Differences in Visual Attention of Seniors When Compared to Juniors According to the Location of Subtitles in a Video Manual

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Abstract

Background This study investigates subtitle usage as an essential element in video manuals for IT devices and apps and empirically analyzes the attention effects of the seniors and juniors according to the proximity of subtitles through eye tracking. This study also analyzes the differences in visual attention of seniors when compared to juniors. In this manner, the study proposes an effective production method regarding subtitle locations in educational videos and video manuals for the elderly.

Methods The space where subtitles appear on the video screen was divided into short-, medium- and long- distance zones. About 20 seconds for each distance, a total of about 1 minute of experimental video, was shown. Through eye tracking, we investigated whether there was a difference in the total fixation count(TFC) and time to first fixation(TFF) by proximity.

Results Both the senior and junior groups commonly showed that the farther the subtitle was from the app screen, the fewer the number of gazes, and the more varied the difference in the TFC became. Furthermore, there was a statistical difference in TFF between the short- and long-distance subtitles for both seniors and juniors. However, in both groups, there was no difference in the TFF between short- and medium-distance subtitles. These results suggest that the short- and medium-distances are spaces that can be used in selecting the positions of subtitles. There was a difference in the TFC for medium- and long-distance subtitles for seniors only.

Conclusions In previous research, since subtitles should not interfere with video images in the news or documentary films, the most recognizable and effective subtitle location could be the bottom right. However, for the video manual, since the bottom-right position was the furthest distance from the image, it drew the least visual attention. In the short and medium distances, there was no difference in the attention of subtitles due to aging. Thus, it was a space that could be used when selecting the locations of subtitles. This study is significant because it investigates the visual attention of the elderly in comparison to juniors according to locations of subtitles. However, this study has limitations in that it examined visual attention through an eye tracker without revealing learning effects on learning videos. As a follow-up study, if not only visual attention but also recall is carried out, the effectiveness according to the location of subtitles is likely to increase.

Keywords Eye-tracking, Senior's Visual Attention, Video Manual, Subtitle Location

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1. Introduction

According to the UN's World Population Ageing 2019 report, the number of elderly will increase significantly in East Asia between 2019 and 2050, and this increase will be the highest in South Korea. Thus, South Korea needs to create and implement various elderly welfare policies, including those addressing health and wellbeing, lifelong learning, social activities, and entertainment. In addition to the growing elderly population, the use of YouTube by the Korean elderly is also rapidly increasing. According to Wise App (2019), the app used most by generations in their 50s or higher in South Korea was YouTube, which has approximately twice the total usage time compared to KakaoTalk. Besides, the total usage time for YouTube has approximately doubled compared to 2018. Furthermore, the total usage time for YouTube by generations in their 50s or higher was the highest among all generations (in the 10s: 117 min, in the 20 s: 91 min, in the 30 s: 68 min, in the 40 s: 62 min, in the 50 s: 122 min) on Wise App(2019). According to the 2021 Netizen Profile Research (NPR) announced by KT Group's digital media lap Nasmedia, the use rate of online videos in their 60s was 92.5%, indicating that almost all of them in their 60s use online videos. In addition, YouTube had the highest usage rate of 88.8 percent for online video channels watched by people in their 60s.

In addition, 45.3% of people in their 60s searched online through YouTube when searching was needed. Compared to other media, the types of information searched mainly through YouTube were higher in product reviews, IT device reviews, leisure, and entertainment. Kang Do-hyun, a policy director at the Ministry of Science, Technology, Information and Communication, said, "The internet service use rate of the elderly in their 60s and 70s is increasing rapidly" (MBN, 2021, para. 6).

In line with this trend, interest in content for seniors is increasing in South Korea. And numerous training videos and video manuals regarding IT services for smart devices and apps that are necessary for the elderly have been created on YouTube. These videos include subtitles. In the past, subtitles played a simple supplementary role in movies and TV that shows the actor's words. However, subtitles have recently functioned as a third speaker that amplifies the humor associated with entertainment videos. Also, Subtitles function as visual cues for attention and cognition in educational videos, so research on the role of new subtitles is actively underway. Subtitles can be memorized as a result of the short-term memory. As the working memory deteriorates with aging, the capacity of the working memory that stores and processes this temporary information decreases (Woodruff-Pak, 1997; Hultsch et al., 1992; Kim et al., 2019; Choi & Sung, 2019). According to Kim et al. (2019), the deterioration of the frontal and temporal lobes occurs when aging begins. Because these portions of the brain process memory information, these areas are closely related to the decline in working memory. The decline in working memory has been described as a representative cognitive issue for the elderly. According to Lang (2000, 2006), due to the limitations in the working memory's capacity, humans cannot process multiple stimuli simultaneously, and thus, they engage in selective attention.

Despite these circumstances, few studies have been conducted on differences in attention to subtitles between the elderly and young adults. Many researchers have studied how subtitles are used in videos and what their effects are, mainly on TV programs. (Ju, 2000;

Han, 2004; Jung, 2009; Jung & Son, 2012). Previous subtitle studies have covered web portal advertisement in broadcasting programs (Kim et al. 2013), advertisements (Lee & Byun, 2009; Cha, 2005), and home shopping channels (Shin et al., 2018); however, no studies have been conducted regarding the effectiveness of subtitles in IT related educational videos, including video manuals on how to use apps. A study by Park (2007) regarding the effects of subtitles on video learning only investigated the effects of the presence or absence of subtitles on the learning effect, memory, and understanding.

Kim et al. (2019) described that the characteristics of subtitles, including various font shapes, colors, font sizes, and locations, contribute to the effectiveness of information delivery in videos to draw viewers' attention. However, compared to studies related to the size, type, function, and frequency of subtitles, little information on the effectiveness of subtitle location is known. Cha (2005) reported that among different locations for subtitles, the recall for messages appearing at the center of the screen was higher than that for the top left or bottom. However, the study included no images of the experiment and provided no detail on the design of the experiment, thereby providing no information as to what the control variable was and under what circumstances the position of the subtitles was effective. Kim (2001) investigated the audience's attention and recall by placing subtitles in only four areas of each corner of the video and found no significant results.

The participants in the above studies were college students; thus, the above studies are limited in terms of understanding age specific attention according to subtitle location. Therefore, this study examines the elderly's attention according to subtitle locations in video manuals on how to use an app and measures the empirical effect through eye tracking.

Under the same experimental conditions, the research is conducted with the juniors as the control group of the seniors. Through this, we would like to analyze what differences the seniors show compared to the juniors depending on the location of the subtitles and what needs to be improved accordingly. In this manner, this study proposes an effective production method regarding subtitle locations in educational videos and video manuals for the elderly.

2. Literature Review about the Text and Subtitle Location on Video

According to the principle of spatial accessibility of multimedia-based learning, the location of subtitles has been described as follows. Park & Son (2003) argued that

> When searching for information through vision, the minimum requirement of search process enables effective learning. Thus, when the language information and the image information are presented in close proximity, a learner can easily process the information through the minimum search process of finding the connected information, which enables effective learning. (p.113)

Moreno & Mayer (1999) applied the principle of the occurrence of lightning to present learning effects according to the locations of animation and text. The location of the text was presented right next to the animation and away from the animation. The learning effect was

high when the text was placed right next to the animation. However, the participants were college students, not the elderly.

Furthermore, Sweller, Ayres, & Kalyuga (2001) reported that the same text and narration content may cause cognitive load in the learner due to the redundancy effect. Spencer (1968, recited from Y. Park 2007) described that the number of letters visible at a glance is approximately 30. However, when reading, 10 to 12 characters, including the spaces between letters, can be seen at once.

Kim et al. (2019) divided the screen into nine equal parts and tested the recognition task and response time of video subtitles at each location for senior and junior groups as shown in Figure 1. In both groups, subtitles in the right-middle and right-bottom positions were found to be accurately recognized. The subtitles in the left-bottom, only the junior group was correctly recognized, and the senior group was not correctly recognized. The different results between seniors and juniors in the left-bottom are consistent with previous studies describing that visual attention allocation for receiving visual information decreases with aging (Horswill et al., 2009; Brewer & Barton, 2014).

(a) Senior

Left top X	Middle top	Right top
Left middle	Middle middle X	Right middle O
Left bottom X	Middle bottom	Right bottom O

(b) Junior

Left top X	Middle top	Right top
Left middle	Middle middle X	Right middle O
Left bottom O	Middle bottom	Right bottom O

Figure 1 The result on recognition of video subtitle (Accurate recognition marked with O, Inaccurate perception marked with X)

According to other studies (Brysbaert et al., 1996; Hunter & Brysbaert, 2008), the word stimulus presented in the right visual field based on the gaze point can be re-recognized more accurately and faster than that in the left visual field. Kim et al. (2019) showed that stimulus presented in the left visual field had a less accurate effect. The same study described that stimulus presented in the right visual field resulted in the activation of a neurological mechanism that can more effectively perceive stimulus than that perceived in the left visual field, which can supplement reduced work memory capacity and spatio-temporal visual attention allocation.

However, the 180 stimulus images used by Kim et al. (2019) were randomly extracted from the news, information, and education programs, and the effects on each image on subtitles could not be determined due to the unknown compositions of each image. The subtitles of 10–20 words exposed to the subjects are close to movie subtitles. As mentioned in the limitations of the study by Kim et al. (2019), the effectiveness of the position of subtitles could be different depending on the type of image.

3. Research Questions

This study investigated how the attention of seniors varies depending on the distance of the subtitles from the image through eye tracking. In order to see the difference between the seniors and the juniors, the following hypotheses were established by putting the juniors as a control group.

Hypothesis 1. The total fixation count according to the proximity of subtitles will be different between the senior and junior groups.

Hypothesis 2. The time to first fixation of seniors will be different depending on the proximity of the subtitles to the images.

Hypothesis 3. The fime to first fixation of juniors will be different depending on the proximity of the subtitles to the images.

The operational definitions of the variables used in each hypothesis are as follows. The subtitles mentioned in the hypotheses do not mean movie captions that show all actors' dialogues or narrations in text. Sweller, Ayres, & Kalyuga (2001) reported that the same text and narration content may cause cognitive load in the learner due to the redundancy effect. Based on Kim (2020)'s research on the visual attention of the elderly in subtitles, in this paper, subtitles refer to short keywords within three characters that are described in the narration.

Proximity refers to the distance between the smartphone app and subtitle, and the video screen is divided into nine equal parts, which are set in the short-, medium-, and long-distance sections. One of the most frequently used variables in eye tracking research is fixation data. The time to first fixation refers to the time at which the first fixation is made on a specific stimulus AOI (Area of Interest), and the total fixation count refers to the sum of the

fixation numbers in response to the stimulus AOI, indicating the degree of visual attention. Selected participants included seniors in their 60s and 70s and juniors in their 20s through 40s.

4. Research Methods

4. 1. Experimental Design

This study recruited participants by convenience and purposive sampling. The primary recruitment process was performed through convenience sampling; participants who voluntarily participated in the study after viewing the recruitment announcement on SNS and publications were recruited. However, to obtain accurate measurements results from eye tracking research through the eye tracker, participants should not have strabismus, glasses, or hard lenses for astigmatism. Thus, this study constructed the secondary participants group by screening the primary participants group through purposive sampling to intentionally select subjects according to the research purposes or to recruit participants who have specific inclinations. The final participants were selected, including seniors in their 60s and 70s and juniors in their 20s through 40s, who were residents of the capital city area.

Previous studies on subtitles divided the screen into several equal parts to set the positions of subtitles, investigating the location and distance of the subtitles (Kim et al., 2019; Cha, 2005; Kim, 2001). Thus, as shown in Figure 2, this study assigned the location of the smartphone showing the app screen onto the left side after dividing the screen into two parts. The study further subdivided the right-side screen into nine equal parts to display the locations. The top-left, middle-middle, and bottom-right were assigned to the short-, medium-, and long-distance, respectively. The monitor used in this experiment is 24 inches, about 53 cm wide and 30 cm long. The location from the part set by proximity to the smartphone is 0cm in the short-distance, 10.6cm in the middle distance, and 21.2cm in the long distance.

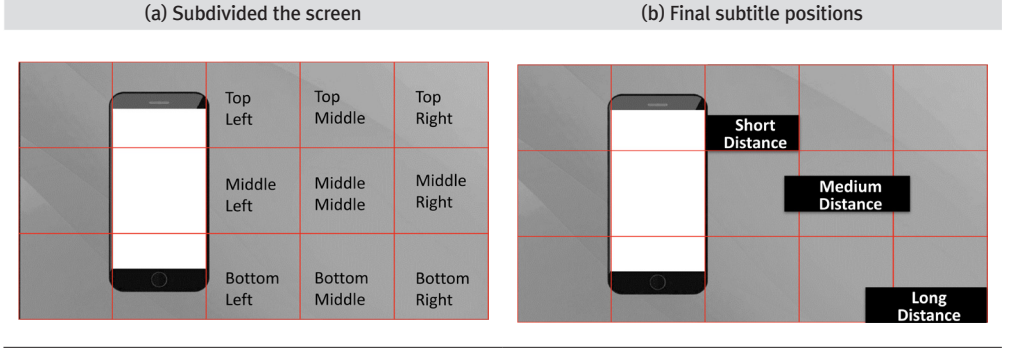

Figure 2 Subtitle positions

Prior to this experiment, nine seniors and juniors were pre-tested, showing that analysis was impossible due to frequently missing gaze data when one video was exposed only once. Thus, subtitles of two images were provided according to each proximity, and the average value was used. The video by proximity includes narration without background music, and

the total viewing time is one minute with about 20 seconds each. In a previous study which analyzed the attention to subtitles in a video manual describing how to use the app, the first fixation was made at the subtitle as soon as the subtitle appeared (Kim & Jang, 2020). In this respect, because the content screen of the app shown in the smartphone would not affect the attention depending on the proximity of subtitles, this study randomly selected and inserted the content in the screen of the app. However, because the composition of that smartphone app occupied the entire screen, this could affect the attention depending on the location of subtitles. As such, this study has fixed its location onto the left side of the screen. The part explained by narration is marked in Black, as shown in Figure 3, which was configured in a similar position for each experimental object.

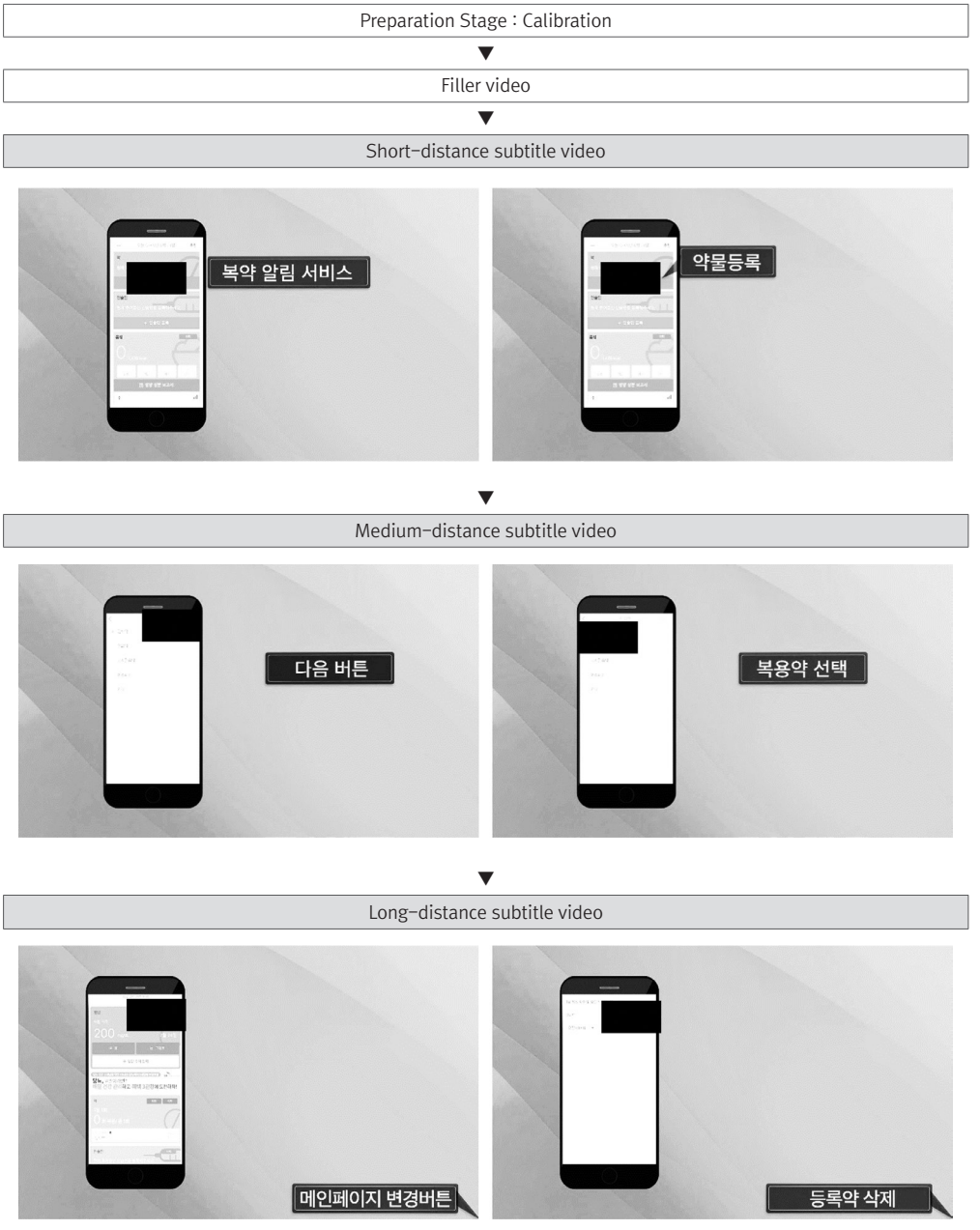

Figure 3 Experiment order and stimuli

4. 2. Experimental Processing and Analytical Methods

As shown in Figure 4, Tobii Pro Spectrum (300Hz), which was integrated with a 24-inch monitor, and the analysis program Tobii Pro Lab were used as eye tracker equipment. Under the guidance of the facilitator, experiments were conducted with only one participant at once in a graduate school lab, which was isolated from the outside.

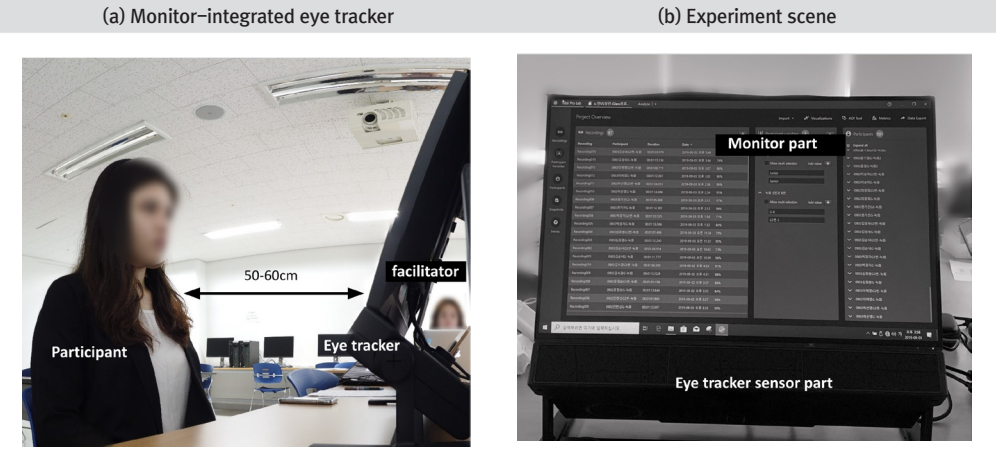

Figure 4 Tobii eye-tracker and participant

Calibrations were first performed to collect accurate gaze data on the participants. Participants who failed in the calibration process repeated the process to increase the accuracy of their gaze data. After the calibration process, the stimuli were exposed to participants in the following order: short-, medium-, and long-distance subtitle video, as shown in Figure 4. After recording each participants' gaze, their attention was analyzed by setting the area of interest (AOI) on the subtitles, as shown in Figure 5.

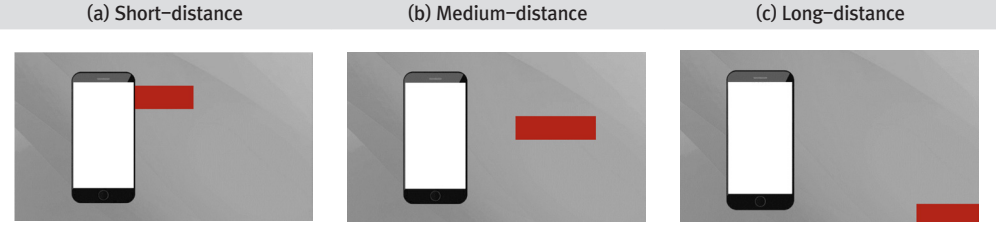

Figure 5 AOI setting of stimuli

The unit for gaze time was seconds. This study set the fixation to the value showing a fixed eyeball by 100 ms or more at a viewing angle of 1°. Hypothesis 1 was validated through a visualized heat map by examining the number of fixations by proximity and the sample group. Hypotheses 2 and 3 were validated through Kruskal–Wallis H tests by exploring the difference in time to first fixation according to proximity. For a post-hoc test, the Mann-

Whitney U test and Bonferroni's correction method were examined as pairwise comparisons on SPSS version 25.

5. Research Results

In this study, the average age of the 31 participants in the senior group (in their 60s and 70s) was 65.1 years (SD = 3.8), and the average age of the 31 participants in the junior group (in their 20s through 40s) was 33.4 years (SD = 12.9). The gender ratio of seniors and juniors was the same: 23 women (74.2%) and 8 men (25.8%).

5. 1. Heat map analysis of the total fixation count for subtitles seen by seniors and juniors

Measurements were made twice for each distance as stated in the study method. Missing values that were not investigated in both cases occurred as Table 1 in senior and junior. In this experiment, missing values refer to no occurrence of fixation in the AOI area. In the case of juniors, the number of missing values was the same in both the short- and medium-distance measurements while the number of missing values was more than doubled in the long-distance measurements. In the case of seniors, there were no missing values in the short-distance measurements while the number of missing values increased as the distance increased from medium to long, which suggests that the farther the subtitles were located from the app screen, the less attractive the subtitles became to the participants. If so, we compared how the rest of the participants, except for the participants with missing values, responded to attention through the heat map visualization of total count in Figure 6.

Table 1 Missing sample data

proximity	Seniors		Juniors	
	N	%	N	%
Short-distance	0	0	2	6.5
Medium-distance	2	6.5	2	6.5
Long-distance	6	19.4	5	16.1

Figure 6 shows the visualization image of the number of fixations; the darker the color, the higher the number of fixations, and the brighter the color, the lower the number of fixations. Examining the subtitles according to the proximity shown in Figure 6 for seniors and juniors reveals that the number of gazes decreases as the subtitles move farther from the app screen. This result shows that subtitles become less attractive to participants as subtitles move farther, indicating the same pattern for the missing rate. Thus, this result suggests that subtitles become less attractive to participants as they move farther away from the app screen.

The comparisons between seniors and juniors for each distance show that the number of fixations by juniors was less than that for seniors in all the short-, medium-, and long-distance measurements. A closer look at the app screen of the smartphone reveals the degree of fixations indicated by the subtitles. The smaller black area surrounding the button

suggests more accurate fixations in the case of juniors than that of seniors. However, the black area surrounding the button is wider for seniors than for juniors, suggesting that more searches were performed to find the button. Due to their faster cognition, juniors could find the app screen of the smartphone for the button using a smaller number of fixations at the subtitles. Seniors due to aging spent more time searching for the button after a larger number of fixations at the subtitles. Therefore, the results have revealed that the total fixation count to subtitles by proximity are different between seniors and juniors (Hypothesis 1).

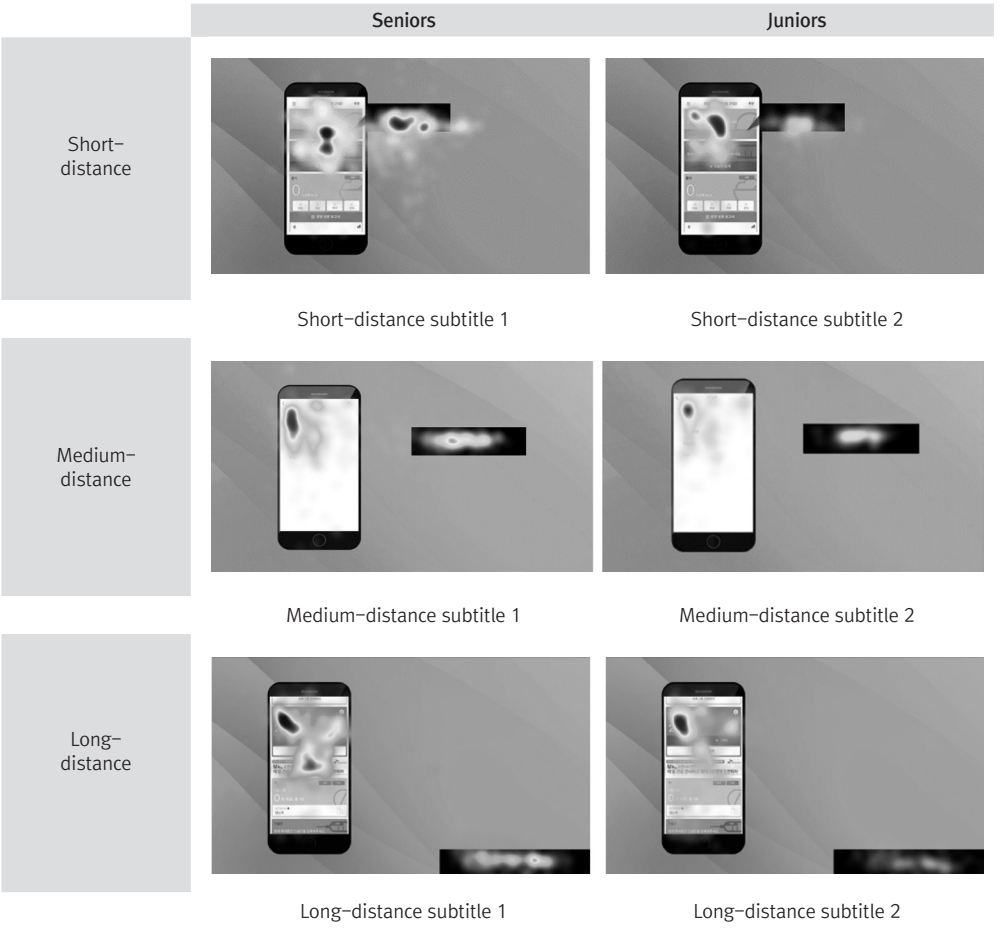

Figure 6 Heat map visualization of total count

5. 2. Analysis of senior's time to first fixation according to the distance of subtitles

Table 2 shows the means and standard deviations of seniors' time to first fixation to subtitles by proximity.

Table 2 Means and standard deviations of seniors' time to first fixation

	Mean	Standard deviation
Short-distance	0.546	0.329
Medium-distance	0.588	0.243
Long-distance	0.995	0.626

(Unit: second)

The normality tests were conducted as shown in Table 3 due to the missing sample data shown in Table 1. The significance probability of each group did not satisfy the normality requirement except for the medium-distance measurements in the Kolmogorov–Smirnov test. Furthermore, the Kruskal–Wallis H test (nonparametric statistics) was performed because the normality requirement was not satisfied in the Shapiro–Wilk test.

Table 3 Normality test for seniors

		Short-distance	Medium-distance	Long-distanc
Normality test: Kolmogorov-Smirnov	Statistic	0.260	0.151	0.222
	n	31	29	25
	Sig.	0.000	0.089	0.003
Normality test: Shapiro-Wilk	Statistic	0.701	0.912	0.785
	n	31	29	25
	Sig.	0.000	0.019	0.000

A Kruskal-Wallis H test showed that there was a statistically significant difference in time to first fixation between the different proximity, Kruskal-Wallis H = 19.743, p = 0.000, with a mean rank time to first fixation of 30.98 for short-distance, 40.98 for medium-distance and 60.24 for long-distance shown in Table 4.

Table 4 Kruskal–Wallis H test of Seniors

Ranks

Proximity		N	Mean Rank
Time to First Fixation	Short-distance	31	30.98
	Medium-distance	29	40.98
	Long-distance	25	60.24
	Total	85	

Test Statistics [a,b]

	Time to First Fixation
Kruskal-Wallis H	19.743
df	2
Asymp. Sig.	0.000

a. Kruskal Wallis Test

b. Grouping Variable: Proximity

Post hoc tests were performed by Mann-Whitney test and Bonferroni Correction Method. I looked at the significance between proximities using the pairwise comparisons shown in Table 5. As shown in Table 2, the time to first fixation for the short- and medium- distances were 0.546 second and 0.588 second, respectively, showing no statistically significant difference(p=0.350). However, there were statistically significant differences between short- and long-distances (p=0.000) and the medium- and long-distances (p=0.013).

In the case of the short- and long-distance, the time to first fixation for the short-distance was 0.546 second, and the long-distance was 0.995 second. In the case of medium- and long-distance, the time to first fixation for the medium-distance was 0.588 second, and the long-distance subtitles was 0.995 second.
The subtitles farthest from the app screen of the smartphone were found to affect the time to first fixation.

Table 5 Pairwise comparison for the senior group

Sample 1–Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Short – Medium distance	−9.999	6.376	−1.568	0.117	0.350
Short – Long distance	−29.256	6.634	−4.410	0.000	0.000
Medium – Long distance	−19.257	6.735	−2.859	0.004	0.013

P<.05

5. 3. Analysis of the juniors' time to first fixation according to the distance of the subtitles

Table 6 shows the means and standard deviations of the juniors' time to first fixation to subtitles by proximity.

Table 6 Means and standard deviations of the juniors' time to first fixation

	Mean	Standard deviation
Short-distance	0.544	0.277
Medium-distance	0.663	0.275
Long-distance	1.033	0.665

(Unit: second)

The normality test was conducted as shown in Table 7 due to the missing sample data shown in Table 1. The significance probability of each group did not satisfy the normality requirement except for the medium-distance measurement in the Kolmogorov–Smirnov test. Furthermore, the Kruskal–Wallis H test was performed because the normality requirement was not satisfied in the Shapiro–Wilk test.

Table 7 Normality test and Kruskal–Wallis H test for juniors

		Short-distance	Medium-distance	Long-distanc
Normality test :Kolmogorov Smirnova	Statistic	0.219	0.145	0.260
	n	29	29	26
	Sig.	0.001	0.123	0.000
Normality test :Shapiro-Wilk	Statistic	0.816	0.919	0.764
	n	29	29	26
	Sig.	0.000	0.029	0.000

A Kruskal-Wallis H test showed that there was a statistically significant difference in time to first fixation between the different proximity, Kruskal-Wallis H= 18.332, p= 0.000, with a mean rank time to first fixation of 29.47 for short-distance, 41.95 for medium-distance and 57.65 for long-distance shown in Table 8.

Table 8 Kruskal–Wallis H test for Junior

Ranks

Proximity		N	Mean Rank
Time to First Fixation	Short–distance	29	29.47
	Medium–distance	29	41.95
	Long–distance	26	57.65
	Total	84	

Test Statistics [a,b]

	Time to First Fixation
Kruskal–Wallis H	18.332
df	2
Asymp. Sig.	0.000

a. Kruskal Wallis Test

b. Grouping Variable: Proximity

Post hoc tests were performed by Mann-Whitney test and Bonferroni Correction Method. I looked at the significance between proximities using the pairwise comparisons shown in Table 9. As shown in Table 9, the time to first fixation for the short- and medium-distances (p=0.154) and the medium- and long-distances (p =0.051) showed no statistically significant differences. However, there was a statistically significant difference between the short- and long-distances (p=0.000). The time to first fixation was 0.544 second and 1.033 second for the short-and long-distances, respectively as shown in Table 6. In contrast to seniors, there was a difference between the short- and long-distance measurements for juniors.

Table 9 Pairwise comparison for the junior group

Sample 1–Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Short – Medium distance	−12.483	6.405	−1.949	0.051	0.154
Short – Long distance	−28.188	6.588	−4.279	0.000	0.000
Medium – Long distance	15.706	6.588	−2.384	0.017	0.051

P<.05

6. Conclusions

This study examined the differences in seniors' attention subtitles according to their proximity through eye tracking.

For Hypothesis 1 I examined the total fixation count of seniors based on the proximity of subtitles compared to juniors through a heat map. The peculiarity was that, in all the short, medium, and long distances, the range of gaze of the subtitles and smart app screens was wider in the seniors than in the juniors, so it was found that a lot of searches were made. Junior was quick to recognize, so they stared at the subtitles a small number of fixation, and then found the target indicated by the subtitles on the smartphone app screen with a small number of fixation. On the other hand, seniors searched for subtitles and smart app screens many times because their recognition was not fast due to aging.

For Hypotheses 2 and 3 I examined the differences in the time to first fixation for each proximity

between seniors and juniors. In both the senior and junior groups, there were no statistically significant differences in the time to first fixation for the short- and medium-distance subtitles. In the short- and medium-distance, it means that there is no difference in the attention of subtitles due to aging, so it is a space that can be used when selecting the locations of subtitles. However, in the case of long-distance subtitles, it should be noted in the application of subtitles to video manuals and IT app training videos.

These results are consistent with the experimental results of Moreno and Mayer, which were described in the Literature Review section. These results also demonstrate a pattern different from the results of Kim et al. Moreno and Mayer examined the effectiveness of displaying subtitles right next to the animation to be described and placing the subtitles far from the animation in the learning video. However, Kim et al. investigated the effectiveness of subtitles according to their locations in a typical TV program screen rather than a learning video. Because subtitles should not interfere with the screen image in the news or documentary films (Lee, 2003; Jung, 2009), the most recognizable and effective location can be considered the bottom-right in this regard. However, as in this study, when the mobile phone app was placed on the left side of the IT app training video, the results showed that the bottom-right position, the most spatially distant location, was the least attractive. Therefore, the subtitle should be shown to avoid this part as much as possible.

In this study, to control other variables, stimulants on the screen exposed only mobile phones and subtitles. Even though only one subtitle was exposed in an experimental situation where there was nothing else to see on the screen, visual attention was lowered when the subtitle moved away from the image to be explained. Also, based on this, the following can be inferred. Exposing a lot of text information at once causes cognitive load in the elderly, as previous studies have shown. If a video is produced for the elderly, it should be produced with this in mind. Nevertheless, if many text information is forced to enter the screen at once, the location can be selectively placed according to the importance of the information due to the proximity of this study.

This study is significant because it investigated the visual attention of the elderly in comparison to juniors according to locations of subtitles. However, this study has its limitations in that it examined visual attention through an eye tracker without revealing its learning effects on learning videos. Further studies could increase effectiveness of subtitles based on location if the studies were to examine recall in connection to visual attention.

In addition, this study conducted an experiment based on video viewing through a monitor. However, with the increase in video viewing through mobile devices, a follow-up study is needed on how the elderly pay attention to subtitles on small mobile screens.

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