A Psychophysiological View at Leakage Theory

A Small Leak Can Sink a Great Ship. (Franklin, 1739)

1. Introduction

Throughout the centuries, mankind has been involved in lying games where they tried to deceive themselves in order to convince each other’s thoughts. Whether in a good way; a white lie, or a bad way, lying is in our lives in everyday life. But who was the first liar in the history or what was the first lie? From a religious or a spiritual point of view, the Satan; lying to Eve, can be named as the first liar. He told Eve that she would not surely die if she ate the fruit in the tree disobeying God’s commands which could be the first lie ever (The Holy Bible, Genesis 3:4, 2:17).

In this paper, to be told in an epigrammatic way, the Satan’s, the first liar’s psychophysiology will be discussed with one of the deception theories, called Leakage Theory.

‘The less aware we are of behaviour, the more likely the behaviour is to signal a lie’ (Granha, Vrij & Verschuere, 2015: 39). According to Granhag et al (2015), the reason of Ekman’s leakage theory being advance is that a human even tries to conceal the information, eventually he/she will give a leakage as soon as his/her awareness decreases. Therefore, in this paper, the leakage theory will be examined and intersected with unaware and involuntary movements created by psychophysiology of human (Granhag et al 2015).
First of all, five channels in terms of Leakage Theory will be explained in the following sections. Mainly, the first channel, called Facial Expressions and Fear Emotion of “Seven Universal Emotions” will be explored in detail. Fear Emotion is a relatively unique emotion by meaning of closeness to deception (Ekman & Friesen, 1969). Also other three channels (Fifth Channel, Verbal Content is not taken into account due to lack of psychophysiological explanation) will be discussed. The main reason that other channels need to be supported is according to Ekman & Friesen, whilst people focus on facial movements during lying, other channels such as body language (legs and feet) could be ignored (Ekman & Friesen, 1969).

2. Literature Review

2.1. Psychophysiology

To understand psychophysiology of the channels better, an afferent (deductive) pathway from whole nervous system, to nerves should be explained:
Table 1: The part of the human nervous system is mainly shown above until the limbic system (Hugdahl, 2001; LeDoux, 2003; LaBar et al., 1995).

The primary part of the limbic system which has an essential role in appraising the emotional valence of stimuli as reward or danger is amygdala (LaBar et al., 1995). When a scary question is directed to a person, one of the specialized units called Cranial Nerves; Cranial Nerve 8 (auditory nerve) takes the stimulus and delivers it to the thalamus. Thalamus projects the stimulus to auditory cortex and auditory cortex process the data.
Limbic structures such as amygdala and hippocampus have reciprocal connections with the prefrontal cortex (LaBar et al., 2006).

The data interpreted in the prefrontal cortex after memory recall is delivered from the hippocampus and amygdala may draw a conclusion about the situation as a threat and send signals to hypothalamus to activate the sympathetic nervous system (Cahill et al., 1995). Hypothalamus stimulates the anterior pituitary gland and pituitary gland sends signal to the cortex of the adrenal gland to secrete the stress hormone called “cortisol” (Hugdahl, 2001). On the other hand, hypothalamus sends a second signal to the adrenal medulla to secrete the “epinephrine” (Hugdahl, 2001). In consequence of secretion of cortisol and epinephrine, heart rate increases, blood pressure increases, digestion and secretion of saliva decrease and as a result mouth dryness occurs, pupil is dilated, sweat secretion is activated, glucose in the blood gather in the limbs in order to provide fast movements as stress responses (Hugdahl, 2001).

Amygdala sends projections to the thalamus, hypothalamic and brainstem areas in order to project the several symptoms of fear (Hugdahl, 2001). Also, amygdala makes another connection with cranial nerves, trigeminal and facial motor nerves to maintain facial expressions (Cattaneoa & Pavesi, 2014). These connections of Amygdala, as an emotion creator, to facial expressions, may lead us to the hypothesis that every emotion can be read from a human’s face (Cattaneoa & Pavesi, 2014).

2.2 Leakage Theory

‘Leakage is betrayal of concealed withheld information’ (Ekman & Friesen, 1969: 89).
According to Leakage Theory, an emotional reaction must be created by deception, and this change must effect liar’s behaviors, meaning changing his/her baseline (Porter & Brinke, 2010). These changes can be in several parts of the body. Imagine a weight-lifter trying to lift a mass, at an amount of just above his maximum capacity. Easily, tension on his arm, shivering bilaterally can be observed. Shivering in this example could be named, as a leakage. Similarly, in this study, the body leaks out when it cannot lift the burden exceeding its capacity to hold the concealed information. Therefore, the signals which are changed by emotional or cognitive loads should be examined (Granhag, Vrij & Verschuere, 2015).

2.3. Five Channels of Leakage Theory

There are mainly five channels of Leakage Theory: Facial Expressions (micro expressions), Body Language (Gestures: Emblems, Illustrators, Manipulators), Voice (Pitch, Speed, Volume, Rhythm, Edge), Verbal Style (Changing in pauses, Stuttering, Word Repetition changing in tone of voice), Verbal Content (the words we say or write) (Lansley & Pearse, 2010).

In this study, Facial Expression Channel has been chosen mainly and fear emotion will be examined as psychophysiologically. Also, eye blink as another Facial Expression, pauses and stuttering as Verbal Style, shoulder shrug and head rotating, gestures (illustrators) as Body Language will be explained as co-pilot studies. If chosen signals of channels mentioned above are put under the psychophysiologic scope, an important common part of brain, called Cranial Nerves, triggering these signals can be observed. In the next section, the five channels of Leakage Theory will be discussed.
2.3.1. Channel 1: Facial Expressions

According to Ekman and Matsumoto (2008) facial expressions have a different working mechanism regarding to muscles working with bones. Contracted muscles for facial expressions are the rare muscles as unfastened muscles to any bones, according to other muscles. (Ekman & Matsumoto, 2008). In this paper, facial expression will be examined deeply rather than other channels.


The facial muscles mentioned above are innervated by facial nerve, the cranial nerve VII (Fehrenbach & Herring, 2011). Although Paul Ekman (2003) called reliable muscles for fear as “AU1+2+4+20” (Ekman, 2003), the studies of reliable muscles still continues (Mehu, Mortillaro, Banziger & Scherer, 2012). For this reason the muscles are not classified as reliable in this paper. There are also “helping nerves” in facial expressions. For example, Lavator Palpebrae Superiors is innervated by Cranial Nerve 3 which is called Oculomotor Nerve (Monkhouse, 2006).

2.3.1.1. Pupil Dilation during Fear Emotion as a Stress Response:

Visual perception mainly takes place in the visual cortex of the brain. The light joins and projects onto retina where light is transformed and transmitted to Cranial Nerve II, the Optic Nerve, to be sent to the brain (Nairne, 2005). Further, the iris, a lens augmenting and contracting the muscle around, regulates the pupil and amount of light entering the eye (Nairne, 2005; Bruce et al., 2003).
On the other hand, during involuntary stress responses, autonomic nervous system takes place and regulates the size of pupil. Under stress, ANS starts sympathetic nervous system and pupil dilation is activated. Finally, the amount of pupil dilation during emotional and cognitive load is relatively lower than visual perception (Fong, 2012).

2.3.1.2. Eye Blink as a Deceptive Movement and as a Facial Expression

An eye blink is a muscle contraction to close the eye for a short time. The main responsible muscles for eye blink are Levator Palpebrae Superioris and Orbicularis Oculi which are contracted by Cranial Nerve 3 and Cranial Nerve 7, respectively (Hartwig, 2008).

Upper and lower eye lids touch to each other in one voluntary and two involuntary ways. The voluntary closure is a motor movement by a conscious decision (Andreassi, 2000). First involuntary eye blink is influenced by an external stimuli such as light, a threatening sound or an action directly towards to face. Second involuntary eye blink is to moisture the cornea (Andreassi, 2000).

On the other hand, rate of blinking can change from different reasons. If an extra attention is needed during an important effort, for example problem solving, blinking rate is lowered. Also, there are theories saying that during negative valence emotions, blinking rate grows, and during positive valence emotions such as happiness, blinking rate is lowered (Andreassi, 2000).

According to Bauer, Strock, Goldstein, Stern, and Walrath’s study (1985) with an auditory stimulus, blink does not occur before comprehension of stimuli and judgment of response (Bauer et al., 1985). This can lead us the idea of relationship between cognitive load and blink rate eventually.
2.3.2. Channel 2: Body Language

*Shoulder Shrug* could be considered as a classic deceptive body movement in evaluating truthfulness. Sometimes a positive approval could be heard from a person where rotating his or her head in order to say a negative implication unconsciously and secretly. This contradiction could be a leakage in a conversation hypothetically (Givens, 2010). Interestingly, these two movements are executed by sternocleidomastoid and trapezius muscles which are controlled by again a Cranial Nerve, eleventh, called Accessory Nerve (Monkhouse, 2006). Therefore, considering general structure of Cranial Nerves and their connections to amygdala, mentioned earlier in this paper, during an emotional load and cognitive load, shoulder shrugs could be counted as leakage signals.

Another body language subject is *Gesture*. Gestures can be defined as autonomous body actions during communication, helping communication, taking place of words or thoughts in a non-verbal way. Although there are connections between spoken language and symbolic gestures, accurate relationship has not been proven up to now. Gestures are helpers either for the teller to explain what he or she tries to explain in mind (working memory) or for the listener to understand clearer (Xu et al., 2009). Gestures are driven in the same brain areas with speech and sign language called *Broca’s and Wernicke’s areas* (Bates & Dick, 2002). There are researches assuming that dyad of gestures and languages were acclimated (Xu et al., 2009). Moreover, another research shows that during gesture and speech, two areas of the brain were activated. These areas are called Inferior frontal and posterior temporal lobes where again Wernicke’s area and Broca’s Area are laid in (Bates & Dick, 2002). Therefore, an idea can be constructed for those people which use gestures more spontaneously with words are more credible than people avoid using gestures or show lack of gestures.
2.3.3. Channel 3: Voice

Producing voice can be detailed in three different systems: Air pressure system, vibratory system and resonating system (Scott et al., 2014). In these systems, two main parts take huge roles which are called larynx (voice box) and throat (pharynx) causing edge and pitch of sound (Scott et al., 2014). Brain controls the voice production with specific nerves and sends signals to the recurrent laryngeal nerve (RLN) and Superior laryngeal nerve (SLN) (Scott et al., 2014). These two nerves specifically are both the branches of Cranial Nerve 10, The Vagus Nerve. The Vagus Nerve can collaborate with SNS or PNS as an equalizer of anxiety. For instance, over activity of Vagus Nerve with emotional stress can cause low blood pressure and lack of oxygen in the brain. (Scott et al., 2014).

As a result, pitch or edge changes in Voice Channel, can be assumed as deceptive depending on evaluation of other channels’ spontaneity.

2.3.4. Channel 4: Verbal Style

Another important channel in Leakage Theory is verbal style and two signals of Verbal Style Pauses and Stuttering will be examined.

2.3.4.1. Pausing:

Studies show that during pausing left temporal cortex which contains Wernicke’s area that is in charge of speech comprehension working together with Broca’s Area was active but not during any gaps between words or sentences (Kircher et al., 2004).

From the clinical point of view at pausing, Parkinson’s disease is a disorder of central nervous system causing involuntary motor movements by lack of dopamine (Caektebeke,
When Parkinson's disease is examined as pausing, the patients have difficulties for creating loud and pitch sounds whilst showing some emotions like anger (Caekebeke, 1991).

Parkinson Patients also have abnormal pauses in daily speech and show a low rate of speech (Skodda et al., 2009).

2.3.4.2. Stuttering:

The Basal Ganglia is the starter (producing and transmitting “go-signals” at a necessary level of quantity) of syllables or words in a speech (Alm, 2004). Another fact about the basal ganglia and stuttering is that the damage of basal ganglia after birth may cause stuttering even after proper speaking for years (Alm, 2004). After researches, effects of drugs showed changes in dopamine system which adjusts mechanism of basal ganglia in the body. Finally, under stress, motor functions of basal ganglia are irregular, showing the causes of stuttering under negative valence emotions (Alm, 2004).

Interestingly, stuttering has a sudden recovery temporarily. The rhythm effect shows that if a stutterer uses metronome and beats during speaking, stuttering may disappear (Alm, 2005). Goldberg discusses this effect as two parallel premotor systems. For example, speech and planning has two simultaneous ways in the brain (Alm, 2005). However, the system containing the basal ganglia works autonomic refusing outer reactions especially during non-rehearse speeches. The system transmits thoughts and emotions which could be examined as leakage signals (Alm, 2004).
3. Conclusion

In this paper, psychophysiology of leakage theory was examined. For four of the Leakage Channels, the importance of cranial nerves was observed. The Leakage Theory’s distinctiveness, based on unawareness (Granhag et al., 2015), was corroborated by cranial nerves triggered by SNS which is the center of involuntary actions.

Also, Broca’s and Wernicke’s Areas effect to detecting deception was explored during communication when those areas are activated by an emotional or cognitive load.

In the future studies, ‘the primary source of both leakage and deception clues’ (Ekman & Friesen, 1969:99), the legs and feet movements such as aggressive foot kicks, soothing leg squeezing (Ekman & Friesen, 1969), could be examined psychophysiologically.

4. References


Franklin, B. (1739). *Poor Richard’s Almanack*, Philadelphia: B. Franklin


