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Emotion, attention and delayed recall task performance: how emotional intensity drives eyes during foreign language subtitle processing

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Abstract

Emotions and cognitive processes are intertwined terms and can frame how we behave and learn. The main aim of this research was to investigate the effect of emotion on attention during L2 subtitle processing and to scrutinize emotional intensity as a factor on delayed L2 vocabulary recall tasks. In this experimental study, quantitative method was utilized. In the study, 40 intermediate volunteer learners of EFL watching a funny or a boring video in which subtitles ended with an enhanced non-word while their eye movements and facial expressions were recorded. After the experiment, they were asked to take an immediate post-test consisted of choosing the correct non-words mentioned in the videos. 5 days later, they sat for the same test individually in a randomized order. The data were analyzed via samples T-Tests and a repeated measures ANOVA with a covariate. The results showed that emotional intensity did not affect time spent on subtitle areas but it was found to have an effect of recalling vocabulary items after a long delay. The results were discussed in terms of noticing and emotional enhancement effect on memory.

Keywords: Emotion, noticing, eye movements, EFL, facial expressions

1. Introduction

1.1. How Emotion and Attention Work in L2 Subtitle Processing?

We have plenty of evidence suggesting that events or experiences associated with strong emotions are better recalled than those lacking emotional intensity. The pinnacle of this effect has been observed in examinations of flashbulb memories where individuals retain a clear and nearly photographic memory of an emotionally loaded event (Heuer & Reisberg, 1990; Neisser& Harsch, 1992). Flashbulb memories are rare by its nature but daily experiences are frequently infused with emotions. Individuals often report that they

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remember emotional events in greater detail with an enhanced vividness while many ordinary events lacking emotional relevance are prone to decay quickly (Conway, 1990). Hence, when individuals are presented a series of emotional and neutral stimuli, they tend to recall a greater amount of the emotional ones than the neutral ones. This emotional memory enhancement effect has been investigated in several studies in which words, pictures or slides have been used (see Hamann, 2001, for a review). In this respect, learners of language may prefer emotionally intense activities in which emotional experience contributes their learning progress and support their memory performance.

One of these emotionally loaded activities is watching TV series or movies of personal preference. Either for learning purposes or not, many people prefer to watch their favorite movie, cartoons or TV series with subtitles. In language learning contexts, it is a common technique; learners of a language adopt it to expand their vocabulary and linguistic knowledge. During this process, learners' emotions are active during the scenes (i.e., a funny scene or a thrilling moment) and simultaneously they focus their attention on subtitles in random intervals. Hence, while learners process visual input with emotional mechanisms, they also read subtitles to reinforce their visual and emotional experience. This experience supports incidental vocabulary learning which is considered to be one of the common ways of expanding vocabulary (Nagy, Anderson and Herman; 1987; Day, Omura and Hiramatsu, 1992; Laufer, 2003; Laufer and Hulstijn, 2001) which was also confirmed by a number of eye tracking studies (Godfroid, Boers and Housen, 2013; Dolgunsöz, 2015). The consensus is that time spent on unknown linguistic items during second language (L2) reading and learning gains are positively correlated. Similarly, emotions during reading process also utilize long term retention of linguistic input since several studies suggested that emotional content enhances long term memory and the likelihood of recalling information over long delays (Buchanan & Adolphs, 2003; Dolan, 2002; Hamann, 2001). The current research is significant as it not only involved attention as a variable for recalling items but also included emotion as a predictor.

2. Emotion, Attention and Memory Performance

As will be reviewed, attention as a crucial component of recalling linguistic items can be affected by emotional arousal which may increase recall performance. Noticing hypothesis (Schmidt, 1990) strongly proposes that attentional mechanisms are responsible for allocating the cognitive resources which lead to noticing linguistic input and encoding in memory. Hierarchical memory model by Robinson (1995; 2003) which was based on Cowan's (1988) memory model supports this argument by suggesting that attention acts as a medium which enables input encoding in working memory. If learners rehearse enough, the linguistic input gained can be recalled from long-term memory when needed.

Although this argument seems convincing enough, in some scenarios, emotions can intervene and drive attention by moderating its predictive effect on recall performance. Several findings have long been proposed on the modulating role of emotions on attention (Oatley & Jenkins, 1996; Eastwood et al., 2001; Fox et al., 2001). When compared to neutral stimuli, people mostly detect emotionally loaded stimuli faster such as angry faces, a spider or a gruesome accident (Öhman et al., 2001; Mather & Knight, 2006) which is caused by high intensity emotional states. Additionally, eye tracking and brain imaging studies showed that people initially fixate on emotional stimuli and also spend more time on them (Rosler et al., 2005; Nummenmaa, Hyöna & Calvo, 2006; Knight et al., 2007; Mather et al., 2006) as emotions and attention use some of the same neural components such as the amygdala, portions of the frontal lobes and the anterior cirgulate cortex (Vuilleumier et al., 2004; Vuilleumeir, 2005).

Emotional stimuli tend to consume extra attentional resources when compared to neutral stimuli (Schupp et al., 2007) and these attentional components of emotion are closely linked to heightened learning and memory (Seli et al., 2016). Emotion and cognition relationship have been convincingly presented in a number of studies proposing that emotions have a considerable effect on cognitive functions with the orbitofrontal cortex processing positive emotions while the amygdala is involved in negative emotions (Critchley et. al., 2000; Lang et. al., 1998; O'Doherty et., al., 2001). The consensus is that memory for emotional material is enhanced, especially for negative emotional arousal in which amygdala is involved (Cahill et. al., 1996). Thus, emotionally loaded stimuli are easier to recall and they are remembered accurately due to the resilience of emotional experiences. Therefore, handling attention alone as a strong determiner of language learning gains would be oversimplification as the power of attention on recalling linguistic input after long delays may depend on the quality of the attention which would be predicted by emotional states during cognitive processes.

3. Face as a Signal System and its Analysis

In general, people laugh or smile when they are happy and adopt a sour face when they disgust. Basically 6 expressions of human emotions were defined; joy, anger, disgust, fear, sadness and surprise (Ekman & Friesen, 1971). Beside these emotional qualities, there are 3 types of valence, which refer to the direction of emotions as positive, neutral and negative (Smith & Kosslyn, 2013). Emotional valence is a wide term inhabiting several similar range of emotions (i.e., sadness and fear are categorized under negative valence).

Being a crucial signal system, human face exhibits internal emotional states by the formation of facial muscles. These muscles form facial expressions, which temporarily change the facial profile and these changes have long been considered to be associated with emotions (Fridlund, Ekman, & Oster, 1987). However, measuring human emotions is a fairly complex procedure and exactly defining what a person feels moment by moment is nearly impossible. In this perspective, facial expressions analysis inherits invaluable clues about emotions and can present strong clues about what a person feels. In modern meaning, Ekman and Friesen (1978) established the basis for this technique by constructing the "Facial Action Coding System" (FACS). This system defines 44 pre-determined facial spots on the face, each referring to one or more facial muscles called 'Action Units' (AUs). FACS depends on the combinations of these AUs, which refer to a large set of possible facial expressions.

Figure 1. Action Units Samples

Taken from Ekman, Friesen and Hager (2002)

With the developments in software technology, FACS is easier to apply today with the correct algorithm which paved the way for researchers. This technique, like eye tracking, requires calibration and is totally non-invasive. When compared to subjective scoring of emotionally loaded stimuli, this technique can provide online data collection by performing real-time frame-by frame analysis of facial expressions. Recently, several studies were performed in psychology (Calvo, Gutiérrez-García, & Del Líbano, 2016), food science (Pellegrino, Crandall, & Seo, 2015;), artificial intelligence (D'Mello, 2015) and language education (Dolgunsöz, 2019).

Facial expression analysis technique is fairly new in examining language learning processes and in this perspective, by using eye tracking and facial expression analysis, the primary aim of this study is to test how delayed recall performance is affected by emotional states in an L2 vocabulary learning context. Secondary aim of the current research is to elaborate on the effect of emotion on attention during L2 subtitle processing. The research questions are as follows:

1. Is there a change in learner face profile while watching funny and boring videos? How do their emotional states affect their ability to recall vocabulary items after a long delay?

2. Does emotional quality during L2 subtitle processing affect attention?

4. Method

This experimental study adopted a quantitative research design, and the details of the research is as follows:

4.1. Participants

A total of 40 sophomore students of EFL in intermediate level (20 males and 20 females) in an age range of 18-24 with same native language (Turkish) voluntarily participated in this research and received course credits. Participants were divided into 2 equal groups as "boring video group" (BVG) and "funny video group" (FVG).

4.2. Materials

For the experiment, 2 different videos were designed. For the funny video, a part of one of the famous cartoon series, "Camp Lazlo" (S1-E7 Dosey Doe - Prodigious Clamus) was used. For the boring stimulus, an old video including the narration of an old version of Microsoft Word™ was used. Both videos lasted for 4 minutes and had intralingual subtitling in which both soundtrack and subtitles were in English.

For both videos, not all speech was subtitled because equalizing the number of subtitles was nearly impossible. Instead, for each video, 30 subtitles were produced and each subtitle was ended with a non-word generated by ARC Non-Word Database (Rastle, Harrington & Coltheart, 2002). 10 non words were used and each non-word occurred 3 times to reinforce rehearsal. Each non-word was also enhanced by color to improve noticing (see Izumi, 2002). The main 10 non-words are as follows: *bliphs, gouzed, ghuidd, phluxt, wawsts, woized, wadged, loarle, gwynse, gnarne*.

As for the unannounced immediate post-test, learners were presented 20 non-words (10 of which they already saw in the videos) and asked to circle the ones which took place in the videos. 20 items were used to avoid any baseline effect. Same procedure was implemented as delayed post-test after 5 days by randomizing non-words. Maximum score to be gained was 10.

Figure 2. Samples from the boring video (right) and funny video (left)

4.3. Apparatus

Eye movements were recorded and analyzed by 60hz Gazepoint™ eye tracker while Facial responses were recorded and analyzed by Imotions Facet™ with a Logitech™ HD camera.

4.4. Procedure

All learners were tested individually in a well-lit room without any distractors. Before the experiment, each participant's eye was calibrated in 9-point grid calibration. For facial expression analysis, a similar calibration procedure was applied. Each participant was first presented a blank grey screen and his/her neutral facial profile was recorded which was called "baselining". After these procedures each participant watched the either funny or the boring video with headphones. Immediately after the experiment, each learner took the post-test. Delayed post-test was applied individually after 5 days to avoid any priming effect of the first test.

4.5. Data Analysis

Eye movement data was analyzed by Gazepoint Pro software. The total fixation duration on the subtitle area was calculated by the Area of Interests (AOI) created on subtitles. Facial response analysis was utilized via Imotions Facet Software and raw data values for "joy" emotion was extracted to obtain mean evidence scores. Higher evidence scores indicate that there is high probability of joy while this probability decreases as evidence score decreases. For the statistical tests, an Independent Samples T-Tests and a repeated measures ANOVA with a covariate was adopted.

5. Results

5.1. Emotional Arousal between Groups: Facial Data Analysis

To test whether the video type affected emotions, a Test was used as group as the factor and joy evidence score as the dependent variable. The results showed that FVG displayed more joy (M=2,28, SD=1,22) when compared to BVG (M=-1,43, SD=1,48). This difference was also found to be significant; $t(38)= 8{,}650$, $p= {,}000$. These findings showed that FVG smiled and laughed more than BVG did during the video. Hence, emotional arousal for FVG was found to be significantly higher than for BVG.

5.2. Attention and Emotion: Eye Tracking Data Analysis

Previous finding has revealed that FVG enjoyed the video more when compared to BVG. To examine if this emotional difference affected their eye movements on subtitle area, a T-Test was used with video group as the factor and total time spent on subtitles as the dependent variable. The findings indicated that FVG spent about 85 seconds (SD=7,93) and BVG spent nearly 83 seconds (SD=7,41) on the subtitles. This difference was not found to be significant at $p< ,05$ level. In brief, the level of emotional arousal did not affect the time spent on subtitles. Figure 2 and Figure 3 below also give more details.

Figure 3. Random Gaze Plot Samples (BVG on the left and FVG on the right)

Figure 4. Random Heat Map Samples (BVG on the left and FVG on the right

Figure 3 showed 4 random gaze plots indicating that learners' fixations on the subtitles were identical. In the subtitle area, non-words attracted most attention in both conditions which can be noticed by observing fixations with greater radius. Random heat maps in Figure 4 also visually supported the gaze plots; both groups processed subtitle areas identically and focused more on enhanced non-words. Hence, the current findings indicate no direct effect of emotion on attention span while processing subtitles for learning purposes. In both groups, learners insisted on focusing on subtitle areas and words that they are not familiar with.

5.3. Delayed Recall Test Performance and Emotional Arousal

So far, the findings showed that FVG displayed more emotional intensity than BVG did. However, this emotional difference did not affect their attention. Mean test scores were as follows.

Table 1. Post and Delayed Post Test Results

	Group	N	Mean	Std. Deviation	Std. Error Mean
Post-Test	FVG	20	7,35	2,00	,44
	BVG	20	5,60	1,81	,40
Delayed Post-Test	FVG	20	5,25	1,48	,33
	BVG	20	2,90	2,02	,45

Table 1. showed that FVG performed better than BVG in first post-test and both group's test scores decreased in delayed post-test as expected. This decrease was higher in BVG although they also scored less in post-test. To examine any possible effect of emotional arousal on this decrease, a repeated measure ANOVA with 2 levels (post and delayed post-test) was adopted with joy evidence scores as the covariate. With this way, time decay effects on recall performance would be measured by controlling emotional arousal.

Table 2. Repeated Measures ANOVA Results

Tests of Within-Subjects Effects						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Decay Effect only (5 days)	Sphericity Assumed	119,527	1	119,527	99,895	,000
	Greenhouse-Geisser	119,527	1,000	119,527	99,895	,000
	Huynh-Feldt	119,527	1,000	119,527	99,895	,000
	Lower-bound	119,527	1,000	119,527	99,895	,000
Decay Effect by controlling emotion	Sphericity Assumed	4,332	1	4,332	3,620	,065
	Greenhouse-Geisser	4,332	1,000	4,332	3,620	,065
	Huynh-Feldt	4,332	1,000	4,332	3,620	,065
	Lower-bound	4,332	1,000	4,332	3,620	,065
Error(Time Effect)	Sphericity Assumed	45,468	38	1,197		
	Greenhouse-Geisser	45,468	38,000	1,197		
	Huynh-Feldt	45,468	38,000	1,197		
	Lower-bound	45,468	38,000	1,197		

According to the Table 2, a repeated measures ANOVA with a Greenhouse-Geisser correction indicated that mean post-test and delayed post-test scores decreased significantly in five-days [$F(1.000, 38.000) = 99.985$, $p < 0.001$]. However, when emotion (joy evidence score) was controlled, no significant effect was observed between the tests at $p > .05$ level. In other words, when joy evidence scores are assumed to be equal among groups, no significant effect of time was found between groups. In brief, this finding underlined the positive effect of emotional arousal on recalling items after a long delay. FVG who enjoyed the video was exposed to less memory decay effect after 5-day interval when compared to BVG who did not enjoy the video as much.

6. Discussion

The primary aim of the current research was to reveal the effect of emotion on attention and on delayed recall performance in an L2 context by blending eye movements and facial expressions. The results indicated no effect of emotional arousal on attention while emotions were observed to have affected recall performance. The first hypothesis was that emotion would affect attention on subtitle areas which was not confirmed by the current findings. However, learners who enjoyed the video scored better in delayed-post-test although they had identical attention span on subtitle areas. A number of eye tracking studies emphasized the facilitative role of attention on learning (Godfroid, Boers and Housen, 2013; Dolgunsöz, 2015; Godfroid et. al., 2018) and indeed, emotion was not a part of these studies. The study by Godfroid, Boers and Housen (2013) examined the predictive role of attention on learning gains by utilizing eye tracking. With 28 participants, they analyzed the total fixation duration as a predictor of learning pseudo-words in comparison to familiar words. Their within subject results that the amount of the attention predicted later recall of pseudo-words; one second more attention on a pseudo-word increased its recognition probability in post-test by 8%. Dolgunsöz (2015) and Godfroid et. al. (2018) also confirmed this facilitative role of attention on vocabulary learning gains in which the second study was in a more authentic reading context. Although attention as a predictor of recall performance is a solid finding, emotion was not involved in these studies as a game changer. Considering the clear role of attention on memory performance suggested in these studies and the intertwined nature of attention and emotion (Schupp et al., 2007), the current findings emphasized the indirect supportive role of emotional intensity on attention. Eye movement results of this study argues that emotional arousal enhances attentional quality. The main argument is that learners who involve in higher emotional states showed better memory performance although they employed similar fixation times when compared to learners without emotional intensity. This finding does not contradict with the studies mentioned as they did not have emotion as a variable but rather adds on them by revealing how emotion and attention work together to build a better memory performance. Hence one important conclusion is that positive emotional arousal supports attentional quality and the quality of attention becomes more predictive on memory performance after long delays rather than the amount of attention when emotion interferes as a variable.

The findings of this study are in line with several other studies proposing that memory performance can be enhanced by emotional arousal (Cahill et. al., 1996; Seli et al., 2016; Finn and Roediger, 2011; Dolgunsöz, 2019) even regardless of valence (Nielson & Powless, 2007; Talarico, LaBar, & Rubin, 2004). The results of this study especially confirm the study of Finn and Roediger (2011) who examined the role of emotional priming on vocabulary retention among Swahili learners. In their first experiment, Swahili learners were given a cued-recall test including 10 pairs of Swahili words after a short study. Following a successful retrieval, each word was primed with a blank screen, a neutral and a negative picture. After an unsuccessful retrieval attempt, participants were presented with either a blank screen or a neutral picture, but never with an emotional picture. In second experiment, all procedures were the same but post-retrieval events were presented 2 seconds late. In both experiments, participants showed significantly best performance after being exposed to negative pictures. Although the current research had a different procedure for recall performance, results of the both studies confirmed the facilitative effect of emotional arousal on memory performance. Additionally, their findings primarily based on negative emotional arousal while the current study used positive emotions. In both conditions, recall performance was enhanced confirming Nielson and Powless (2007) proposing that intense emotional states positively affect memory performance regardless of emotional valence. However, although the results Finn and Roediger (2011) and the current research results coincide, some of the results contradicted with Dolgunsöz (2019) in which no effect of negative emotional arousal on learning gains was found. In this recent study, 40 learners of EFL were tested in a multi modal learning environment and watched a subtitled video containing taboo visuals. The results revealed a high disgust emotion for taboo but no significant test performance difference was observed between the groups. This contradiction may also be resulted from the nature of tests and the design of the study but surely claiming that both positive or negative valence can support learning gains and recall performance in language learning context needs more examination. This topic still needs further research.

7. Conclusions

In L2 learning, emotional intensity has the potential to enhance long term vocabulary gains. Learners' interaction with emotionally loaded language materials can help them to retain newly learned vocabulary items longer when compared to neutral ones. Using generic neutral visuals does not work well for long term learning and teachers of EFL should seek ways to design materials which may invoke emotions among learners. Showing a picture of a real apple does not work as good as demonstrating its funnier form. By doing so, instructors may also help students to learn with less attentional sources. Such an adoption should substitute high cognitive resource consuming techniques such as memorization. Besides, technically, this study has shown that facial expression analysis is a useful and practical research instrument for L2 research revealing robust online data when compared to subjective measurements. Although this technique requires researchers to create a perfectly planned design, it is still rare and open to development.

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