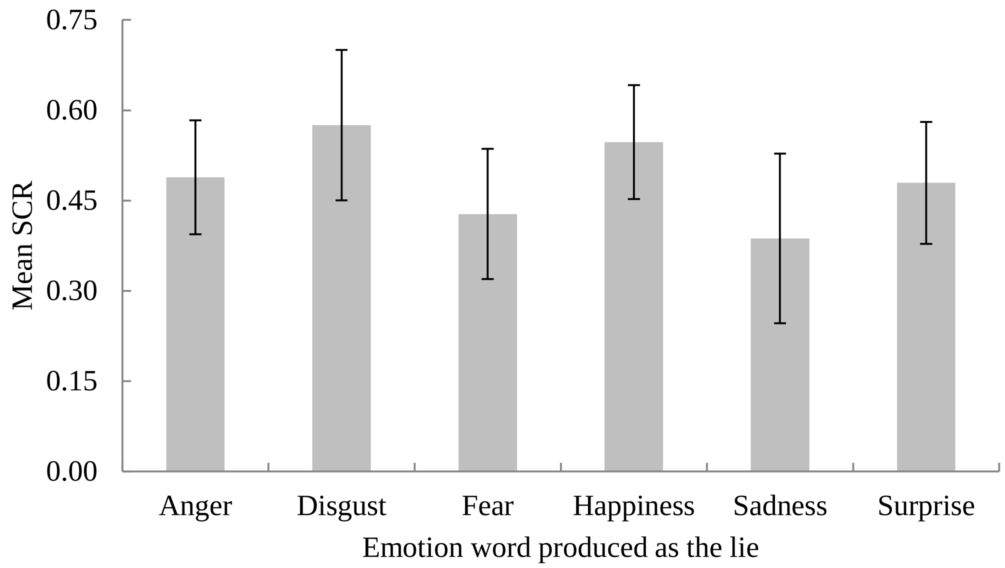

Figure 2.20. Mean (with 95% *CI*) skin conductance response by the emotional word produced as the lie

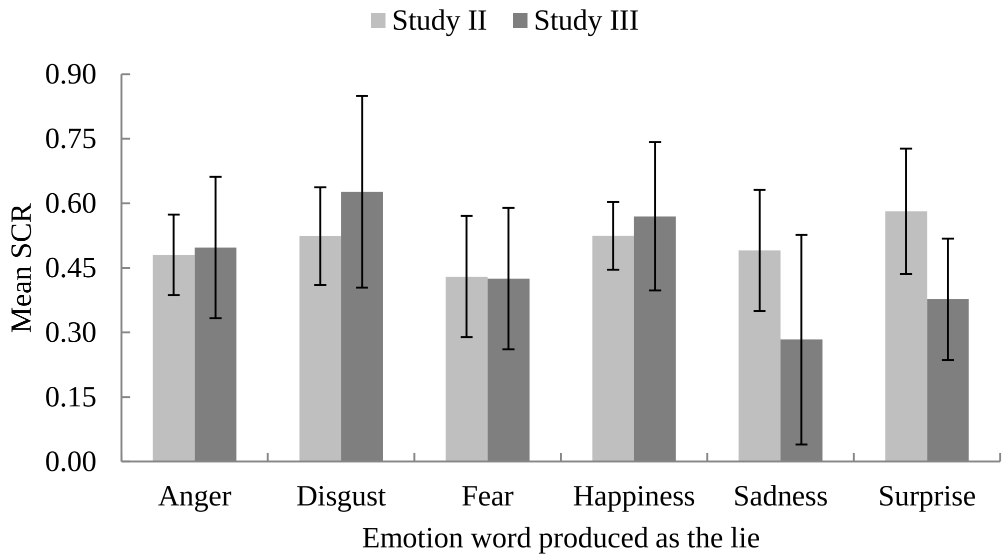

Figure 2.21. Mean (with 95% *CI*) skin conductance response as a function of study group participants were in by the emotion word produced as the lie

time measurements acquired through correctly identifying the presented emotional facial expressions trials of participants from Study I, Study II and Study III were compared by conducting a 3 (Study I, Study II, Study III) x 6 (emotion presented) factorial ANOVA. Results indicated that there was a significant main effect of the group on mean response time required to categorize the emotion presented, $F(2, 395) = 86.12$, $p < .01$, $\eta^2 = .30$. Participants in Study II were observed to identify facial expressions slower ($M = 2358.53$, $SE = 60.66$) both than the participants in Study III ($M = 2012.59$, $SE = 64.52$) and participants in Study I ($M = 1199.06$, $SE = 66.19$), while participants in Study I respond faster ($M = 1199.06$, $SE = 66.19$) both than participant in Study III ($M = 2012.59$, $SE = 64.52$) and Study II ($M = 2358.53$, $SE = 60.66$) (See Figure 2.22). In addition, significant main effect of the emotional facial expression presented was observed, $F(5, 395) = 2.85$, $p < .01$, $\eta^2 = .04$. According to this, participants identified facial expression of happiness faster ($M = 1573.39$, $SE = 89.69$) than facial expressions of disgust ($M = 1926.07$, $SE = 87.94$), anger ($M = 1988.69$, $SE = 95.95$), surprise ($M = 1931.94$, $SE = 87.44$) and sadness ($M = 1924.42$, $SE = 88.47$). It was observed the only facial expressions that was identified in similar response time with happiness was fear ($M = 1795.85$, $SE = 91.87$) (See Figure 2.23). Similarly, group*emotion interaction effect on response time was significant, $F(10, 395) = 2.81$, $p < .05$, $\eta^2 = .07$. According to this, facial expressions of anger ($M = 1088.62$, $SE = 162.13$), disgust ($M = 1107.43$, $SE = 162.13$), fear ($M = 904.29$, $SE = 162.13$) and sadness ($M = 1319.29$, $SE = 162.13$) identified faster by participants in Study I in comparison to participants in Study II ($M_{anger} = 2439.00$, $SE_{anger} = 148.59$; $M_{disgust} = 2551.60$, $SE_{disgust} = 148.59$; $M_{fear} = 2572.20$, $SE_{fear} = 148.59$; $M_{sadness} = 2324.80$,

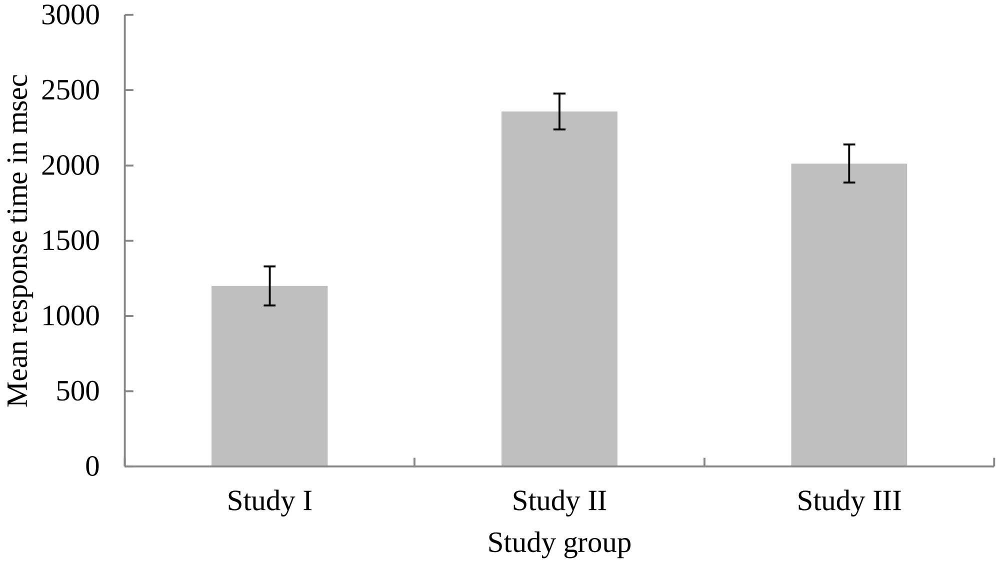

Figure 2.22. Mean (with 95% CI) response time for correct identification of emotional facial expressions by the study group participants were in

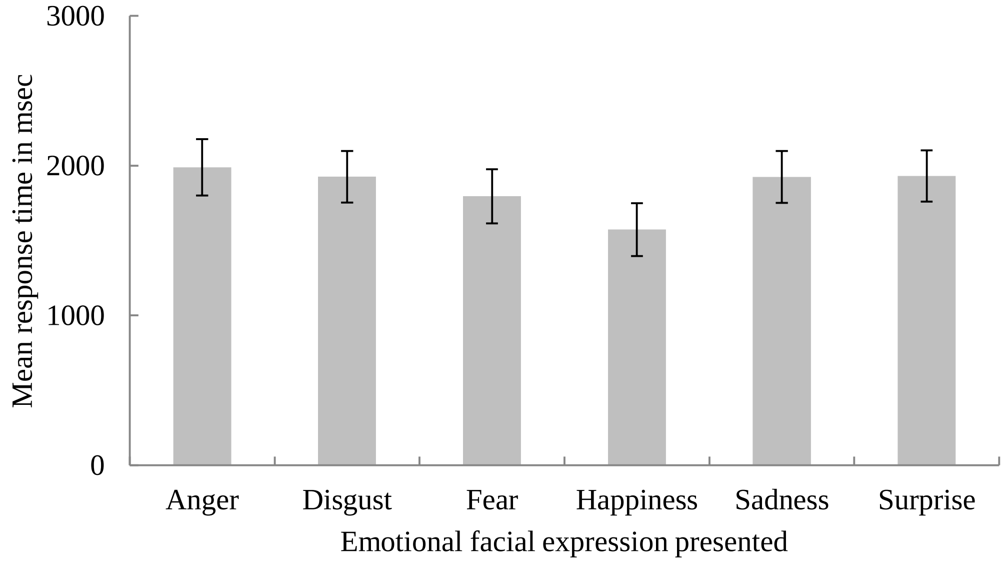

Figure 2.23. Mean (with 95% *CI*) response time for correct identification of emotional facial expressions by participants in Study I, Study II, Study III

$SE_{sadness}$ = 148.59) and Study III (M_{anger} = 2438.44, SE_{anger} = 185.74; $M_{disgust}$ = 2119.19, $SE_{disgust}$ = 145.71; M_{fear} = 1911.05, SE_{fear} = 166.13; $M_{sadness}$ = 1857.15, $SE_{sadness}$ = 142.98) (See Figure 24).

Skin Conductance Response Analysis

In order to investigate if skin conductance response time for lying about different emotional facial expressions varies between participants in different study groups, skin conductance response measurements acquired through correctly categorizing the facial expression trials of participants from Study I, Study II and Study III were compared. A 3 (Study I, Study II, Study III) x 6 (emotion) factorial ANOVA revealed that there was a main effect of the group on skin conductance response, $F(2, 396) = 6.66$, $p < .05$, $\eta^2 = .03$. According to this, participants in Study III, who were asked to decide when to lie had lower skin conductance responses ($M = .25$, $SE = .02$) than both the participants in Study II ($M = .34$, $SE = .02$) and Study I ($M = .37$, $SE = .02$). Additionally, the difference between skin conductance responses of participants in Study I and Study II was significant. According to this participants in Study II ($M = .34$, $SE = .02$) had lower skin conductance responses than participants in Study I ($M = .37$, $SE = .02$) (See Figure 2.25). On the contrary, main effect of the emotional facial expressions on skin conductance response was not significant, $F(5, 396) = .28$, $p > .05$. According to this, facial expressions of anger ($M = .34$, $SE = .03$), disgust ($M = .32$, $SE = .03$), fear ($M = .32$, $SE = .03$), happiness ($M = .33$, $SE = .03$), sadness ($M = .30$, $SE = .03$) and surprise ($M = .30$, $SE = .03$) yield in similar skin conductance responses (See Figure 2.26). Similarly, group*emotion interaction was not significant, $F(10, 396) = .47$, $p > .05$. (See Figure 2.27).

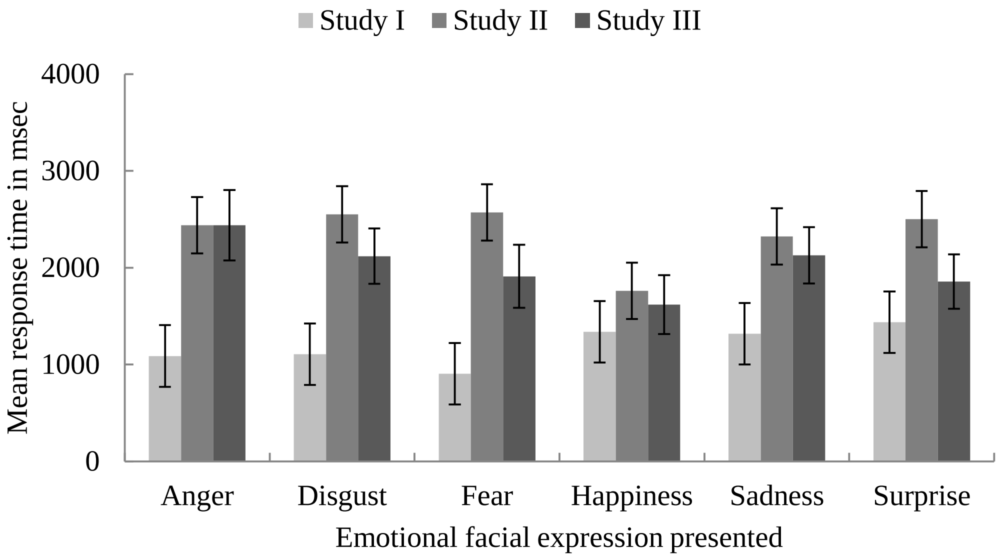

Figure 2.24. Mean (with 95% *CI*) response time for correct identication of emotional facial expressions by the study group participants were in

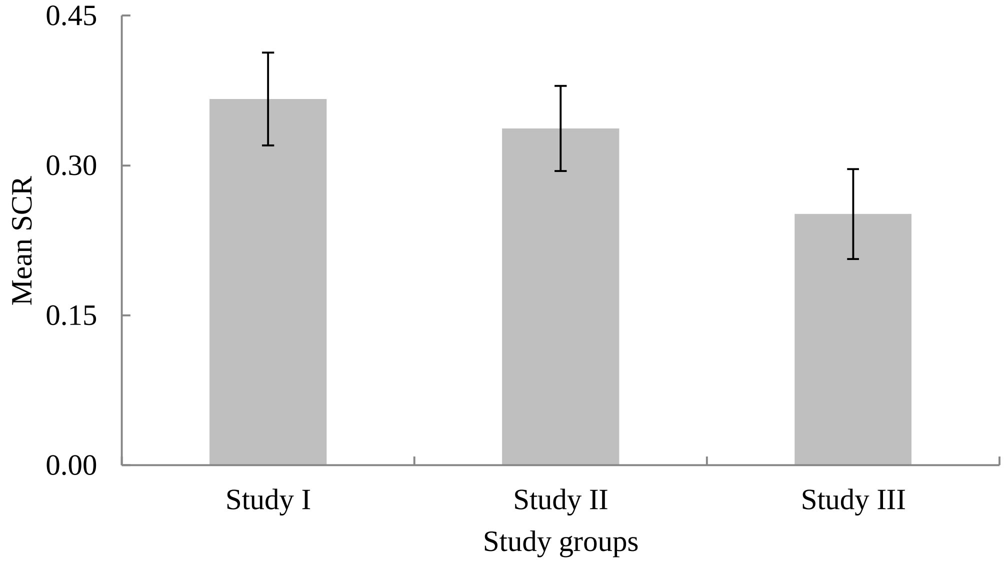

Figure 2.25. Mean (with 95% *CI*) skin conductace response for correct identification of emotional facial expressions by study groups participants were in

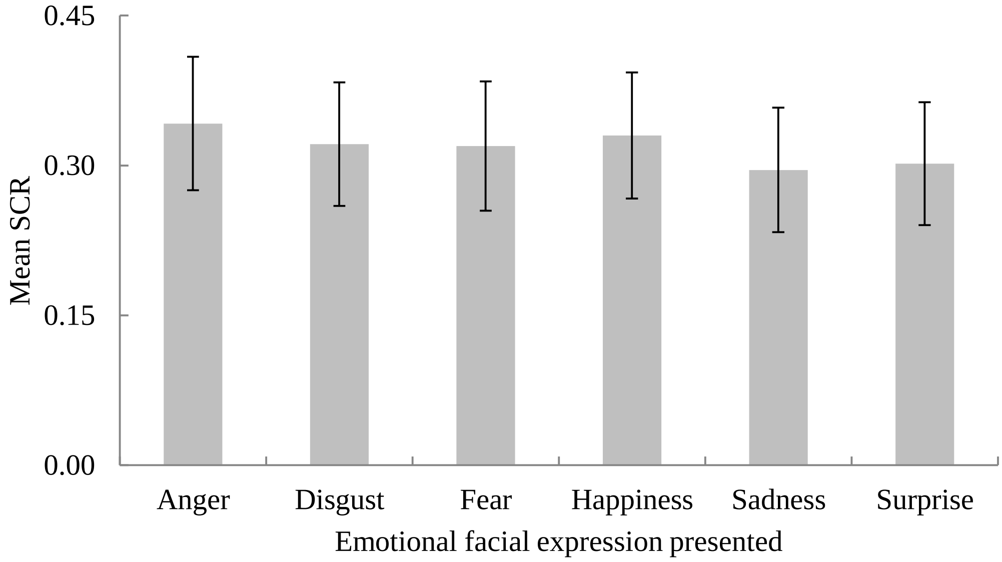

Figure 2.26. Mean (with 95% *CI*) skin conductace response for correct identification of emotional facial expressions

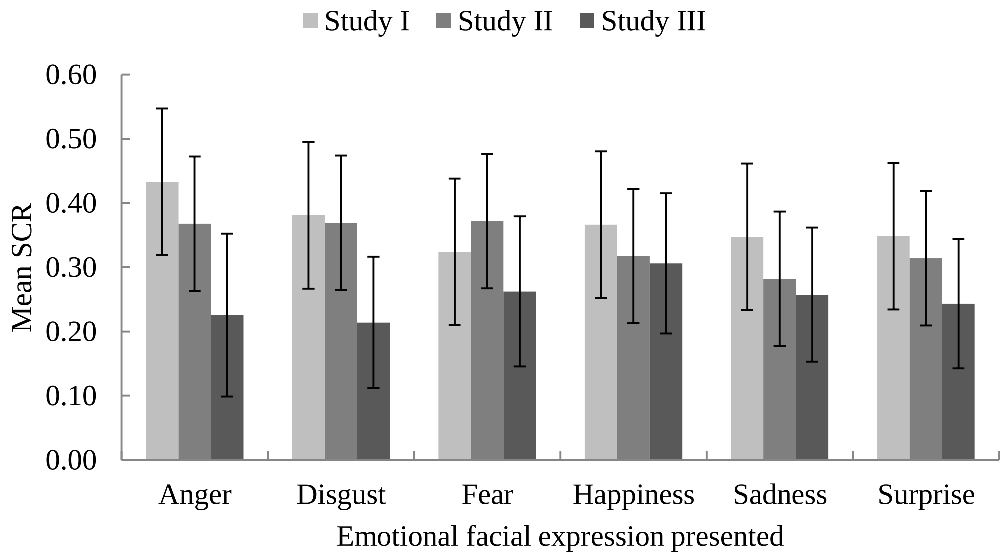

Figure 2.27. Mean (with 95% *CI)* skin conductance response for emotional facial expressions by the study group participants were in

CHAPTER 3

DISCUSSION

The question of how facial expressions of six universal emotions are processed by brain gives rise to two strong and conflicting hypotheses, which are the right hemisphere hypothesis and the valence hypothesis. Although data on support of these two hypotheses is still acquired through studies conducted by using different paradigms, no consensus is reached yet on the issue of which hypothesis describes best the principles of facial expression processing. While this debate is still on, there is another view that visual saliency level of facial expressions lead to a hierarchical processing of facial expressions. Therefore, in the present study, it was aimed to investigate if facial expressions of different emotions vary on the basis of their saliency levels. In order to address this question, instructed lying paradigm was applied in an emotion recognition task while response time and skin conductance measurements were being recorded. The experiments conducted in the scope of this study were organized around three questions: (1) if emotional facial expressions vary in terms of their visual saliency levels as a function of the emotion presented in the face, (2) if the resistance of the facial expressions to the cognitive load that lying about them brings into vary as a function of their saliency levels, and (3) if resistance of emotional facial expressions to the different instructions provided about lying differ for distinct emotional facial expressions. In this section, results acquired through each experiment will be summarized and their implications with respect to the questions asked in each experiment will be described.

Do emotional facial expressions vary in terms of their visual saliency levels as a function of the emotion presented in the face?

In order to address this question, an emotion recognition task was applied in the first study, in which participants were asked to identify the emotion presented in the face while response time and skin conductance measurements were being recorded. It is known that recognition of facial expressions with high saliency levels takes shorter time than recognition of emotional facial expressions with low salience. As in consistency with the previous findings regarding to the response time differences between facial expressions with distinct saliency levels, it was observed that facial expressions of happiness identified faster than facial expressions of disgust, fear, sadness and surprise, while it was processed within similar response times with facial expression of anger. Although having comparable response time requirements with facial expression of happiness to be processed accurately, facial expression of anger was not observed to be differentiating from facial expressions of disgust, fear, sadness and surprise in terms of the response time requirements. On the contrary to these response time differences, facial expressions of six universal emotions were not observed to differentiate on the basis of the skin conductance response they induce.

Considering these response time differences between facial expressions of distinct emotions, the hierarchical order of saliency for the basic emotions was proposed to be as (1) happiness, (2) anger, (3) disgust, fear, sadness, surprise. In this order, happiness has the highest saliency level; whereas disgust, fear, sadness and surprise are entities of low saliency category, and anger is the transition point between low and high saliency groups.

It is known that from the evolutionary account, some emotional facial expressions are more essential for survival than others on the basis of the information they convey. For instance, facial expression of anger is generally associated with a possible attack towards an individual, therefore it is important to decipher this facial expression in order to avoid or survive an attack. Similarly, decoding facial expression of fear is proposed to be essential for survival. In addition to facial expressions of fear and anger, facial expression of disgust is regarded as an important facial expression for survival of an organism since it conveys signals for germ avoidance. On the other hand, the visual salience order obtained in this study implied that although facial expressions of disgust and fear are related with survival of an organism, identification of these facial expressions take longer response time than identification of facial expression of happiness. However, since the task used in this study was related with semantic categorization of emotional facial expressions, it could be proposed that semantic computations of facial expressions of fear and disgust may be carried out at a later time or carrying out semantic computations of these facial expressions may be cognitively more demanding.

Does the resistance of the facial expressions to the cognitive load that lying about them brings into vary as a function of their saliency levels?

In order to assess the degree to which the salience of the emotional facial expressions interfere with the cognitive load that lying produce, the second study was designed, in which participants were asked to complete an emotion recognition task. Throughout the emotion recognition task used in the second study, participants were presented facial expressions of emotions as in a similar fashion with the emotion recognition task used in the first study, and were asked to identify the emotion that is associated with the presented facial expression. However, as different from the first study, participants were also asked to lie about the emotion presented in the face when it was cued prior to the presentation of the facial expression. Considering the effects of salience on how efficiently a facial expression will be processed under high cognitive load (Tracy & Robins, 2008), and the complex cognitive processes that act of lying involves, it was expected to observe that it was expected to observe that lying about facial expressions of emotions with high saliency levels would require longer times than lying about facial expressions with lower saliency levels because of the interference between the saliency and suppressing the truth and the truth related memory activated requirement of lying. To be more specific, on the basis of the results obtained in the first study, lying about facial expressions of happiness and anger was expected to take longer response times than correctly identifying them.

The initial examinations conducted in order to establish if the instructed lying paradigm used in this study produced results consistent with literature on lying and response time along with lying and skin conductance response revealed that as in consistency with the given literature of lying, lying require 888msec slower response times and .14 microsiemens higher skin conductance response than true responses, as independent of the emotional facial expression presented. It was observed that facial expression of happiness triggered responses faster than any other facial expression regardless of the instruction provided, which indicated that even under high cognitive load facial expression of happiness processed faster than other emotional facial expressions. More importantly, data regarding to the interference between the saliency of facial expressions and the cognitive load of the task revealed that lying about facial expressions of happiness, anger and sadness took longer time than correctly identifying these facial expressions require. Although these observations seem in line with the hypothesis that lying about salient emotional facial expressions would take longer time than lying about less salient emotional facial expressions, observing facial expression of sadness requiring longer response time to be lied about in comparison to being correctly identified contradicts with the expected observations, since it was determined to have lower saliency than happiness and anger in the first study.

However, when skin conductance responses of lying and correctly identifying the facial expression presented were examined for each emotion, it was observed that the emotional facial expressions about whom lying yielded in higher skin conductance responses than correctly identifying were happiness and anger. Therefore, it was thought that this observed response time differences among lying and correctly identifying trials for facial expression of sadness might arisen from other factors but salience. The first factor that was thought to effect the response time of lying about facial expression was the emotion preferred as the lie for this facial expression. However, examination of the relationship between the facial expression presented and emotions preferred as lie for a given facial expression revealed that the word happiness was the most frequently used lie almost for all facial expressions, including sadness, therefore the observed response time differences for sadness among different trials could not be explained in terms of preferring emotion words that belong to facial expressions with low salience as the lie. On the other hand, considering that successful lying requires suppression of the activated memory related with the truth as well as the truth itself, and suppression attempts made by the secret bearer results in the secret to gain hyperaccessibility (Lane & Wegner, 1995), the observed response time differences among lying and correctly identifying the facial expression of sadness was thought to be due to that the facial expression and emotion word of sadness might gain hyperaccessibility throughout the study. Therefore, in order to examine if providing instructions to lie effected the way in which facial expressions were processed and altered the cognitive accessibility of emotion words, a third study was designed in which participants were asked to decide on the facial expression they would lie about.

It was observed that when participants were asked to decide on the facial expression they would lie about, they produced the lies faster than the participants who were provided instructions to lie. More importantly, participants in the third study were observed to prefer the word sadness as the lie for a given facial expression less frequently than the participants in the second study, which strengthen the idea that the observed resistance of sadness to lying in terms of response times might be due to effects of providing instructions to lie which resulted in the facial expression to gain hyperaccessibility.

Does the resistance of emotional facial expressions to the different instructions provided about lying differ for distinct emotional facial expressions?

In order to evaluate how facial expressions with distinct saliency levels were processed by participants who were given different instructions on lying and to investigate the effects of distinct instructions provided to participants on the way that facial expressions were processed to be identified correctly, response time and skin conductance response measurements of participants from the first, second and third study were compared. It was observed that participants from the first study, who were not provided any instructions to lie, process facial expressions of emotions faster both than the participants in the second and third study, who were either instructed to lie or instructed to decide on when to lie. Additionally, analyses of skin conductance responses revealed that participants who decided to lie without an instruction had the lowest skin conductance responses, which was followed by the participants in the second study, who were provided instructions when to lie, whereas participants who were not provided any instructions about lying had the highest skin conductance responses. These observed differences in terms of the skin conductance responses of participants from different study groups raised the idea that the cognitive load of following instructions either to tell lie or to respond correctly might be higher than deciding how to respond.

Response time analyses conducted on the correct responses of participants form different study groups revealed that facial expressions of happiness was processed faster than facial expressions of anger, disgust, sadness and surprise regardless of the instruction participants were provided. More strikingly, it was observed that response time required to identify facial expression of happiness correctly did not differentiate between distinct study groups, whereas facial expressions of anger, fear, disgust, sadness and surprise were processed faster by participants who did not receive any instructions about lying. These observations regarding to the response time differences between different study groups in identifying facial expressions gave rise to the conclusion that facial expression of happiness which was determined to be the facial expression with highest saliency was observed to be the facial expression that was most resistant to the effects of different instructions.

Limitations and future directions

Throughout the experiments conducted in scope of the present study, we faced with losing excessive amount of participants. Such loss of participants may be due to the differences between the tasks used in pilot study and the main studies, in addition to the task requirements. In the first study, participants were asked to identify verbally the emotion presented in a facial expression presented. The facial expressions used in the study were determined via pilot study conducted prior to main studies. As it was indicated before, in pilot study, participants were asked to name the emotions that can be presented via facial expressions and the paper on which the emotions participants remembered and the ones that were aimed to be investigated was written was left near participants in case of they need to remember, as different from the main studies. Main purpose of such pilot studies is finding a model whose facial expression represents a specific emotion best. In order to achieve that goal, the most commonly used technique is asking participants to complete an emotion recognition task. In such studies, participants are presented a model's photograph which is taken while s/he is presenting a facial expression, and following the presentation of the facial expression, participants are asked to choose the emotion that model's facial expression corresponds to according to them from a given list consisted of emotion words such as anger, happiness, surprise, etc. At the end of the study, a photograph with the highest accuracy rate among other photographs is accepted as the representative of the related emotion. Although providing emotion words with which a facial expression can be matched seems lightening the work load of both researchers and participants, recent researches warn against some confounding effects of providing a word list in emotion recognition tasks by presenting shaping effect of words on emotion percepts, and highlight some strategies that participants use in forced-choice emotion recognition tasks that may mislead researchers. Therefore, the loss of participants in the first study, who could not identify more than half of the facial expressions which were determined to have high acuracy rates in pilot study, correctly may stem from the differences between the pilot study and the first main experiments.

In order to display how emotion words may affect emotion percepts, Gendron, Lindquist, Barsalou and Barrett (2012) discuss performance change of participants in different tasks such as in aforementioned classical emotion recognition tasks, freely labeling facial expressions or perceptual matching. Gendron et al. (2012) explain any decrease in performance of participants as the task becomes more remote from words in terms of words' mediation to resolve the ambiguity that facial expressions have in their nature by drawing a context. According to them, emotions and mental states cause facial actions and these facial actions are transferred into mental states by the perceiver via words, for instance, smiling is interpreted as happiness and scowling is interpreted as anger. A strong evidence for the Gendron et al.'s point of view comes from the findings of studies in which emotion words are made temporarily inaccessible while participants are asked to match facial expressions to each other on the basis of the emotion they present. Gendron et al. note that observed decrease in face matching task performance when meanings of words are satiated is the indicator of the role of words in emotion perception tasks.

On the other hand, it is not only the effects of words on emotional facial expression perception that makes the conclusions acquired from pilot studies in which emotion word list provided to participants to choose among them to describe the emotion that the facial expression they see represent difficult to interpret but also decision making strategies participant follow. James A. Russel (1993) wisely claims that it may not be possible to accurately interpret the results since participants can make relative judgments by comparing the options provided by the researcher with each other, which results in choosing the “most likely” option as an answer. Therefore, there is always possibility that the answer intended by participants may not always be the same with the answer they choose. It is also claimed that researchers are themselves already making a selection while providing emotion words to participants when it is considered that happiness is the only positive option among alternatives in general. In order to avoid any misleading that participants' decision making strategies may cause as Russel (1993) stressed out and both to observe and to prevent the percept shaping effects of emotion words if there is any, two different forms, one open-ended and one forced-choice questionnaires should be used in a pilot study in order to determine the photographs for each emotional facial expression category.

Another limitation regarding to the small sample size used in the second study was that although participants correctly identified the facial expressions of emotions throughout the practice trials, they were observed to either could not remember the genuine emotion presented in the face after lying about it or spend more than 5000msec to produce a lie about any given facial expression, along with misidentifying more than half of the facial expressions correctly in responding truthfully trials. All of these observations raise the question if the task requirements bring additional cognitive load into, since instructions to produce a lie or respond correctly were presented prior to presentation of facial expressions and were removed from the screen following to the presentation of the stimuli. In a study conducted by Williams, Bott, Patrick and Lewis (2013) in order to investigate the processes that causes lying to take longer response times than truth telling, it was observed that keeping the instruction on the screen along with the stimulus that was asked to lie about reduces the response time required to produce lies about the given stimulus. In addition to removing instructions from the screen, throughout the lying trials, participants were asked to indicate the genuine emotion presented in the face following to the production of a lie in order to be sure that participants processed the facial expression first. However, when it was considered that producing lies for the facial expressions presented requires suppression of the truth and deciding on the plausible alternatives, remembering the genuine emotion may get harder for the participants when questions regarding to the genuine expression were asked following to the lie production. Therefore, in order to reduce the cognitive load that task requirements bring into, instructions about lying or responding correctly should be presented following to correct responses of participants.

Another limitation of the present study was that emotion words preferred as lie were not observed to be distributed equally both in general and across different facial expressions. For instance, while the emotion word happiness was frequently used as the lie, the emotion words of disgust, fear or surprise were not used as frequently as happiness. Although comparing response time or skin conductance response differences between trials in which distinct emotion words used as a lie for a given facial expression would provide valuable information on the hierarchical semantic analysis of facial expressions, such comparisons could not be conducted because of unequal distribution of emotion words used as lies. Therefore, considering the limitation described above, it is suggested that using emotional stroop task - in which facial expressions of emotions presented with emotion words written on them, and participants were asked to decide if the emotion word and the facial expressions are associated with the same or different emotions - would be more useful in terms of determining the hierarchical semantic analysis of distinct facial expressions.

Conclusion

Overall findings indicate that being engaged in lying is a more cognitively demanding task than responding correctly and the resistance of the facial expressions to the cognitive load of lying differs on the basis of their salience. Consistent with the previous findings that facial expression of happiness, which has the highest saliency level, was identified more accurately and faster even under high cognitive load, in this study, facial expression of happiness was observed to be identified fast and hard to lie about than other facial expressions. Another facial expression that had been observed to have similar response time requirements to be correctly identified and longer response time requirements to be lied about was anger. Although facial expressions of fear and disgust convey essential messages that enhabces surival of an organism along with the facial expression of anger, no such response time or skin conductance response differences for facial expressions of fear or disgust was observed, which implies that hierarchical analysis of facial expressions with distinct salience may highly related with the importance of the facial expressions for social interactions.

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APPENDIX A

Participant Evaluation Form

İZMİR EKONOMİ ÜNİVERSİTESİ
PSİKOLOJİ LABORATUVARI
KATILIMCI BİLGİ FORMU

AD – SOYAD:	KATILIMCI #:
CİNSİYET:	TELEFON NUMARASI:
YAŞ:	MAIL:
MESLEK:	OKUL:
BÖLÜM:	SINIF:

Aşağıdaki soruları yanıtlarken lütfen durumunuzu en iyi yansıtan seçeneğin yanına işaret koyunuz.

1. Yakın zamanda (son 1 sene dahil) başka bir psikoloji deneyine katıldınız mı?
   ○ Evet, …………………..önce…….…………………………. çalışmasına katıldım
   ○ Hayır
2. Herhangi bir psikolojik rahatsızlık geçmişiniz var mı?
   ○ Evet (3. Sorudan devam ediniz) ○ Hayır (5. Sorudan devam ediniz)
3. Bir uzman tarafından rahatsızlığınıza konulan tanı nedir?
   ………………………………………………………………………………………
4. Rahatsızlığınızla ilgili kullandığınız ilaçlar var mı?
   ○ Evet, ……………………………………………….................isimli ilaç(lar)ı kullandım/kullanmaktayım.
   ○ Hayır
5. Herhangi bir nörolojik rahatsızlık geçmişiniz var mı?
   ○ Evet (6. Sorudan devam ediniz) ○ Hayır (8. Sorudan devam ediniz)
6. Bir uzman tarafından rahatsızlığınıza konulan tanı nedir?
   ………………………………………………………………………………………
7. Rahatsızlığınızla ilgili kullandığınız ilaçlar var mı?
   ○ Evet,……………………………………………………...........isimli ilaç(lar)ı kullandım/kullanmaktayım.
   ○ Hayır

“Participant Evaluation Form” (cont.).

8. Düzenli olarak halen kullanmakta olduğunuz ilaçlar var mı?
   ○ Evet,…………………………………………………………………………………
   ○ Hayır
9. Herhangi bir görme bozukluğunuz var mı?
   ○ Evet: ○ Hayır (Edinburgh El Kullanım Envanteri’nden devam ediniz)
   - ○ Miyop   Derece: ………. Sol/………. Sağ
   - ○ Hipermetrop   Derece: ………. Sol/………. Sağ
   - ○ Astigmat   Derece: ………. Sol/………. Sağ
   - ○ Renk körlüğü (10. Sorudan devam ediniz)
10. Lütfen hangi renkleri görmede sorun yaşadığınızı belirtiniz:
   ○ Yeşil – kırmızı   ○ Mavi – yeşil

Aşağıdaki belirtileri bugün de dâhil olmak üzere son bir hafta içinde ne ölçüde yaşadığınızı göz önünde bulundurarak yanıt veriniz.

		Hiç	Orta	Hafif	Ağır
1.	Bedeninizin herhangi bir yerinde uyuşma/karıncalanma				
2.	Sıcak/ateş basmaları				
3.	Bacaklarda halsizlik, titreme				
4.	Gevşeyememe				
5.	Çok kötü şeyler olacak korkusu				
6.	Baş dönmesi/sersemlik hissi				
7.	Kalp çarpıntısı				
8.	Dengeyi kaybetme korkusu				
9.	Dehşete kapılma				
10.	Sinirlilik				
11.	Boğuluyormuş gibi olma duygusu				
12.	Ellerde titreme				

“Participant Evaluation Form” (cont.).

		Hiç	Orta	Hafif	Ağır
13.	Titreklik				
14.	Kontrolü kaybetme korkusu				
15.	Nefes almada güçlük				
16.	Ölüm korkusu				
17.	Korkuya kapılma				
18.	Midede hazımsızlık/rahatsızlık hissi				
19.	Baygınlık				
20.	Yüz kızarması				
21.	Terleme (sıcağa bağlı olmayan)				

Edinburgh El Kullanım Envanteri

Lütfen aşağıda sayılan aktiviteler sırasında el kullanım tercihinizi ilgili kutunun içine işaret koyarak belirtiniz. Söz konusu aktivite sırasında her zaman tek elinizi kullanıyorsanız, o ele ait kutuya iki işaret koyunuz. Eğer söz konusu aktivite için iki elinizi birden ayrıt edilemez biçimde her iki ele de ait kutucuklara işaret koyabilirsiniz.

	Sol El	Sağ El
Yazma	□□	□□
Çizim yapma	□□	□□
(Bir şey) fırlatma	□□	□□
Makas kullanma	□□	□□
Diş fırçası kullanma	□□	□□
(Bıçak olmadan) çatal kullanma	□□	□□
Kaşık kullanma	□□	□□
Süpürge tutarken üstte olan el	□□	□□
Kibrit çakma	□□	□□
Kutu açma	□□	□□

“Participant Evaluation Form” (end.).

Tüm insanlarda, içinde yaşadıkları kültürden bağımsız olarak evrensel bir biçimde paylaşılan duygular vardır. Bu duygulardan özellikle 6 tanesi birbirinden ayrı yüz ifadelerine sahiptir.

Kişilerin yüzlerinden anlaşılabilecek duygulardan 6 tanesinden hatırlayabildiğiniz kadarını aklınıza gelen sırada aşağıdaki boşluklara yazınız.

1……………………………………………………………..
2. ……………………………………………………………….
3. ……………………………………………………………….
4. ……………………………………………………………….
5. ……………………………………………………………….
6. ……………………………………………………………….

APPENDIX B

Informed Consent Form

İZMİR EKONOMİ ÜNİVERSİTESİ
PSİKOLOJİ LABORATUVARI
BİLGİLENDİRİLMİŞ ONAM FORMU

Değerli katılımcı,

Bu çalışmada, temel duygulara ilişkin yüz ifadelerinin temsil ettikleri duygu temelinde sahip oldukları görsel belirginlik düzeyleri incelenmektedir.

Çalışma boyunca bilgisayar ekranında farklı modellerden çeşitli yüz ifadeleri sunulacaktır. Sizden istenilen, modelin gösterdiği yüz ifadesinin hangi duyguya ait olduğunu belirlemenizdir. Cevaplarınız için bir süre kısıtlaması yoktur ancak mümkün olduğunca hızlı ve doğru cevaplar vermeniz istenmektedir.

Deney sonucunda elde edilecek olan veriler, kişisel bilgiler gizli tutularak analiz edilecektir. Deneye katılmanız gönüllülük esasına dayanmaktadır. Deney öncesinde ya da deney sırasında istediğiniz takdirde deneyden ayrılabilirsiniz. Araştırmayla ilgili sorularınız çalışma sonrasında araştırmacı tarafından yanıtlanacaktır.

Çalışmamızda bize yardımcı olmak isterseniz lütfen aşağıda yer alan ifadeyi dikkatle okuyup imzalayınız.

Yukarıdaki bilgileri okudum ve deney hakkında bilgilendirildim. Sorularım araştırmacı tarafından açık bir biçimde yanıtlandı. Deneye katılmayı kabul ediyorum.

Tarih : …./…./……..
İmza : ……………...

Katılımcıya gerekli bilgiler verilmiş, katılımcının soruları tarafımdan cevaplandırılmıştır.

Ayşegül AYDINLIK