

## An Investigation of Biological Markers of Adult Attachment in the Framework of Polyvagal Theory



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**ABSTRACT:** In this dissertation, the physiological effects of attachment theory were investigated with respect to the Polyvagal theory. The aim of the study is to investigate comparatively whether there is a physiological change that can be proven by activating the attachment system as a result of romantic relationship and vital threat with emotional stimuli through the participants who are classified as avoidant and anxious attachment dimensions by applying ECR scale. 60 participants divided into the two groups; avoidant and anxious were exposed to visual stimulus in three qualified categories (romantic relationship-positive, neutral and romantic relationship-negative) for 12 min. Skin conductance level (SCL) computed from GSR by measuring changes in the conductivity of the skin regulated by the Autonomic Nervous System. In order to observe the changes in facial expressions regulated by the VII. cranial nerve, the metrics of 7 basic emotions in AFFDEX facial expression analysis modules (anger, sadness, disgust, happiness, etc.) were analyzed with "Time Percentage". Thus, it was investigated whether there was a statistically significant difference in terms of physiological change between two different groups in three different stimulus categories. It was observed that there is no significant difference in the measurement of SCL  $\mu\text{S}/\text{m}$  of two groups. However, when peaks were included in the analyses, it was observed that the anxious group have more peak counts than the avoidant groups in terms of romantic positive, romantic negative, and polyvagal-negative measures ( $\chi^2(4) = 45,084, p = .000$ ). As for AFFDEX analyses, Positive, Sadness (mean, 0.03  $ss = 0.26$  - mean 00  $p = .014$ ), Neutral, sadness (mean, 0.15  $sd = 1.53$  - mean .00  $p = .025$ ) Negative, fear (mean, 0.12  $sd = 1.06$  - mean.00  $p = .045$ ) Negative time percentage (mean: 0.33  $sd = 2.58$  - mean: 2.43  $ss = 11.24$   $p = .038$ ) were observed significant differences between groups. As a result, it is assumed that revealing concrete and important findings on biological markers of adult attachment with respect to the framework of polyvagal theory would provide both theoretical and practical contributions to the field.

**KEYWORDS:** Attachment, Polyvagal, Galvanic Skin Response, Automated Facial Coding

### INTRODUCTION

The attachment system is an evolutionary system that is vital for the survival of the newborn and is not unique to humans but is seen in all mammals in nature. It is claimed that starting from the relationship between the caregiver and the baby, it acts as a model for all the relationships that the individual establishes from the cradle to the grave. The main emphasis of attachment theory, which was put forward by John Bowlby (1982) has been on the emotional bonds between the caregiver and the infant, the formation process of these bonds and their functions. Early attachment studies focused on behavior patterns between caregiver and infant. As a result of recent attachment studies, adult attachment has become an important theory used to explain cognitive, emotional and behavioral patterns in adults' relationships with others (Zuvela, 2014). One of the most important differences in adult attachment is that attachment to friends, institutions and romantic partners occurs in adult life of humans (Hazan and Shaver, 1994). Adult attachment literature has shown that attachment bonds hierarchically transference to another adult in romantic relationships and this transference process is similar to early relationships with caregiver and infant (Mikulincer et al., 2000). Attachment researchers have indicated that individual differences in attachment orientations are associated with romantic relationships, relationship satisfaction and social adaptation in adulthood. Although the relationships between individual differences in attachment oriented and other relationship-related variables have been well documented (Feeney, 1999), transference of normative aspects of attachment bonds, including attachment formation and components have received less attention by researchers (Zayas, Günaydın and Shoda, 2015). However, Porges (2011) described Polyvagal theory is a key to figure out the biology of attachment theory and how our biology take form the interactions form attachment styles. By this way, Polyvagal theory give us a way about conceptualize the biology of attachment and trying to uncover biological markers of adult attachment

The polyvagal theory (Porges, 2007, 2011, 2017) describes attachment behaviors through a biobehavioral framework that links the neural regulation of the vagus nerve, the myelinated ventral component of the Cranial nerves. Porges (2011) describes how the

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polyvagal theory regulates the functioning of the automatic fear response in regulating close relationships and intimacy behaviors. As a result of the function and effect of the multi-branched and bidirectional neurological pathway known as the Vagus nerve with its anatomical structure on the autonomic nervous system, the autonomous structure of the perception of security and threat is based on the integration of mind and body. Porges (2003) defines the autonomic nervous system as the evolutionary role of the ability to detect situations of safety and danger, regulate and express emotions, and engage in social interaction and withdrawal. The vagus nerve allows rapid interactions (approach and abduction) with the environment by establishing rapid and continuous communication between many parts of the body, including the brain, body, heart, lungs, digestive system, facial muscles, and tone of voice. Thus, it can fine-tune bodily reactions in social environment relations and situations.

Porges (2011) assume that polyvagal theory is a key to figure out the biology of attachment theory. According to Polyvagal theory our biology shapes the interactions that form attachment styles. Extending polyvagal theory to attachment theory, Porges (2007) described three phylogenetic hierarchical stages in the neural development of ANS. The first stage is the unmyelinated (vegetative) vagal system. At this stage, freezing response is shown as a behavior in case of acute threat. The freezing behavior occurs when the dorsal components of the vagus nerve are stimulated and the parasympathetic system is suppressed, resulting in inhibition behavior that avoidant individuals typically report dampened levels of subjective distress (Dimond, 2001). According to Attachment theory, people with avoidant attachment tendencies hypoactivate attachment systems when they have to face with stress. In addition to that people with avoidant attachment tendencies distance themselves from the stress stimuli when they have to face with it. Similarly, in our study found that people with avoidant attachment tendencies who used deactivating strategies when directed to emotional stimuli showed decrease in peak count response and the facial expressions time-percentages scores. On the other hand, people with anxiety tendencies who used hypoactivating strategies when directed to emotional stimuli showed increases in both peak count response and the facial expressions scores.

Attachment theories have shown that early inconsistent attachment experiences result in poorly developed mental representations of secure attachments. Attachment researchers have also indicated that differences in attachment patterns are associated with romantic relationships, relationship satisfaction, and social adaptation in adulthood. Differences in attachment patterns in adulthood and their relationships with other variables have often been the subject of studies. However, attachment development which is the physiological aspect of adult attachment, has not received sufficient attention. Relevant to the issue the Polyvagal theory that provides a biological understanding of attachment relationships and formulates how attachment system on vagally mediated processes within the autonomic nervous system (Porges, 2007) taken into consideration with our study.

The aim of the study is to investigate comparatively whether there is a physiological change that can be proven by activating the attachment system as a result of romantic relationship threat with emotional stimuli through the participants who are classified as avoidant and anxious attachment dimensions by applying ECR scale. Skin conductance level (SCL) computed from GSR by measuring changes in the conductivity of the skin regulated by the Autonomic Nervous System (ANS). In order to observe the changes in facial expressions regulated by the VII. cranial nerve, the metrics of 7 basic emotions in AFFDEX facial expression analysis modules (anger, sadness, disgust, happiness, etc.) were analyzed with "Time Percentage".

## **MATERIALS AND METHODS**

### ***Research Area and Samples***

The area of this research is healthy individuals who are prone to suggestions between the ages of 18-30 in the 2020-2021 academic year. Participants ( $N = 60$ ) were heterosexual students who were studying at undergraduate and graduate degrees. The participant group was composed of volunteers who were not diagnosed with depressive disorder or generalized anxiety disorder. This sample size is proportional to the number of participants in similar studies in which physiological measurements were taken (e.g., Bryant and Hutnamon, 2018, Yee and Shiota, 2015). The ages of the participants were determined as 18-30 years old. The following criteria were determined for the participants to be included in the study. Participants were excluded if they were undertaking heart medications and have moderate or severe depression score and have moderate or severe anxiety scores. The ethics committee approval was obtained by Uskudar University and complied with the declaration of Helsinki.

### ***Socio-demographic Form***

In the study, a socio-demographic form was used to obtain whether the participants had chronic illnesses, whether they used medication, whether they had psychiatric/psychological disorders, gender, educational status, marital status, and age.

### ***The Experiences in Close Relationships- Revised (ECR-R)***

The Experiences in Close Relationships-Revised (Ecr-r), developed by Fraley, Waller, and Brennan (2000), was used to measure participants' attachment anxiety (18 items) and attachment avoidance (18 items). It was found that the internal consistency of the avoidance dimension of the scale was .90 and the anxiety dimension was .86. (Selçuk et al., 2005). The test-retest reliability of the scale was determined as .82 for the anxiety dimension and .81 for the avoidance dimension.

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### ***Beck Depression Inventory (BDI)***

In this study, the 21-item Beck Depression Inventory was used to evaluate symptoms of depression. Validity and reliability of BDI was adapted into Turkish by Hisli (1988). BDI measures self-dissatisfaction, guilt, punishment, self-dislike, self-accusation, suicidal ideas, crying, irritability and so on. The inventory questions are scored on four different points as 0=least, 3=most. The lowest score on the scale is 0, the highest score is 63. The distribution between scores is evaluated as normal, mild, moderate and severe. The test-retest reliability of the scale was determined as .65.

### ***Beck Anxiety Inventory (BAI)***

In this study, the 21-item Beck Anxiety Inventory was used to evaluate the symptoms of anxiety. The inventory questions are scored on four different points as 0=least, 3=most. The lowest score on the scale is 0, the highest score is 63. Validity and reliability of BAI was adapted into Turkish by Ulusoy (1993). The test-retest reliability of the scale was determined as .93 and correlation coefficient was determined as .45 to .72.

### ***Data Collection and GSR recording***

In the present study, exosomatic recording technique was employed. The recording was done by Shimmer3 GSR+ Unit. It is a mobile, lightweight, and wireless device that uses a Bluetooth connection to stream real-time participant data. DC voltage is used in the device. The GSR+ Unit is designed for skin resistance purpose between 10k $\Omega$  and 4.7M $\Omega$  (100uS to 0.2uS). The device applies a constant of 0.5 V across Ag/AgCl electrodes with a surface area of 1cm<sup>2</sup> to measure the change in skin conductance (SC). The experiment was designed for the participants to use only their right hands during the procedure. Therefore, electrodes were attached to the index and middle fingers of participants' left hands, and they were instructed to keep that left hand steady on the desk during the entire study to minimize the motion artifacts. The data collection was controlled by iMotions software (version 8.1, iMotions, Inc., MA, USA) and all physiological signals were sampled at a rate of 128 Hz. The experimenter remained out of sight of the participant and talking was avoided during the recording. No filter was applied during the acquisition of the raw EDA signal.

### ***Data Collection and AFFDEX recording***

The facial expressions of 30 among 47 panelists were evaluated using Affdex based on the facial inputs. The affdex system was integrated with iMotions Facial Expression Analysis Module for coding the facial emotions as using a group of action units. In order to observe the changes in facial expressions regulated by the VII. cranial nerve, the metrics of 7 basic emotions in AFFDEX facial expression analysis modules (anger, sadness, disgust, happiness, etc.) could be analyzed with "Time Percentage (iMotions, 2016).

## **PROCEDURE**

In order to record the physiological change data in the laboratory environment, photographs with fixed size and resolution obtained with special permission from the International Affective Picture System (IAPS) and The Nencki Affective Picture System (NAPS) were used as visual emotional stimuli during the experiment. In addition to that some photographs were taken from commercial sites to pose a threat to a romantic relationship. Size, color and resolution are adjusted using bitmap files. Adjusted photographs were eliminated based on the feedback received from researchers who conducted experimental studies on The Love Consortium Dataverse. A total of 40 photographs were shown to each participant at 6-sec intervals after 6-sec black screen transitions (designed to prevent GSR physiological changes from being carried over to the next photographs task). Thus, avoidant and anxious participants were exposed to visual stimulus in three qualified categories (romantic relationship-positive, neutral and romantic relationship-negative) for 12 min. Upon arrival at the laboratory, participants were asked to sit comfortably at an approximate distance of 60 cm from a computer screen running with a 1.920 x 1.080-pixel screen resolution. For the hypothetical scenario of the study to be sufficiently comprehensible and clear enough, participants were given detailed information about the experimental procedure. In the laboratory, light conditions were held constant, and the temperature was controlled at 20-23 Celsius Degree to minimize their effects on recording (Boucsein, 2012). The data collection was controlled by iMotions software (version 8.1, iMotions, Inc., MA, USA) and all physiological signals were sampled at a rate of 128 Hz. No filter was applied during the acquisition of the raw EDA signal and AFFDEX.

## **RESULTS**

In this section, the findings of the study are presented. Emotional-emotional (positive, neutral, and negative) photographic tasks were given to the participants, who were divided into two groups according to their Avoidant and Anxious Attachment characteristics. The facial expressions and skin conductances of the participants were examined physiologically.

It was observed that the anxious group has more peak counts than the avoidant groups in terms of romantic positive, romantic negative, and polyvagal-negative measures ( $\chi^2(4) = 45,084, p = .000$ ). As for AFFDEX analyses, Romantic Positive, Sadness (mean, 0.03 ss = 0.26 - mean 00 p = .014), Neutral sadness (mean, 0.15 sd = 1.53 - mean .00 p = .025) Romantic Negative fear (mean, 0.12 sd = 1.06 - mean.00 p = .045) Romantic Negative, Negative time percentage (mean: 0.33 sd = 2.58 - mean: 2.43 ss = 11.24 p = .038) were observed significant differences between groups.

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60 healthy-volunteers who were divided into two groups as avoidant and anxious attachment according to their ECR-R scores. Demographic characteristics, group distributions and scale scores of the participants can be viewed in Tables 1 and 2.

**Table 1: Descriptive Statistics for Scales**

	<i>n</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Mean</i>	<i>ss</i>
Anxiety	30	1,50	4,61	3,06	0,97
Avoidant	30	1,33	4,50	2,95	0,89
Anxiety Score	30	1,00	17,00	9,83	4,21
Depression Score	30	0,00	17,00	11,30	4,08

**Table 2: Sociodemographic Characteristics of the Participants**

		<i>Anxiety</i>		<i>Avoidant</i>	
		<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>
<b>Gender</b>	Female	22	73,3	16	53,3
	Male	8	26,7	14	46,7
<b>Marital Status</b>	Married	16	53,3	17	56,7
	Single	14	46,7	13	43,3
<b>Education Status</b>	University Degree	25	83,3	22	73,3
	Masters	5	16,7	8	26,7

50% of the participants in the research are in the anxious group, while 50% are in the avoidant group. The average anxiety score of the participants in the study was 3.06; avoidance 2.95; anxiety 9.83 and depression 11.30. 73.3% of the anxious group were women; 53.3% of them do not have a girlfriend and 83.3% of them are at the undergraduate education level. In the avoidant group, 53.3% are women, 56.7% do not have a girlfriend, and 73.3% are at the undergraduate level. The mean age of the anxious group was 24.43 and the avoidant group was 25.73.

### *Galvanic Skin Response Findings*

The Mann Whitney U test was used to test whether the depression and anxiety scores of the participants and the romantic positive, neutral, romantic negative and polyvagal measures were different according to the anxious and avoidant attachment dimensions. According to the results obtained, it was determined that the measurements did not differ according to the attachment dimensions (e.g. table 3). The relationship between the depression and anxiety scores of the participants and the results obtained from the physical measurements performed as a result of the values of the romantic positive, neutral and romantic negative-polyvagal negative tasks of the SCL measurements was examined by spearman rho analysis. As a result of the measurements there is no significant relationship was found between depression and anxiety scores. On the other hand, romantic positive microsiemens measurement and romantic positive amplitude total measurement were found to be equivalent ( $r=1.000, p<.001$ ). It was understood that the Romantic Negative MicroSiemens measurement and the Romantic Negative Amplitude Total measurement were equivalent ( $r=.999, p<.001$ ). It was understood that the Polyvagal Negative MicroSiemens measurement and the Polyvagal Negative Amplitude Total measurement were also equivalent ( $r=1.000, p<.001$ ). In summary, it is observed that the measurements are equivalent to each other, but they are not related to the depression and anxiety levels of the participants.

**Table 4: Relationship Between SCL Measures and Participants' Depression and Anxiety Inventory Scores**

			<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
Spearman's rho	Beck Depression (1)		1,000									
	Beck Anxious (2)		0,248	1,000								
	Romantic Positive MicroSiemens Us (3)		-0,046	0,085	1,000							
	Neutral MicroSiemens Us (4)		-0,169	-0,064	,816**	1,000						

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Romantic Negative MicroSiemens Us (5)	- 0,216	-0,101	,421**	,561**	1,000			
Polivagal Negative MicroSiemens Us (6)	- 0,156	-0,110	,388**	,499**	,744**	1,000		
Romantic Positive Amplitüd Total (7)	- 0,044	0,086	1,000**	,814**	,421**	,388**	1,000	
Neutral Amplitüd Total (8)	- 0,177	-0,060	,791**	1,000**	,561**	,478**	,789**	1,000
Romantic Negative Amplitüd Total (9)	- 0,210	-0,097	,429**	,570**	,999**	,745**	,429**	,571** 1,000
Polivagal Negative Amplitüd Total (10)	- 0,158	-0,109	,388**	,499**	,744**	1,000**	,388**	,478** ,745** 1,000

After it was determined that the amplitude averages of the participants above did not differ, the "peak count" of skin conductivity was included in the analysis. Different parameters can be used to detect a peak in skin conductivity. It is one of the methods used to determine the thresholds of the peak amplitudes of the start and end times and signal jump thresholds and to calculate the peak points (e.g., Nikula, 1991). In this section, the values obtained in the GSR of the participants with avoidant and anxious attachment were compared with the dependent sampling method. The Kruskal Wallis test was performed because the results obtained were not normally distributed. As a result of Peak Counts measurement, there was a significant difference in the mean of neutral ( $x=.04$ ), romantic positive ( $x=.09$ ), romantic negative ( $x=.06$ ), and polyvagal ( $x=.28$ ) ( $\chi^2(4) = 45.084$ ,  $p = .000$ ) was determined.

**Table 5: Differences in GSR Measurement of Avoidant Participants**

		Avoidant				X2		p
		Romantic positive		Romantic negative		Polyvagal-negative		
		Neutral						
		Mean	Med	Mean	Med	Mean	Med	
Startms	216.429,37	185.869,59	34.665,14	65.527,35	34.665,32	400.479,46	399.727,50	,000*
Durationms	6.112,20	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	,156
Signal Durationms	6.112,20	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	,156
	217.228,50	185.869,59	34.665,14	65.527,35	34.665,32	400.479,46	399.727,50	
	5.995,00	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	
	6.112,20	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	
	306.220,18	187.185,50	34.665,32	67.017,50	34.667,11	400.479,46	399.727,50	
	5.994,25	5.995,00	4,49	5.994,00	4,49	5.993,90	5.994,00	
	5.994,25	5.995,00	4,49	5.994,00	4,49	5.993,90	5.994,00	
	67.017,50	187.185,50	34.665,32	67.017,50	34.667,11	400.479,46	399.727,50	
	5.995,00	5.995,00	4,49	5.994,00	4,49	5.993,90	5.994,00	
	5.995,00	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	
	307.364,00	185.869,59	34.665,14	65.527,35	34.665,32	400.479,46	399.727,50	
	5.994,00	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	
	5.994,00	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	
	1001,407	185.869,59	34.665,14	65.527,35	34.665,32	400.479,46	399.727,50	
	6.644	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	
	6.644	5.994,63	4,37	5.994,57	4,37	5.993,90	5.994,00	

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.245	.245
5,443	5,437
0,00	0,00
.50	4,98
.17	1,67
0,00	0,00
.51	5,07
.11	1,07
0,00	0,00
.43	4,34
.11	1,13
0,00	0,00
.44	4,38
.11	1,10
0,00	0,00
.13	1,27
Peak Count	Peaks Per Minute

\*p<0,05 Kruskal Wallis

As a result of Peak Counts measurement, no significant difference was found in neutral, romantic positive, romantic negative and polyvagal-negative.

**Table 6: Differences in GSR Measurement of Anxious Participants**

p	X2	Anxious						Peak Count	Peaks Per		
		Polyvagal-negative		Romantic negative		Romantic positive				Neutral	
		Med	ss	Med	ss	Mean	ss	Med	ss		
		399.719, 00	17.135, 87	307.685, 00	34.657, 95	65.275, 12	34.656, 12	185.628, 12	217.458, 00	216.191, 43	Startms
		5.995,00	4.73	5.994,00	4.52	5.993,97	4.41	5.995,00	5.995,00	6.111,89	Durationms
		5.995,00	4.73	5.994,00	4.52	5.993,97	4.41	5.995,00	5.995,00	6.111,89	SignalDurationms
		0,00	,68	0,00	,32	,09	,36	0,00	0,00	,06	Peak Count
		0,00	6,77	0,00	3,16	,87	3,56	0,00	0,00	,63	Peaks Per

\*p<0,05 Kruskal Wallis testi

As a result of Peak Counts measurement, there was a significant difference in the mean of neutral (x=.04), romantic positive (x=.09), romantic negative (x=.06), and polyvagal (x=.28) ( $\chi^2$  (4)= 45.084, p=.000) was determined. No significant difference was found in Durationms and SignalDurationms measurements. In summary, it was observed that the group with anxious attachment had much more peaks in the polyvagal-negative measurement than the avoidant measurement group in the peaks count. Likewise, in the



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measurement of the number of peak values per minute, it was determined that the polyvagal-negative measurement had a larger average than the other measurements.

### Affdex Findings

AFFDEX measurements were carried out as 4 measurements: “neutral”, “romantic positive”, “romantic negative” and “polyvagal-negative” for the participants in two groups as avoidant and anxious.

In the romantic negative photograph task (e.g. Table 5), the mean of Fear Frames  $\geq$  Threshold measurement was 0 (ss=0) in those with avoidant attachment, while it was 0.10 (sd=0.95) in those with an anxious attachment style, and this difference was found to be significant. ( $p=.045$ ) was determined. In the Fear Time Percentage measurement, the mean was 0 (sd=0) in the avoidant group, while it was 0.12 (sd=1.06) in the anxious attachment style, and this difference was found to be significant ( $p=.045$ ). As a result of the measurements of the romantic negative photograph task, it is understood that the participants with anxious attachment have a higher mean score in fear (fear) than those in the avoidant group.

**Table 7: Romantic Negative Emotional Stimuli Task of Affdex**

	<i>Romantic Negative</i>						<i>Mann-Whitney U</i>	<i>p</i>
	<i>Avoidant</i>		<i>Anxious</i>					
	<i>Mean</i>	<i>ss</i>	<i>Med</i>	<i>Mean</i>	<i>ss</i>	<i>Med</i>		
Startms	306.220,18	34.667,11	307.364,00	305.991,55	34.657,95	307.685,00	44775,500	,916
Durationms	5.994,25	4,49	5.994,00	5.994,33	4,52	5.994,00	44511,000	,817
Count Frames	89,85	0,35	90,00	89,90	0,32	90,00	43072,000	,117
Anger Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Anger Framesgt Threshold	0,00	0,00	0,00	0,00	0,00	0,00	45000,000	1,000
Anger Time Percentage	0,00	0,00	0,00	0,00	0,00	0,00	45000,000	1,000
Sadness Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Sadness Framesgt Threshold	0,03	0,46	0,00	0,03	0,24	0,00	44552,000	,180
Sadness Time Percentage	0,03	0,51	0,00	0,03	0,27	0,00	44552,000	,180
Disgust Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Disgust Framesgt Threshold	0,00	0,00	0,00	0,01	0,13	0,00	44700,000	,157
Disgust Time Percentage	0,00	0,00	0,00	0,01	0,14	0,00	44700,000	,157
Joy Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Joy Framesgt Threshold	0,00	0,00	0,00	0,00	0,00	0,00	45000,000	1,000
Joy Time Percentage	0,00	0,00	0,00	0,00	0,00	0,00	45000,000	1,000
Surprise Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Surprise Framesgt Threshold	0,12	1,71	0,00	0,02	0,35	0,00	44849,500	,562
Surprise Time Percentage	0,13	1,90	0,00	0,02	0,39	0,00	44849,500	,562
Fear Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Fear Framesgt Threshold	0,00	0,00	0,00	0,10	0,95	0,00	44400,000	,045*
Fear Time Percentage	0,00	0,00	0,00	0,12	1,06	0,00	44400,000	,045*
Contempt Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Contempt Framesgt Threshold	0,01	0,08	0,00	0,42	4,12	0,00	44696,000	,406
Contempt Time Percentage	0,01	0,09	0,00	0,47	4,58	0,00	44696,000	,406
Engagement Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000

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Engagement Framesgt Threshold	0,64	4,01	0,00	1,81	9,30	0,00	43881,000	,248
Engagement Time Percentage	0,71	4,47	0,00	2,02	10,36	0,00	43885,500	,250
Attention Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Attention Framesgt Threshold	83,16	14,34	87,00	83,15	14,64	88,00	42573,500	,230
Attention Time Percentage	92,56	15,97	97,75	92,50	16,29	97,78	42835,000	,286
Positive Threshold	50,00	0,00	50,00	50,00	0,00	50,00	45000,000	1,000
Positive Framesgt Threshold	0,01	0,17	0,00	0,02	0,29	0,00	44849,500	,562
Positive Time Percentage	0,01	0,19	0,00	0,03	0,32	0,00	44849,500	,562
Negative Threshold	-50,00	0,00	-50,00	-50,00	0,00	-50,00	45000,000	1,000
Negative Framesgt Threshold	1,98	9,82	0,00	0,97	7,25	0,00	44926,000	,931
Negative Time Percentage	2,21	10,94	0,00	1,08	8,06	0,00	44924,000	,929
Neutral Frames Between Threshold	82,21	17,65	88,00	86,74	9,25	90,00	35862,000	,000*
Neutral Time Percentage	91,50	19,64	97,78	96,48	10,27	100,00	36500,000	,000*

\*p<0,05

In the measurement of polyvagal-negative photograph tasks (e.g. Table 6), the average of Negative Frames  $\geq$  Threshold measurement was 2.19 (sd=10.09) in avoidant attachment group, while the average was 0.30 (sd=2.58) in anxious attachment group. This difference was found to be significant (p=.038). In the Negative Time Percentage measurement, the mean was 2.43 (sd=11.24) in the avoidant group, and 0.33 (sd=2.58) in the anxious attachment group, and this difference was found to be significant (p=.038).

In the Neutral Frames Between Threshold measurement, the mean was 80.47 (sd=19.68) in the avoidant group, while it was 87.21 (sd=5.51) in the anxious group, and this difference was found to be significant (p=.001). In the Neutral Time Percentage measurement, the mean was 89.36 (sd=21.88) in the avoidant group, and 96.60 (sd=6.70) in the anxious attachment group, and this difference was found to be significant (p=.005).

According to the results obtained regarding the measurement of the polyvagal-negative photograph task, it was observed that participants with avoidant attachment had a higher average score in negative time percentage than those in the anxious group, but participants in the anxious group had a higher average score in neutral time percentage than the avoidant group. In other words, avoidant group response the task as neutral approach while anxious group response the task as negative approach.

**Table 8: Polyvagal Negative Emotional Stimuli Task of Affdex**

	<i>Polyvagal</i>						<i>Mann-Whitney U</i>	<i>p</i>
	<i>Avoidant</i>			<i>Anxious</i>				
	<i>Mean</i>	<i>ss</i>	<i>Med</i>	<i>Mean</i>	<i>ss</i>	<i>Med</i>		
Startms	400.479,46	17.157,52	399.727,50	400.258,57	17.135,87	399.719,00	11171,500	,917
Durationms	5.993,90	4,35	5.994,00	5.994,57	4,73	5.995,00	10266,500	,189
Count Frames	90,07	1,14	90,00	90,39	3,78	90,00	10384,500	,071
Anger Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Anger Frames $\geq$ Threshold	0,13	1,16	0,00	0,41	3,83	0,00	11248,000	,989
Anger Time Percentage	0,15	1,28	0,00	0,46	4,25	0,00	11248,000	,989
Sadness Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Sadness Frames $\geq$ Threshold	0,05	0,57	0,00	0,06	0,73	0,00	11249,500	,996



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Sadness Time Percentage	0,05	0,64	0,00	0,06	0,75	0,00	11249,500	,996
Disgust Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Disgust Frames >= Threshold	0,03	0,26	0,00	0,02	0,24	0,00	11175,500	,565
Disgust Time Percentage	0,03	0,28	0,00	0,02	0,27	0,00	11176,000	,568
Joy Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Joy Frames >= Threshold	0,17	2,04	0,00	0,21	1,55	0,00	11100,000	,410
Joy Time Percentage	0,19	2,27	0,00	0,23	1,72	0,00	11100,000	,410
Surprise Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Surprise Frames >= Threshold	0,13	1,63	0,00	0,14	1,63	0,00	11175,500	,565
Surprise Time Percentage	0,14	1,68	0,00	0,16	1,82	0,00	11175,000	,562
Fear Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Fear Frames >= Threshold	0,03	0,41	0,00	0,17	1,57	0,00	11174,000	,557
Fear Time Percentage	0,04	0,45	0,00	0,19	1,74	0,00	11174,000	,557
Contempt Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Contempt Frames >= Threshold	0,04	0,35	0,00	0,84	6,30	0,00	11172,000	,640
Contempt Time Percentage	0,04	0,39	0,00	0,93	7,00	0,00	11172,000	,640
Engagement Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Engagement Frames >= Threshold	2,22	6,95	0,00	2,57	9,90	0,00	11036,500	,669
Engagement Time Percentage	2,44	7,63	0,00	2,84	10,98	0,00	11037,000	,670
Attention Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Attention Frames >= Threshold	81,39	17,13	87,00	84,02	11,65	87,00	10513,500	,312
Attention Time Percentage	90,38	19,03	96,72	93,06	13,14	97,75	10554,000	,340
Positive Threshold	50,00	0,00	50,00	50,00	0,00	50,00	11250,000	1,000
Positive Frames >= Threshold	0,19	2,13	0,00	0,20	1,28	0,00	10952,000	,155
Positive Time Percentage	0,21	2,36	0,00	0,22	1,43	0,00	10952,000	,155
Negative Threshold	-50,00	0,00	-50,00	-50,00	0,00	-50,00	11250,000	1,000
Negative Frames >= Threshold	2,19	10,09	0,00	0,30	2,33	0,00	10642,000	,038*
Negative Time Percentage	2,43	11,24	0,00	0,33	2,58	0,00	10642,500	,038*
Neutral Frames Between Threshold	80,47	19,68	88,00	87,21	5,51	90,00	8831,500	,001*
Neutral Time Percentage	89,36	21,88	97,77	96,60	6,70	100,00	9266,000	,005*

## DISCUSSION

The aim of the study is to investigate comparatively whether there is a physiological change that can be proven by activating the attachment systems a result of romantic relationship threat with emotional stimuli through the participants who are classified as avoidant and anxious attachment dimensions by applying ECR scale. The important findings of the study were observed that there is no significant difference in the measurement of SCL  $\mu\text{S}/\text{m}$  of two groups. However, when peaks were included in the analyses, it was observed that the anxious group has more peak counts than the avoidant groups in terms of romantic positive, romantic negative, and polyvagal-negative measures. In addition to that it was observed that anxious group has sadness, fear emotions and negative

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time percentage in three qualified categories. As a result, we assumed that revealing concrete and important findings on biological markers of adult attachment with respect to the framework of polyvagal theory would provide both theoretical and practical contributions to the field.

The important findings of the study were observed that there is no significant difference in the measurement of SCL  $\mu\text{S/m}$  of two groups. However, when peaks count were included in the analyses, it was observed that the anxious group has more peak counts than the avoidant groups in terms of positive, negative, and polyvagal-negative measures. Different parameters can be used to detect a peak in skin conductivity. It is one of the methods used to determine the thresholds of the peak amplitudes of the start and end times and signal jump thresholds and to calculate the peak points (Nikula, 1991).

Different types and patterns have been studied to examine the relationship between attachment and psychophysiological effects. The findings our research of electrodermal activity as an indicator for arousal are evaluated with notable researches. Diamond et al., (2006) analyzed the skin conductivity levels of 148 participants using the SCL method by exposing them to stress. SCL activation was observed in all stress exposure tasks, particularly in female participants with avoidant attachment. This effect has been associated with the fact that avoidant individuals do not accept that they are affected when they are exposed to negative situations. Thus, this situation may increase in physiological arousal levels when individuals with avoidant attachment are exposed to stressful life events. In another study, 43 participants divided into the two groups; avoidant and anxious were exposed to positive visual stimulus and their physiological measurements were measured by skin conductivity. The findings of the study showed that participants with avoidant attachment had a reduction in skin conductance at the start of positive photographic tasks. The findings of the study showed that early physiological response to reward opportunities offered by the environment was negatively related to the avoidant attachment dimension (Yee and Shiota 2015). On the other hand, Sebastien et al., (2020) examined 68 participants divided into the three groups; avoidant, anxious and secure were exposed to visual stimulus in three qualified categories (positive, neutral and negative). The study's findings showed that participants with anxious attachment had a higher increase in skin conductance level in negative photo tasks than participants with avoidant attachment. The result of the study show similarity with our research findings.

In order to observe the changes in facial expressions regulated by the VII. cranial nerve, the metrics of 7 basic emotions in AFFDEX facial expression analysis modules (anger, sadness, disgust, happiness, etc.) were analyzed with "Time Percentage.

The findings of affdex were that the participants with anxious attachment who exposed to positive photograph task have higher average score in sadness time percentage than participants with avoidant attachment. For neutral photograph task, the participants with avoidant attachment have higher average score in contempt time percentage than the participant with anxious attachment. Similarly for negative photograph task, the participants with anxious attachment have higher average score in anger, fear and disgust time percentage than the participant with avoidant. The findings of this study shown that the attachment system is activated as result of romantic relationship threat. Different patterns have been studied to examine the effects of physiological difference in facial expressions. Suslow et al., (2010), have investigated the relationship between adult attachment avoidance and anxiety and automatic affective responses to basic facial emotions. The findings of the study showed that participants with avoidant attachment did not respond emotionally to negative photographic tasks, whereas participants with anxious attachment showed emotional responses to sad photographic tasks. The findings of the study indicate that avoidant attachment is related to a low automatic affective responsivity to sad facial expressions. Similarly, Borgström and Jönsson (2014) shown that avoidant participant did not respond emotionally to the angry face task, whereas the anxious participants responded with a significant reaction to the angry face task. These findings were interpreted for participant with avoidant attachment as a repression of their earlier negative emotion reaction.

Some methodological limitations of these studies should be consider. First limitation when generalizing findings is that the majority of participants identified as university students were highly educated with 47 volunteer undergrad and 13 volunteer postgraduates. The homogeneity of participants reduces confounding variables and reduce generalizability of the findings. Future research could provide more diverse samples. Second, in our research Ecr-r, BDI and BAI were used to assess the dimension of both avoidant attachment and anxious attachment in sample of university students. Future research should use to assess the dimension of attachment by also applying Adult Attachment Interview. Third, we did not include gender differences that precluded consideration of differential impact of sex that can reduce generalizability of findings. Future studies could benefit from inclusion gender differences.

### **CONCULISON**

Despite potential limitations, we explored the relationship between attachment and psychophysiological effects were investigated with respect to the Polyvagal theory. We not only investigated the relationship of attachment anxiety and avoidance dimensions on skin conductance level, but also examined the changes in facial expressions regulated by the VII. cranial nerve. As prior studies showed that people with anxious attachment are expected to have physiologically detrimental emotion-regulation that relates to the sympathetic fight or flight response. Conversely, people with avoidant attachment are characterized by emotion-regulation as involving suppression of negative feeling and thoughts that relates to the parasympathetic shut-down response. This freezing

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behavior occurs when the dorsal components of the vagus nerve are stimulated and the parasympathetic system is suppressed, resulting in inhibition behavior that avoidant individuals typically report dampened levels of subjective distress. Similarly, our research indicated that there was a statistically significant difference in terms of physiological change between people with avoidant and people with anxious attachment. Anxious participants exposed to visual stimulus in three qualified categories for activating the attachment system showed a higher arousal level than avoidant participants. Similarly, Affdex facial expression result indicates that anxious participants showed a higher facial expression in two categories as sadness and fear than avoidant participants. As a result of our research, it is assumed that revealing concrete and important findings on biological markers of adult attachment with respect to the framework of polyvagal theory. In summary, this research is expected to contribute to the current literature about the biological markers of adult attachment. Overall, results of this study will facilitate more comprehensive and distinctive studies on adult attachment and will significantly contribute to the developing field in science and applications.

### Compliance of Ethical Standards

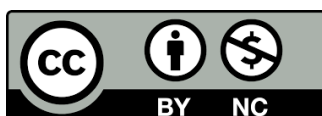
The ethics committee approval was obtained by Uskudar University and complied with the declaration of Helsinki.

### REFERENCES

- 1) Boucsein, W. (2012). Electrodermal activity. Springer Science ve Business Media.
- 2) Bowlby, J. (1982). Attachment and Loss: Vol. 1. Attachment. Basic Books Classic
- 3) Bryant, R.A., and Hutanamon T. (2018). Activating Attachments Enhance Heart Rate Variability. *Plos One*, 13(2), 1-10.
- 4) Diamond, L. M. (2001). Contributions of psychophysiology to research on adult attachment: Review and recommendations. *Personality and Social Psychology Review*, 5, 276–295
- 5) Diamond, L.M., Hick, A. M., & Henderson, O., K. (2016). Physiological Evidence for Repressive Coping Among Avoidantly Attached Adults. *Journal of Social and Personal Relationships*, 23(2), 205-229.
- 6) Feeney, J. A. (1999). Adult romantic attachment and couple relationships. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications*. 355–377. The Guilford Press.
- 7) Fraley, R. C., Waller, N. G., & Brennan, K. A. (2000). An item-response theory analysis of self-report measures of adult attachment. *Journal of Personality and Social Psychology*, 78(2), 350-365.
- 8) Hazan, C. & Shaver, P. (1994). Attachment As an Organizational Framework for Research on Close Relationships. *Psychological Inquiry*, 5(1), 1-22.
- 9) Hisli, N. (1989). Beck Depresyon Envanterinin Üniversite Öğrencileri için Geçerliliği, Güvenirliği. *Psikoloji Dergisi*, 7(23), 3-13.
- 10) iMotions (2016). Facial Expression Analysis: The definitive guide. Retrieved from <https://imotions.com/facialexpression-guide-ebook/>
- 11) Mikulincer M., Birnbaum, G., Woddis D. & Nachmias, O. (2000). Stress and Accessibility of Proximity- Related Thoughts: Exploring the Normative and Intraindividual Components of Attachment Theory. *Journal of Personality and Social Psychology*, 78(3), 509-523.
- 12) Nikula, R. (1991). Psychological Correlates of Nonspecific Skin Conductance Response. *Psychophysiology*, 28(1),86-90
- 13) Porges, S.W. (2003). Social engagement and attachment: A phylogenic perspective. *Annals of New York Academy of Science*, 1008(1), 31-47.
- 14) Porges, S. W. (2007). The Polivagal perspective. *Biological Psychology*, 74(2), 116-143.
- 15) Porges, S. W. (2011). *The Polivagal Theory: Neurophysiological Foundations of Emotions, Attachment, Communication, Self-regulation*. W.W. Norton & Company
- 16) Porges, S. W. (2017). *The Pocket Guide to the Polivagal Theory: The transformative power of feeling safe*. W.W. Norton & Company.
- 17) Sebastien, H., Nandrino, J.L., Pezard, L., Ott, L., Coady L.V., & Doba K. (2020). The Influence of Attachment Styles on Autonomic Correlates of perspective-taking. *Biological Psychology*, 154(4), 1-11.
- 18) Selçuk, E., Günaydın, G., Sümer, N., and Uysal, A. (2005). Yetişkin Bağlanma Boyutları için Yeni Bir Ölçüm: Yakın İlişkilerde Yaşantılar Envanteri-II'nin Türk Örnekleminde Psikometrik Açından Değerlendirilmesi. *Türk Psikoloji Yazıları*, 8(16), 1-11
- 19) Sonnby-Borgström, M. & Jönsson, P. (2004). Dismissing-avoidant pattern of attachment and mimicry reactions at different levels of information processing. *Scandinavian Journal of Psychology*, 45, 103–113.
- 20) Suslow, T., Dannlowski U., Arolt, V. & Ohrmann, P. (2010). Adult attachment avoidance and automatic affective response to sad facial expressions. *Australian Journal of Psychology*, 62(4), 181-187.
- 21) Ulusoy, M. (1993). Beck anksiyete ölçeğinin psikometrik özellikleri, Uzmanlık tezi, İstanbul.
- 22) Yee I.C. & Shiota N. M. (2015). An insecure base: Attachment style and orienting response to positive stimuli. *Psychophysiology*, 52(7), 905–909.

## An Investigation of Biological Markers of Adult Attachment in the Framework of Polyvagal Theory

- 23) Zayas, V., Günaydin, G., & Shoda, Y. (2015). From an unknown other to an attachment figure: How do mental representations change as attachments form? In V. Zayas & C. Hazan (Eds.), *Bases of adult attachment: Linking brain, mind, and behavior* (pp. 157–183). Springer Science + Business Media
- 24) Zuvela, B. (2004). Affective Bonding of Adolescents in Partner Relationships. *Philosophy, Sociology and Psychology*, 3(1), 83 - 97.



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