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RESEARCH

Effect of Basic Emotional Facial Expressions on Time Perception

Temel Duygusal Yüz İfadelerinin Zaman Algısı Üzerindeki Etkisi

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Abstract

The main aim of this study was to investigate the influence of stimulus duration manipulations of pictures expressing universal six basic emotions by using a prospective paradigm including verbal estimation and reproduction tasks. The study was conducted with 75 participants (47 female and 28 male) who verbally estimated and reproduced the duration of emotional facial expressions (anger, fear, sadness, disgust, surprise, happiness and neutral) presented for different durations (500, 1000, 1500, and 2000 ms). In each presentation duration, durations of all emotional facial expressions were perceived to be shorter than target durations and temporal distortions increase with duration of intervals. On the other hand, durations of all emotional facial expressions except the sadness facial expression were perceived longer than the duration of neutral facial expression. According to internal clock model and in the context of arousal and attention, tendency to underestimate the duration of emotional stimuli compared to target duration was consistent with an attentional model while tendency to overestimate duration of the emotional stimuli compared to duration of neutral stimulus was consistent with the arousal based model. The findings of this study suggested that in regard to the effects of emotional facial expressions on time perception, not only the involvement of effects emanating from arousal and attention but also memory and decision making processes could have an effect due to the type of temporal task difference.

.**Keywords***:* Time perception, attention, arousal, emotional facial expressions.

Öz

Bu çalışmanın amacı, evrensel olarak kabul edilen 6 temel duyguya ait yüz ifadelerinin sunum süresi değişimlenmesinin zaman algısı üzerindeki etkisini, zaman aralığı yeniden oluşturma ve süreyi sözel tahmin etme yöntemleri aracılığıyla incelemektir. Araştırma, dört farklı sunum süresinde (500, 1000, 1500 ve 2000 ms) sunulan yüz ifadelerinin (kızgınlık, korku, üzüntü, tiksinme, şaşkınlık, mutluluk ve nötr) sözel olarak tahmin edilmesi ve yeniden üretilmesini içeren iki farklı yöntemle 75 gönüllü öğrenci (47 Kadın ve 28 Erkek) ile yürütülmüştür. Her bir sunum süresinde, tüm duygusal yüz ifadeleri hedef süreye göre kısa algılanmakta ve sunum süresi artıkça zamansal bozulmalar artmaktadır. Öte yandan, tüm duygusal yüz ifadeleri, üzüntü yüz ifadesi hariç, nötr yüz ifadesinden daha uzun algılanmaktadır. İçsel saat modeli ile dikkat ve genel uyarılmışlık düzeyi bağlamında, yüz ifadelerinin hedef süreye göre kısa algılanması dikkat kaynaklı modelle; nötre göre daha uzun algılanması ise genel uyarılmışlık düzeyi kaynaklı modelle daha uyumlu görünmektedir. Duygusal yüz ifadelerinin zaman algısı üzerindeki etkisinde, genel uyarılmışlık düzeyi ve dikkat kaynaklı ortak etkilerin yanı sıra, zamansal yöntem türlerindeki farklılıklardan kaynaklanan bellek ve karar verme süreçleri de etkili olabilmektedir.

Anahtar sözcükler: Zaman algısı, dikkat, genel uyarılmışlık düzeyi, duygusal yüz ifadeleri

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MANY cases in daily life require the ability of time estimation. The ability of estimating the passing of time is important for perceptive, cognitive and motor functions for people and other living beings (Meck 2005, Lake et al. 2016). Even though there is no specific sensory organ for perceiving time, the behavioral and cognitive processes required for sustaining our daily lives are closely related with time perception and the ability to use it properly. People have different neural systems for the appropriate processing and perception of multiple time intervals such as milliseconds, seconds, minutes and hours. Thus, time estimation plays a significant role in decision making, attention, language processing and motor control at the millisecond level; and in assessment of environmental stimuli, processes of adapting to the environment, sport and art activities, and sleep-wake cycle at the second, minute and hour levels (Meck 2005, Grondin 2010).

One of the oldest models on how living things perceive time in their dynamic environment is the internal clock model of Triesman (1963). This model that was later developed by Gibbon et al. (1984) with an information processing approach (Scalar Expectancy Theory); is comprised of the clock component made up of a pacemaker, switch and accumulator as well as memory (working memory and reference memory) and decision making components (Droit-Volet and Meck 2007). Following the information on the start of temporal events (e.g. with the presentation of the stimulus for the assessment of duration) the pulses generated by the pacemaker (tics of the clock), are transmitted to the accumulator and stored here after the switch between the pacemaker and the accumulator is closed. Later, as output the number of pulses are transferred to the memory system and compared with a reference value at there, and then, that output is transferred to the decision making component and a reaction is generated with regard to whether the stimulus duration is short or long (Allman and Meck 2012, Bahadırlı et al. 2013).

The workings of the pacemaker and switch in the internal clock model are also affected from the arousal and attention. Accordingly, while an increase in arousal level results in the speeding up of the pacemaker, and thus, generating more pulses leading to the perception of time as if it is longer; contrarily, a decrease in the arousal level leads to the slowing down of the pacemaker, hence, generation of less pulses and in turn perception of time as shorter (Leujene 1988, Buhusi and Meck 2009). On the other hand, attention effects the opening and closing of the switch. This effect, also, leads to changes in the number of pulses accumulated in the internal clock. According to the time-sharing hypothesis, attention related resources are shared between stimuli and tasks when a second task or more attractive stimulus is introduced during the carrying out of a temporal task and thus fewer sources are allocated to temporal processes. Therefore, resources of attention focused on time decrease in cases of distraction by emotional stimuli which have an effect on arousal and attention and the duration of emotional stimuli is perceived as shorter. On the contrary, the duration of emotional stimuli is perceived as longer in cases when attention can be focused on the temporal process (Lejeune 1988, Buhusi and Meck 2009, Johnson and Mackay 2018).

On the other hand, it is also known that the emotional state or the emotional dimension of the stimuli play an important role on time perception with regard to the relationship between time perception and emotion (Angrilli et al. 1997, Droit-Volet, et al. 2004, Gil and Droit-Volet 2011, Mella et al. 2011). For example, whereas time

flows faster for most of people when they are happy; it slows down when they are afraid or angry. The effect of emotion on attention and the perception of time are studied by pictures, emotional facial expressions and emotional sounds in studies carried out with regard to the relationship between emotion and time perception (Angrilli et al. 1997, Droit-Volet, et al. 2004, Gil and Droit-Volet 2011, Mella et al. 2011). It is important what emotion is in these studies and how it is defined. Researchers who consider what emotion is by way of a dimensional approach generally emphasize the dimensions of arousal and valence (pleasant/unpleasant or positive/negative) (Lang et al. 1993); whereas researchers with a more evolutionary approach claimed that there various fundamental categories of emotion (happiness, sadness, anger, surprise, fear and disgust) (Ekman and Friesen, 1969, 1971). Each of the fundamental categories of emotion may be distinguished from each other with regard to the elements of dimensional approach. For example, anger, fear and disgust have negative valence and high arousal; happiness has a positive valence and high arousal; whereas sadness has a negative valence and low arousal (Droit-Volet and Meck 2007, Droit-Volet and Gil 2009). There are findings which indicate that the duration of negative emotional facial expressions is perceived longer in comparison with the duration of positive emotional facial expressions (Droit-Volet et al. 2004, Gil et al. 2007).

The attention model and the arousal model which are derivatives of the internal clock model assert that the differences in time perception suggested by internal clock model studies result from the processes of attention and arousal (Zakay and Block 1996, Gautier and Droit-Volet 2002, Droit-Volet et al. 2004, Effron et al. 2006, Droit-Volet and Meck, 2007, Gil et al. 2007, Tipples 2008, 2011, Lui et al. 2011). There are many studies carried out with different test methods on the effect of emotional stimuli on the perception of time (Angrili et al. 1997, Droit-Volet et al. 2004, Tipples 2008, Gil and Droit-Volet 2011). These studies have tried to explain the effect of emotional stimuli on perceived duration by attention, arousal, attention-arousal interaction and negative-positive emotion based effects.

The studies assuming that the effect of emotions on time perception is due to the arousal, and emotional facial expressions used as stimuli with durations of 400 ms and 1600 ms indicate that the durations of emotional stimuli are perceived for longer periods of time relative to durations of neutral stimuli (Droit-Volet et al. 2004, Droit-Volet and Meck 2007). It was found also in another study carried out by Effron et al. (2006) in accordance with the arousal based effect that even though it was not observed in the experiment group, the durations of emotional events in the control group were perceived as longer than those of neutral events and that emotions had maximum effect on the perceived duration in anger condition. Even though it was found in previous studies that the arousal based effect has an effect on the perceived time, it was also shown that the emotion type may also have an effect. For example, though not finding an effect for disgust facial expression; compared to the duration of neutral facial expression, the anger facial expression duration was perceived as the longest followed by the durations of happy and sad facial expressions (Droit-Volet et al. 2004, Effron et al. 2006, Gil et al. 2007, Bar-Haim et al. 2010, Gil and Droit-Volet 2011).

On the other hand, studies assuming that the effect of emotions on time perception is attention based have shown that the duration is perceived shorter than it actually is when attention shifts from temporal processing to another process (Gautier and Droit-

Volet 2002, Coull et al. 2004). Lui et al. (2011) carried out such a study in which 5 experiments have been conducted using reproduction and comparison of duration methods for the emotional sound and picture stimuli with auditory and visual modality. As the result of the study, it was shown that the stimulus durations following emotional stimuli are perceived as shorter compared to the stimulus durations following the neutral stimuli. In addition, the study by Angrili et al. (1997) explaining the effect of emotions on time perception with the interaction of arousal and attention has added the dimensions of emotion to the relationship between time perception and emotion. In this study, reproduction and verbal estimation methods were used for showing the effect of the valence and arousal dimensions of emotional pictures presented at durations of 2 s, 4 s, and 6 s on perceived duration.

In conclusion, it is suggested in these studies that the duration of emotional visual or emotional auditory stimuli are perceived for longer durations of time compared to neutral stimuli and that negative emotional stimuli are perceived for longer durations of time compared to positive or neutral stimuli. On the contrary, it is found in the attention based condition that the durations of stimuli are perceived as shorter when emotional stimuli affect attention.

The effect of emotions on cognitive functions such as attention and memory are quite varied due to both their dimensional characteristics and the fact that they can be classified under various basic emotion categories each of which has a function for survival. This complexity increases with the addition of the perception of time into the equation thus leading to many different findings observed in literature. There is a need for more controlled studies in order to understand the emotion-time perception interaction. Accordingly, the main aim of the present study is to examine the effect of 6 basic emotions accepted as universal on the perception of time via "reproduction" and "verbal estimation" which are among the prospective paradigm methods. Another aim is to examine effect of the changes in the duration of emotional facial expressions on the perception of time within the context of attention and arousal mechanisms. In this study, it is planned, in a controlled manner, to shed light on the complex relationship pattern between emotion and time perception through the main and common effects of the stimuli related to six basic emotions in four different stimulus durations and two different time estimation methods. Moreover, it is considered that the study will contribute to the current literature since it is one of the first studies carried out with a Turkish sample group.

Method

Sample

A total of 98 volunteer students comprised of 63 female and 35 male students at Hacettepe University with ages ranging between 18-25 could be reached within the scope of the study. However; the final sample group was composed of 75 (M=20.23, SD=1.56, 47 females and 28 males) volunteer students after participants with psychiatric or neurological disorder history which may have an effect on their cognitive functions and those with reports for medication use; those with scores of 17 and above from the Beck Depression Inventory (BDI) applied for determining the depression symptom level and those with scores of 55 and above from the State-Trait Anxiety Inventory (STAI)

applied for determining the anxiety level and making up a total of 23 participants (16 Females and 7 Males) were excluded. Table 1 shows a summary of the means and standard deviations for the demographic characteristics and neuropsychological test scores of the participants. Signed informed consent forms were obtained from all the participants prior to the applications. In addition, ethical approval of the study was obtained for the study from Hacettepe University Ethics Commission (24.07.2015 – 3585372/431-2300).

Table 1. Demographic characteristics and scores of neuropsychological tests

Variable	Experiment
Age	M =20.23, SD =1.56
Sex	Female=47, Male=28
Hand Preference	Right=72, Left= 3
BDI Score	M =8.6, SD =4.32
STAI Score	M =42.82, SD =4.89

BDI: Beck Depresion Inventory; STAI: State-Trait Anxiety Inventory.

Measures

Beck Depression Inventory (BDI)

A 21 item scale developed for measuring the severity of depression symptoms via self-assessment (Beck et al. 1961). The minimum and maximum scores that would be taken from the scale are 0 and 63 and the cutoff point is 17. The Turkish adaptation, validity and reliability studies for the Beck Depression Inventory used in the present study were performed by Hisli (1988). Accordingly, the split-half reliability for the inventory was found to be as 0.74, internal consistency coefficient as 0.80 and as an indication of construct validity, the correlation between the inventory and the depression scale of MMPI was reported be highly significant ($r=0.63$, $p<.001$).

State-Trait Anxiety Inventory (STAI)

The State-Trait Anxiety Inventory developed by Spielberger et al. (1970) for determining the state and trait anxiety levels of individuals is comprised of two sub-tests as "State Anxiety Inventory" and "Trait Anxiety Inventory" with twenty items each. Turkish adaptation and standardization studies for the inventory were carried out by Öner and Le Compte (1983). Accordingly, the reliability coefficient of the inventory was found between 0.83 and 0.87 for Trait Anxiety Inventory; between 0.94 and 0.96 for State Anxiety Inventory; whereas test-retest reliability was found between 0.71 and 0.86 for Trait Anxiety Inventory and between 0.26 and 0.68 for State Anxiety Inventory. Öner (1997) applied the scale to normal and patient (anxious) groups and considered the difference between the two groups ($p<.001$) as well as the correlation coefficients between the scale item scores and total scores at the significant levels of $p<.001$ as indication of construct validity.

Pictures of Facial Affect

Emotional facial expressions used as stimuli in the tasks were selected from among facial expression photos included in the Pictures of Facial Affect (POFA) produced by Ekman and Friesen (1976). The set used has photos for six basic emotions (happiness, fear, disgust, surprise, sadness, and anger). The set contains a total of 110 photos of different facial expressions of 14 individuals (8 females, 6 males). The photos are printed on a grey background in black and white color with dimensions of 384 x 570 pixels.

In a pilot study, the set has been evaluated prior to the main study with regard to recognizing the emotions. Considering also the age levels of the individuals in the photos, a total of two photos, 1 for male (10.06 %) and 1 for female (7.38 %), with lowest recognition error ratio were selected for each emotion and sex. Table 2 represents the valence and arousal mean and standard deviations for these photos (a total of 14 photos with 6 emotional and 1 neutral facial expression photo for one female and one male) from the pilot study. .

Table 2. Values of valance and arousal of emotional facial expressions used in experiment (N=50)

	Valance		Arousal	
	Unpleasant (1) --- Pleasant (9)		Calm (1) --- Excited (9)	
Emotion Type	F2	M1	F2	M1
Anger	2.72±1.59	2.68±1.24	6.00±1.94	6.08±1.97
Fear	2.04±1.07	2.84±1.26	7.08±1.77	6.76±1.74
Sadness	3.54±1.51	3.26±1.24	4.58±2.24	4.80±1.86
Disgust	2.60±1.43	2.48±1.18	5.70±1.63	4.80±1.87
Surprise	3.80±1.28	4.08±1.28	5.74±1.84	6.46±1.72
Neutral	4.50±1.18	5.18±1.02	3.34±2.03	3.34±2.01
Happiness	7.28±1.64	6.70±1.54	5.96±2.28	4.98±2.28

F: Female; M: Male

Experimental Design

The effect of emotional facial expressions on time perception in the study was examined by within-subject manipulation of independent variables of Task Type, Emotion Type and Presentation Duration. A repeated measures factorial design was used in the study as 2 (Task Type: Verbal Estimation Task, Reproduction Task) x 7 (Emotion Type: Anger, Fear, Disgust, Sadness, Surprise, Happiness, Neutral) x 4 (Presentation Duration: 500 ms, 1000 ms, 1500 ms, 2000 ms).

The dependent variable is the relative duration value used in verbal estimation and reproduction tasks indicating temporal performance which is measured by the accuracy index.

$$Relative\ duration\ value = \frac{Estimated\ duration - Target\ duration}{Target\ duration}$$

Relative duration value approaching 0 indicates an increase in the accuracy of duration estimation; whereas positive or negative relative duration values indicate that the target duration is perceived as either longer or shorter (Angrilli et al. 1997, Noulhiane et al. 2007).

Procedure

The experiments were done individually between 10.00 am – 16.00 pm in a suitable room that was appropriately arranged for light and sound. After receiving the signed informed consent forms from the participants, Demographic Form, BDI and STAI were applied. The temporal tasks and stimuli were presented on the computer screen with using E-prime 2.0 Professional (Psychology Software Tools, USA).

The experiment started with training phase. Even though experimental and training phases were the same with each other procedurally, they differentiated from each

other with respect to the 2 facial expression photos used as stimuli (1 female and 1 male) and the stimulus presentation durations (500 ms, 1000 ms, 1500 ms, 2000 ms). In the training phase, the participants were asked to estimate the duration (250 ms - 2250 ms) of neutral stimulus (pink triangle) for the verbal estimation task and to type the stimulus duration, different from those of the experiment phase, on the numeric keyboard in milliseconds and then to confirm this answer by pressing "ENTER" button. The participants were informed that the stimulus presentation durations vary between 100 ms to 2500 ms and the stimulus presentation durations were randomly presented 5 times. This procedure was followed by the reproduction task during which the participants were asked to reproduce the same stimulus durations by pressing a certain button once.

Whereas it was indicated during the experiment phase that the participants will carry out the same tasks as those in the training phase using stimuli included emotional facial expressions. The presentation duration of each facial expression was manipulated in four different ways (500 ms - 1000 ms - 1500 ms - 2000 ms). Each of the 7 facial expressions of the same 2 individuals (1 female and 1 male) were presented once for each task during the experiment and 112 trials were carried out for the two tasks with 56 trials per task. Emotional facial expression presentation durations were manipulated randomly among those four durations. The order of the tasks was balanced among the participants. The verbal estimation task consists of the presentation of the facial expression used as the stimulus on the screen (between 500 ms - 2000 ms) followed by an empty screen (interval between the stimuli), followed by the text "READY" displayed on the screen and entering the duration in milliseconds in the box on the screen and hitting "ENTER" for confirmation. The duration of empty screen and the duration of the "READY" text screen were both manipulated randomly among 1000 ms, 1250 ms, and 1500 ms.

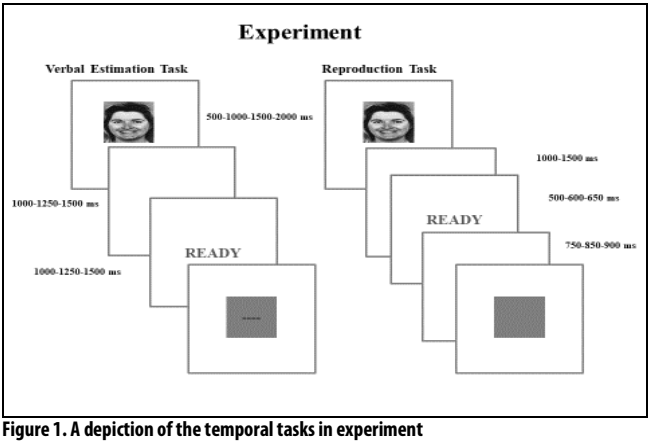

Figure 1. A depiction of the temporal tasks in experiment

On the other hand, the reproduction task started with the presentation of the facial expression followed by an empty screen, the word "READY" and one other empty screen again. After this flow, a square was displayed on the screen with the same dimensions and background color as those of the stimulus pictures. Participant should

have responded to that square with pressing "SPACE" button on the keyboard when s/he thought that the square presentation duration was now the same with the presentation duration of the previous facial expression stimulus. Once s/he responded, the square was disappeared on the screen, and then, a new trials began. The first empty screen presentation durations were again randomly manipulated between 1000 ms-1500 ms and the presentation duration of the word "READY" text on the screen was manipulated randomly among 500 ms, 600 ms, and 750 ms.

The stimulus presentation durations were manipulated differently during the training phase in comparison with the presentation durations of the stimuli during the experiment for the prevention of a temporal reference. Similarly, the display time of the first empty screen during temporal tasks (1000 ms, 1500 ms), the display time of the word "READY" text on the screen (500 ms, 600 ms, 650 ms) and the display time of the second empty screen (750 ms, 850 ms, 900 ms) were manipulated for preventing temporal reference. The assumption that the period of time required for comparison and analysis in the working memory regarding the duration of time that has passed and that the time interval during which the perceptual flow of time takes place is less than the 3 s – 5 s interval (Block and Gruber 2014) was taken as reference for manipulating the inter-stimulus interval (ISI). Therefore, the inter-stimulus interval was determined randomly for each trial with the minimum value of 1 s and the maximum value of 3 s. In addition, the display durations of the empty screens were manipulated as (500 ms-900 ms) since two empty screens were used during the reproduction task. The participants were informed at the beginning of the experiment that the stimulus presentation durations would be changed between 100 ms and 2500 ms. No feedback was given to the participants about accuracy of their responses during the tasks. Written information was obtained from the participants at the end of the study regarding whether they used a certain strategy during the verbal estimation and reproduction tasks and, if they did, what were those strategies were also needed to be reported. The temporal tasks in the experiment are presented schematically in Figure 1.

Table 3. Summary of relative duration means and standart errors for variables

Variable Name		M ± SE	Post Hoc Comparisons
Emotion Type	Anger	0.12 ± 0.02	
	Fear	0.11 ± 0.02	Fear> Sadness, p=.02
	Sadness	0.15 ± 0.02	Anger> Sadness, p=.07
	Disgust	0.11 ± 0.02	Disgust> Sadness, p=.06
	Surprise	0.12 ± 0.02	
	Neutral	0.13 ± 0.02	
	Happiness	0.03 ± 0.02	
Presentation Duration (ms)	500 ms (A)	0.02 ± 0.03	A>B, A>C, A>D, p=.000
	1000 ms (B)	0.11 ± 0.02	B>C, B>D, p=.000
	1500 ms (C)	0.16 ± 0.02	C>D, p=.002
	2000 ms (D)	0.20 ± 0.02	
TaskType* Presentation Duration (ms)	REPT 500 (E)	0.11 ± 0.03	E>F, E>G, E>H, p=.000
	REPT 1000 (F)	0.03 ± 0.02	F>G, F>H, p=.000
	REPT 1500 (G)	0.14 ± 0.02	G>H, p=.000
	REPT 2000 (H)	0.19 ± 0.02	

REPT: Reproduction Task.

Statistical Analysis

During the study for all 75 participants, 4200 relative duration value measurements were taken for each task including "verbal estimation" and "reproduction" tasks. Thus, there were 8400 trials as total in the study. The relative duration means for 75 individuals in total obtained at the level of each independent variable were examined by 2x7x4 three-way repeated measure ANOVA.

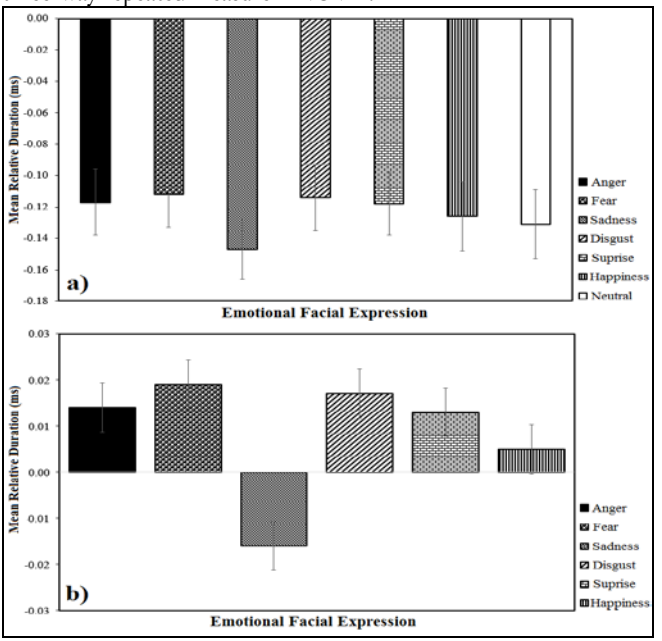

Figure 2. The relative duration means of emotional facial expressions for the Emotion Type variable and emotional facial expressions relative to neutral facial expression

Results

The effects of Task Type, Emotion Type and Presentation Duration variables on relative duration values were analyzed with by 2x7x4 three-way repeated measures variance analysis. Prior to the anaylses, the dataset was screened for missing, incorrect data entrance and outliers. Greenhouse-Geisser (GG) corrected F-tests were used when the sphericity assumption was violated and; Bonferroni corrected results were reported for post hoc comparisons in order to prevent the Type I error that might stem from the multiple-comparison effect. According to ANOVA results; the main effects of Task Type ($F(1, 74)=9.28$, $p=.000$, $\eta 2p=0.11$), Emotion Type ($F(6, 444)=2.67$, $p=.01$, $\eta 2p =0.03$) and Presentation Duration ($F(1.44, 106.86)=34.91$, $p=.000$, $\eta 2p =0.32$, $GG\varepsilon=0.48$) variables on relative duration value are significant. For interaction effects, only the Task Type*Presentation Duration interaction effect is significant ($F(1.62, 119.75)=21.68$, $p=.000$, $\eta 2p=0.23$, $GG\varepsilon=0.54$). Based on the post hoc comparisons for the Task Type variable; mean relative duration (M= -0.06 ms, SE=0.02) in the Reproduction Task is significantly greater than that of the Verbal Estimation task (M=-0.19

ms, SE=0.04). Since, both relative duration means were in the negative direction, there were underestimation of time for all stimuli. But relative to Verbal Estimation Task, in the Reproduction Task emotional stimuli were more overestimated compared to target duration.

For the Emotion Type variable; there was a statistically significant difference between only the mean of fear related facial expression and the mean of sadness related facial expression (p=.02). When considering mean rative durations of all emotion categories, the longest time estimation was found for the fear (M=-0.11 ms, SE=0.02) and the shortest time estimation was found for the sadness (M=-0.15 ms, SE =0.02). The order of emotional facial expressions from the longest to the shortest with respect to the target duration is as follows: fear (M=-0.11 ms, SE=0.02), disgust (M=-0.11 ms, SE=0.02), anger (M=-0.12 ms, SE=0.02), surprise (M=-0.12 ms, SE=0.02), happiness (M=-0.13 ms, SE=0.02), neutral (M=-0.13 ms, SE=0.02) and sadness (M=-0.15 ms, SE=0.02). The fact that the relative duration means of all facial expressions are in the negative direction indicates that these stimuli are perceived as shorter than the target duration. Similarly, the emotional facial expressions can be ordered from the longest to the shortest perception with respect to neutral face category as fear (M=0.02 ms, SE=0.02), disgust (M=0.02 ms, SE=0.02), anger (M=0.01 ms, SE=0.02), surprise (M=0.01 ms, SE=0.02), happiness (M=0.01 ms, SE=0.02) and sadness (M=-0.02 ms, SE=0.02). Therefore, all facial expressions, except for sadness, were perceived as longer than the neutral facial expression. Moreover, negative facial expressions (fear, anger and disgust) were perceived as longer in comparison to the positive facial expression (happiness) excluding the sadness related facial expression. The sad facial expression category which was found to be significantly different in this study is perceived as shorter than negatively valenced other the facial expressions of fear, anger and disgust (See. Figure 2).

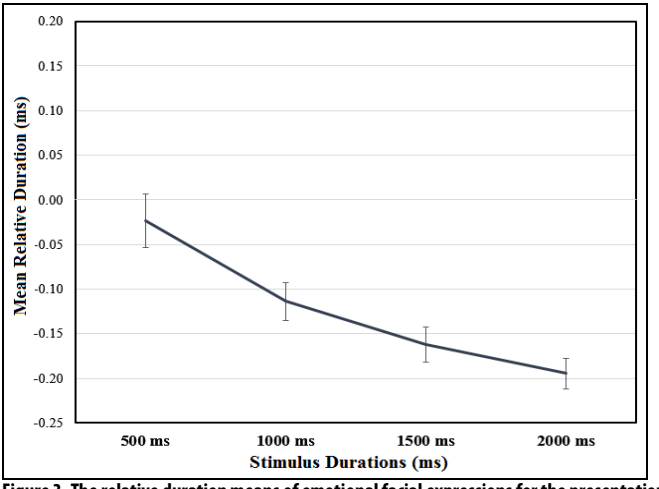

Figure 3. The relative duration means of emotional facial expressions for the presentation duration variable

There was a statistically significant difference between all duration intervals (500 ms, 1000 ms, 1500 ms, 2000 ms) for the Presentation Duration variable (p <.05). The

estimated stimulus durations increase linearly starting from 500 ms (M=-0.02 ms, SE=0.03) towards 1000 ms (M=-0.11 ms, SE=0.02), 1500 ms (M=-0.16 ms, SE=0.02) and 2000 ms (M=-0.19 ms, SE=0.02) (See Figure 3). In all these duration levels, it is seen that there is a shorter perception of the duration of emotional facial expressions and temporal performance deterioration increases as the duration level increases.

With regard to the significant Task Type*Presentation Duration interaction effect; whereas there was no statistically significant difference between the duration intervals for the Verbal Estimation Task; a statistically significant difference was found at all duration levels for the Reproduction Task (p=.000). While there was an overestimation in the positive direction (M=0.11 ms, SE=0.03) for the Reproduction Task; there was an underestimation in the negative direction starting from 1000 ms (M=-0.03 ms, SE=0.02), in 1500 ms (M=-0.14 ms, SE=0.02) and in 2000 ms (M=-0.19 ms, SE=0.02) (See Figure 4). While there was longer reproduction times in short durations, shorter reproduction times were observed in longer durations.

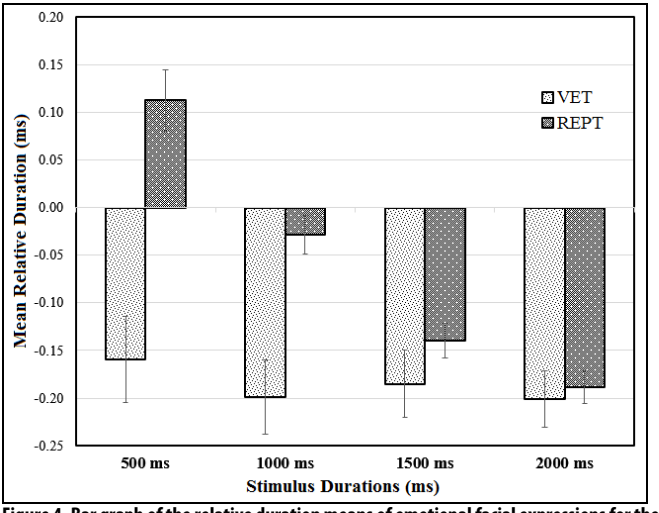

Figure 4. Bar graph of the relative duration means of emotional facial expressions for the Task Type*Presentation Duration variable

The findings obtained from the study indicate that task type, different emotion types and different presentation durations have an effect on time perception. Not observing significant triple interaction effect of task type, emotion type and presentation duration indicate that emotion type is not effective at different duration intervals and task types. Table 3 presents the summarized data for the findings with regard to main and interaction effects obtained as a result of the 2x7x4 repeated measures ANOVA in the Verbal Estimation and Reproduction Tasks for relative duration values.

Discussion

The aim of the present study is to examine the effect of universal 6 basic emotions on time perception with regard to attention and arousal mechanisms by using "verbal estimation" and "reproduction" methods of the prospective paradigm. Parallel to litera-

ture, the most important finding of this study is that while all emotional and neutral facial expressions are perceived as shorter compared to the target duration at each presentation duration in both temporal tasks used; emotional facial expressions (except for sadness) are perceived as longer in duration compared to neutral facial expression. While the tendency to underestimate the duration of emotional stimuli compared to target duration is consistent with the attention based model, tendency to overestimate duration of the emotional stimuli compared to duration of neutral stimulus is consistent with with the arousal based model. The fact that perception is shorter at all duration intervals in comparison with the target duration indicates that the participants may have reached the target duration earlier thinking that "time is running faster". In the participants who perceive the estimated time shorter with respect to the target time, the temporal evaluations now approach to the target time due to perceiving the time longer than the neutral face expression in the presence of emotional facial expressions. In conclusion, the people are quite sensitive in estimating temporal differences to adapt to their environments. Thus, the variation in subjective time indicating the decision making ability of individuals in temporal processing information is observed to be consistent with overestimation (Droit-Volet and Gil 2009, Gil and Droit-Volet 2011).

On the other hand, other important findings of this study are that even though the main effect of emotion type is statistically significant, this effect is only due to the difference between the sadness and the fear related facial expression and that the sadness expression is perceived as shorter in comparison with the neutral facial expression and that the longest estimation is for the fear facial expression and that temporal distortion is observed in the disgust facial expression. From the perspective of the valence and arousal, perceiving shorter durations for sad facial expression with respect to the neutral facial expression (i.e. underestimation) are inconsistent with the findings of studies supporting the arousal model. According to these studies, overestimation supports the assumptions of the arousal based model; but, underestimation of duration of the sad facial expression with respect to the neutral one supports the assumptions of the attention based model. The sadness related facial expression used in this study has a low level of arousal and a negative valence. Time perception is affected from attention related processes during the presentation of stimuli with low arousal. According to the assumptions of the attention models in time perception; the complex and different stimulus durations are observed to be in accordance with the expectation of a shorter time perception since significant attention resources are required for the processing of the stimulus itself (Angrili et al. 1997). The shorter time estimation for sadness category compared both to the neutral one and to other negative facial expressions such as disgust, anger and sadness might be resulted from the fact that the sadness emotion is related with low arousal level and that it emerges together with other emotions such as anger and shame (Droit-Volet, 2013). Therefore, the recognition and temporal processing of this emotion requires greater attentional resources than other mentioned emotions above, which inturn, may cause to decrease of attentional resources for time processing itself for sad facial expression.

The finding that fear facial expression has the longest estimation duration is observed to be in accordance with the findings of the pilot study done for the assessment of the valence and arousal values of the picture set (POFA) used in this study. Accordingly, fear expressions had the highest arousal level at there, so that, the longest esti-

mation for the fear facial expression may be related with an arousal based effect. The finding of this study indicating that threatening emotional stimuli such as fear and anger are perceived as longer in time compared to neutral stimuli this study as well in comparison with emotional stimuli is in accordance with the other studies done by Tipples (2008, 2011) using the emotional facial expressions for fear and anger together; by Gil and Droit-Volet (2011) using only the anger facial expression; by Bar-Haim et al. (2010) using only the fear facial expression and the study done by Droit-Volet et al. (2004) using the facial expressions for anger and other emotional facial expressions without using the facial expression for fear. This overestimation results in changes in internal clock mechanisms due to the effect of the high arousal levels of threatening stimuli which can be explained by the fact that individuals are ready to react early to threatening stimuli.

Another finding of this study indicates that duration estimations for emotional stimuli compared to target duration decrease with the increased presentation durations. Emotional facial expressions, except the sadness, are perceived as shorter with increasing presentation duration with respect to the neutral facial expression, and they are perceived as shorter with respect to the target duration can be explained by relating the duration estimations with the arousal for short durations and relating with attention mechanisms for longer durations due to the return of the arousal to the basic level (Bar-Haim et al. 2010). In addition, the assumption that temporal processing is affected by automatic processes such as arousal for short durations and by cognitive processes such as attention for longer durations are supported by these findings (Gil and Droit-Volet 2011). Threatening emotional stimuli such as fear and anger may also be perceived as longer due to the effect of automatic processes and the high arousal level by making fast adaptive response required for adapting to the environment and also the triggering of the defense mechanism (Droit-Volet and Gil 2009). Moreover, emotional stimulus (fear) at a level of 500 ms is perceived as longer due to the effect of the arousal. However, there is a shorter time estimation for the emotinal stimuli longer than 1 s. That short estimation occurs with the effect of the diminution in the attention given to time as a result of the increment in the attention resources for emotional stimuli as well as the decrement in the effect of the arousal level of emotional stimuli in durations longer than 1 s (Smith et al. 2011). It has been observed that overestimation due to the effect of emotional facial expressions results in less temporal distortion at the 500 ms. However, the type of emotional facial expressions attracts greater attention with increasing duration thereby resulting in a greater decrease in the attention given to time. This leads to even shorter perception in durations estimated with respect to target durations. The fact that short perception with respect to target duration increases with increasing duration level for emotional stimuli in general indicates that the effect of the arousal level for emotional facial expressions is limited. The arousal level of emotional facial expressions due to their nature remains at the tonic level with increasing duration level and it is observed to result in perceiving the estimated durations as shorter with respect to target durations by taking on a distracting task with effect on attention processes. The increment in temporal distortion with increasing duration is a scalar property assuming that the variation in duration estimations is proportional to duration intervals. Accordingly, the variation in duration estimations will increase with increasing duration. In addition, the increase in temporal distortion with increasing duration is also in

accordance with Vierordt's Law. Vierdordt's Law states that relatively short time intervals tend to be overestimated and long ones tend to be underestimated (Woodrow, 1934, cited from Lee et al. 2011). This law emphasizes the effect of temporal context. Meaning that estimations regarding the duration of a stimulus is subject to the actual presentation duration of that stimulus, however; the presentation of the same stimulus at different presentation intervals may lead to changes in estimations regarding the stimulus duration (Lee et al. 2011).

When compared with the findings of this study for verbal estimation and reproduction tasks, it has been observed that the duration estimations for both temporal methods have been observed as shorter than the target duration for all conditions. This undersetimation has been interpreted as the effect of the attention function that emerges with the use of visual stimulus presentations for prospective paradigms and tasks. Moreover, it has been shown that underestimation is observed in the reproduction task in comparison with the verbal estimation task (Angrili et al. 1997). Researchers claimed that the reproduction task which includes pressing a button increases attention to time. Temporal performance in reproduction task is related with attention and updating for keeping the target duration in mind and working memory since it contains executive functions such as accessing information and switching set (Mioni et al. 2016, Ogden et al. 2014). The effect of attention and working memory is less for the verbal estimation task since the target duration estimation requires only access to information and hence differentiations in the internal clock level can be carried out more effectively. Cognitive transformation (determining the perceived duration at millisecond level) was carried out for perceiving the difference in target duration and the estimated duration during the verbal estimation task. It is considered that this cognitive transformation function has an effect on the temporal functions of the participants due to its effect on attention even though it requires less attention and memory resource in comparison with the task of reproducing the duration by pressing a button in the reproduction task. Another reason may be that the stimulus duration is perceived as shorter due to the fact that attention is directed more to emotional stimuli rather than temporal processing in verbal estimation task. In line with these results, it is considered that short perception due to the decrease in attention to temporal processing since emotional facial expressions and cognitive transformation use more attention and cognitive resources. In addition, the linear increase in shorter perception with increasing duration for especially the reproduction task among both tasks leads us to think that it may be due to the more complex processes related with duration estimations for longer durations in comparison with shorter durations. While the processing of shorter durations is a more automatic process; the processing of longer durations is a more complex process since it requires memory and attention resources. Estimated durations tend to decrease more due to the fact that the increase in duration level includes complex processes with greater cognitive load such as keeping the temporal information in working memory with attending its start and end, decision making and comparison. Thus, more cognitive processes are required for generating the responses to duration estimations over longer durations (Angrili et al. 1997, Droit-Volet and Gil 2013).

In conclusion, findings of the present study are partially consistent with the findings of other time perception studies which have also inconsistent findings due to using of different methods, emotional stimuli types and presentation duration intervals.

Moreover, it is also important for putting forth that the effect of emotional facial expressions on time perception was not only related with attention or arousal mechanism as well as the interaction effects of these mechanisms. It is showed that memory and decision making processes could also be effective with regard to the effect of emotional facial expressions on time perception in addition to the effects of arousal and attention based effects.

One of the limitations of the present study was using six different emotional facial expressions of only one female and one male. Also, arousal level of emotional facial expressions is short lived. For controlling arousal level produced by perception of emotional facial expressions that could be used physiological measurements in addition to behavioral measurements. In this study, data were obtained from 75 participants because of that increasing the number of participants may be efficient for the insignificant interaction effects during the power analyses and also for the generalizability of the study results. Young age of the sample group and the exclusion of psychiatric and neurological symptoms without psychiatric interviews was another limitation. As the final limitation of the study, even though using counting strategy of participant during temporal tasks for durations shorter than 2 s, it was determined based on the feedback of the participants at the end of the study that the counting strategy has been used. For this purpose, it is suggested that use more effective methods for future studies.

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