Psychologie
Faculteit der Sociale Wetenschappen

Advertising and memory: The modulation of eye vergence applied in marketing.

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Abstract

Eye tracking is an objective way to test whether advertisements draw attention and cause the consumer to remember the message and brand that is presented. Fixations are the most common measure in eyetracking, however research indicates that fixations are not a valid measurement for attention and retention. Fixations represent sensory memory which, due to limited processing capabilities, selects only the information which is important for further action and thus not transfers all information onto working and long-term memory. In the current study a new eye tracking method was applied, namely the modulation of eye vergence, which, according to recent research, is related to increased attention. The goal of the current study is to investigate if the modulation of eye vergence is a predictor for the retention of brand and message when participants look at advertisements.

While being recorded with an eye tracker, the 26 participants, which were divided over two groups, were presented with four blocks of advertisements. After the first three blocks the participants were asked which brand and message they had seen. In the fourth block twelve pairs of the same brands were presented to the participants, to study the effect of manipulating advertisements on the modulation of eye vergence. Based on the results, it can be concluded that the average and maximum modulation of eye vergence in this study have not been found to be predictors for retention of brand and message in advertisement. Though, simulations of the median data points do show significant difference in the modulation of eye vergence between the group that remembered and the group that did not remember. The modulation has the potential to become an objective predictor for the effectiveness of advertisement but since it has barely been researched yet, much more studies have to be done to find out how it exactly correlates with increased attention.

Keywords: Eye tracking, eye vergence, marketing, advertisement

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In today's society advertisers have numerous ways to advertise their product or services. The possibility to advertise anywhere at any moment creates for one, a lot of advertisements and second, a lot of competition between advertisers. An advertisement is effective when it generates conversion, which means turning potential customers into paying customers, but there is one important condition to be satisfied first. A prerequisite for a consumer to buy a product is being consciously aware of its existence. Due to the large competition for advertisers it is important to maximize attention and memory for their advertisements (Wedel & Pieters, 2000; Pieters, Warlop & Wedel, 2002). An advertisement that fails to attract the attention of the consumer is definitely not effective. On the other hand, if advertisements do attract attention this also does not automatically mean the advertisement is consciously remembered and thus effective in influencing consumers' behaviour. Because of our limited processing capacity information is not always transferred to memory (Basil, 1994). An effective advertisement draws attention to such an extent that the information that it presents will be processed and leaves traces in consumers' memory (Wedel & Pieters, 2000).

Eye tracking is a popular technique in marketing research (Purucker, Landwehr, Sprott, & Herrmann, 2014; Duchowski, 2002). Eye fixations provide objective and quantitative indications for the consumers' attention to advertisements (Duchowski, 2002; Malhotra, 2008). The eye tracker is an innovative instrument with possibly still a lot of undiscovered

possibilities. In this study we have studied a new measurement, the modulation of eye vergence, which improves the accuracy in predicting the effectiveness of advertisement. This measurement has been researched by Puig, Zapata, Aznar-Casanova and Supèr (2013), and they have discovered a relation between the modulation of eye vergence and increased attention.

The goal of the current study is to bring theory and practice together by applying the modulation of eye vergence method in the marketing sector, more specifically in printed advertisement. In the text below theory and practice will initially be divided. Firstly, based on previous research on eye tracking, the complications in eye tracking will be discussed as well as the cause of these complications. Also, the theory about the modulation of eye vergence method will be addressed. To make the transition to practice, there will be elucidated how eye tracking has been applied in marketing research and what advertisements generally consist of. After having explained both theory and practice, the implications for advertisement will be discussed.

The Eye Tracker and its Complications

Eye tracking devices capture the four most occurring eye movements, which are fixations (focussing on one point in space), saccades (short, fast movements of the eye), smooth pursuits (following an object) and blinks (closing the eye). Due to the characteristics of these movements the eye tracker is able to separate one from another by using an algorithm (Zhao, Yuan, Tu, & Lu, 2015).

Even though eye tracking is a popular instrument for measuring advertising effectiveness, it comes with some complications. There is a vast amount of literature that questions the direct relationship between fixation and attention. For example, Underwood, Chapman, Bowden and Crundall (2002) studied the recall of objects by participants who had been looking at driving scenes. Results show that the participants reported seeing fewer

objects than the fixations implied. A second example it the inattentional blindness study (Pappas, Fishel, Moss, Hicks, & Leech, 2005) where eye movements were recorded while looking at the 'gorilla video' (Simon & Chabris, 1999). Results show that a part of the participants that did not remember seeing the gorilla, did have fixations on the gorilla, which means that not all fixations are equal to conscious attention. Additionally, misdirection paradigms and other inattentional blindness paradigms show findings that underline the same conclusion: Fixations are not always equal to consciously attending stimuli and further processing into memory (Barnhart & Goldinger, 2014; Beanland & Pammer, 2010; Kuhn & Findlay, 2010; Kuisma, Simola, Uusitalo, and Öörni, 2010).

As stated above, because of our limited processing capabilities we cannot consciously attend to all the stimuli around us. To remember what is presented, visual information has to be stored in long-term memory. According to '*the modal model of the mind*' (Figure 1, Gray, 2007) there are three types of memory stores: the sensory memory, working memory and the long-term memory, and each store has its own function, capacity and duration. Control processes (attention, rehearsal, encoding and retrieval) guide the processing of information and the movement of information from one store to the other (Gray, 2007). In current eye tracking the information gathered is basically the position of the eyes and when comparing this to '*the modal model of the mind*' this is similar to the sensory memory. As the model

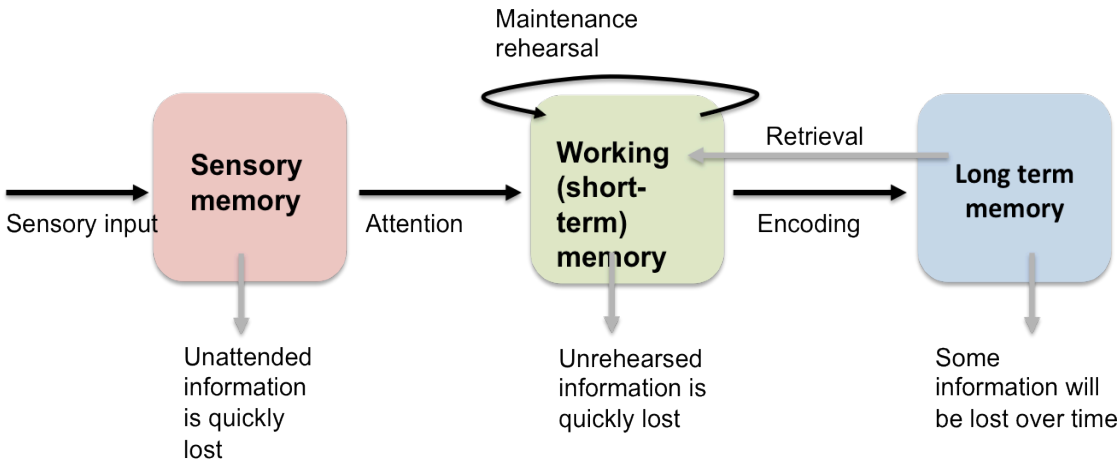

Figure 1: The modal model of the mind. Reprinted from "Psychology" by Gray P. (2007), p. 304, Worth Publishers.

shows, if this information is unattended the information is quickly lost (Gray, 2007). An explanation for the losing of information from the sensory memory can be found in the early selection theories (Broadbent, 1958; Treisman, 1960). According to early selection models only information that needs further reaction will be let through to the working memory because the sensory memory has a large capacity for a short time to hold information. In the study of Underwood (2002) the task was to mind the road, so only relevant information (objects on the road) for completing this task was transferred to working memory and other

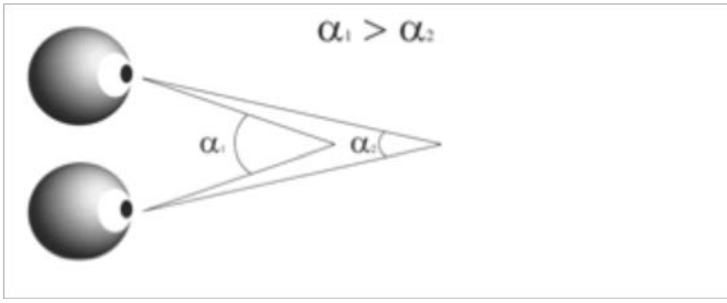

Figure 2: The eyes focus on a single point in space. The Angle of Eye Vergence relates to the distance of the focus point to the eyes. For a near point the vergence angle (α1) is larger than for a far point (α2). α represents the angle of eye vergence. Reprinted from "A Role of Eye Vergence in Covert Attention" by M. S. Puig, L.P. Zapata, and H. Supèr (2013), PLos ONE, *8,* p. 2.

objects were not. The same goes for the study of Papas et al. (2005) where the task was to count how many times the ball was passed between teammates. Therefore, the information that was needed for further reaction was the ball. Both examples show the influence of 'the goal' on short term memory and thus what is remembered. This means that using fixations, which lead to only sensory memory for sure, as a measurement for long term memory may be insufficient. Fixations do not determine if information has been moved from sensory memory to working memory and to long-term memory.

To be able to make better predictions about the effectiveness of advertisement there is need for a method that can differentiate between sensory memory and further processing levels. Puig et al. (2013; in press) have recently discovered that the modulation of eye

vergence is related to attentional processing. Vergence is the simultaneous movement of the eyes in opposite direction to obtain single binocular vision. This is an important cue in depth perception. The eyes rotate towards each other when an object is closer by (convergence), and when an object is further away the eyes rotate away from each other (divergence). As illustrated in Figure 2 (Puig, 2013), eye vergence makes depth perception possible (Puig, 2013). Crucially, the study of Puig (2013) has found that next to depth perception, attentional processing is also correlated with the convergence of the eyes. Depth perception and attentional processing discriminate their selves in size. The changes in the AoEV related to attentional processing are one factor smaller as opposed to the changes in depth perception. When visual attention increases, the eyes slightly rotate towards each other (converge), which increases the AoEV. Puig (2013) studied the relation between the AoEV and covert attention with a cue/no-cue paradigm. In the first experiment the participants had to focus on a cross in the middle of the screen. Eight bars appeared around the cross and one of the bars was going to tilt. The participants task was to detect the direction of the tilted bar. Half of the participants were presented with a cue stimulus (suggesting which bar was going to tilt) and the other half was

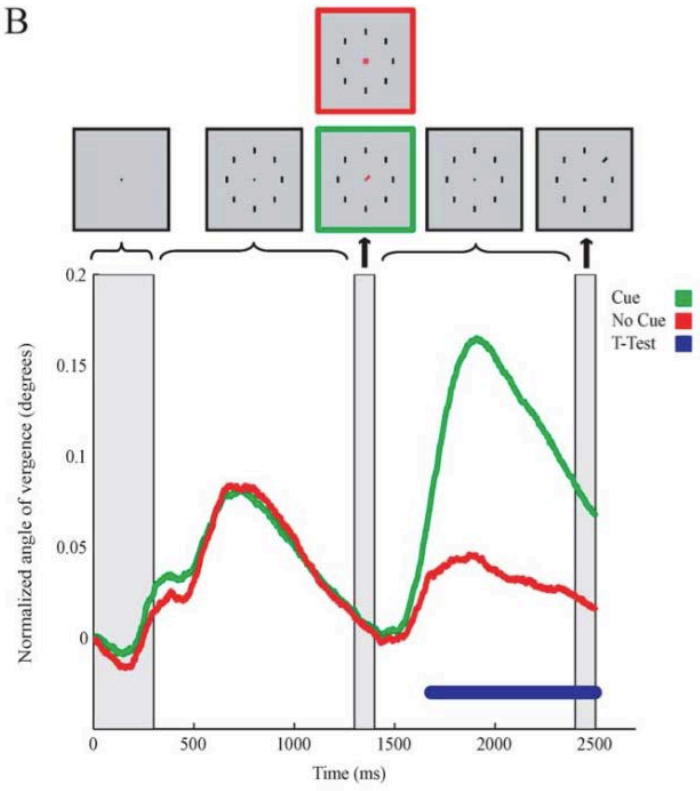

Figure 3: Average (across all subjects) size of AoEV in the cue (green) and no-cue (red) conditions over time. Time points (blue) indicate a significant difference in AoEV between both conditions. Reprinted from "A Role of Eye Vergence in Covert Attention" by M. S. Puig, L.P. Zapata, and H. Supèr (2013), PLos ONE, *8,* p. 2.

presented with the no cue stimulus (a red cross, not indicating any direction). The results (Figure 3) show that there was a significant difference between the eye vergence in the cue condition and the no-cue condition. The cue induces the difference by increasing attention. To support the idea that the modulation of eye vergence is caused by a cognitive mechanism, the second experiment was exactly the same as experiment one except that the participants did not have a task. They only had to focus on the cross and when one of the bars tilted no response was required. The results show that there is no difference between the cue and no-cue condition, which suggests that the modulation of eye vergence is based on engagement in the task.

Another research of Puig et al. (in press) researched the relation between the modulation of eye vergence and memory. Participants were subjected to a memory game where they had to scan eight or twelve images for ten seconds. Afterwards when new and repeated images were shown the participants had to indicate if they could remember the images. Results showed that the AoEV during scanning time was significantly higher for the correctly remembered images than for the incorrectly remembered images, which suggests that the modulation of eye vergence is a predictor for the processing of stimuli into retrievable memory traces. In this study the frequency and duration of fixation was also tested as a predictor but results showed there was no significant difference between the remembered and not remembered group images.

Unlike the point wise fixations, eye vergence can be better described as a 'state' of attention, which increases and decreases over time. The longer the modulation of eye vergence is increased the longer attention is maintained and more information is processed into deeper processing levels. Suggested by Puig (in press) is that eye vergence is controlled by neurons in the brainstem, in particular the midbrain reticular formation. The midbrain reticular formation may form a part of a broader pathway, including the frontal and parietal regions of the cerebral cortex and cerebellum that is involved in the control of eye vergence movements. Next to the control of eye vergence the structures have a role in managing visual attention. Therefore, it is assumed that the brainstem nuclei involved in vergence control are a part of the attention system of the brain (Puig, in press).

Advertisement and the Application of Eye Tracking Research

Malhotra (2008) gives an extensive review about research in eye tracking and marketing. One of the first studies specified to print advertisements (Witt, 1977) studied the effect of emotional images on eye movement. The results showed that emotional images result in an increase in fixation frequency but fixations on other parts than the image

presented in the advertisement remained the same. The study showed a moderate correlation between fixation frequency and the recall of information presented in the advertisements. In 1979, Treistman and Greg, studied various elements within advertisements with the goal to predict which advertisement had the highest sales potential. Results showed a relation between eye movements and involvement, familiarity and purchase intent. This study laid down groundwork for research studying top-down and bottom-up effects. A relevant study from Wedel and Pieters (2000) studied the relationship between long-term memory and fixations in advertisement. The theory behind this relationship is that the more fixations you have on an object the more time you have to encode information into long-term memory. In this study the different elements (text, image and brand) are compared on the number of fixations the elements attract. Results show that the brand attracts the most fixations and, most importantly, fixations on the brand and the pictorial promoted memory for the brand, while fixations on the text did not. Pieters et al. (2002) extended the former research to the originality of advertisements and the effect it has on memory. Results showed that advertisements that were original and familiar attracted more attention, which improved brand recognition.

There is a great variety among advertisements but most of them contain the following elements (See Figure 5): A brand logo, which displays the brand name, text elements, which communicate a message and an image (Pieters & Wedel, 2004).

According to Samu and Krishnan (2009) brand names play an important role in communicating benefits, image and the identity of the product. Also, the brand name guides consumers' choice. Because

Figure 5: Advertisements usually consists of an image, text, and a brand logo. On the right is an example of an advertisement.

of the wealth of information associated with the brand name, it is important that the potential consumer is able to retrieve the brand name after being exposed to the advertisement.

Besides the brand name advertisements communicate a message. The goal of the message presented in the advertisement is to trigger the consumer with the content of their message. Also, the features of the text element like logotype, size and colour may affect consumer experience and behaviour (Doyle & Bottomley, 2006). It is important that the message is clear so that consumers can retrieve the information they are presented with and thus makes it an effective advertisement in influencing consumers' behaviour.

Even though the image does not contain as much information as the brand name or communicated message (For example see Figure 3), consumers spend more time looking at advertisements with an image compared to advertisements lacking one (Higgins, Leinenger, & Rayner, 2014). Therefore, an image contributes to the effectiveness of the whole advertisement.

The Modulation of Eye Vergence Applied to Advertisement

Because of the large quantities of advertisements consumers are exposed to in a day the exposure does not often coincide with consumers making purchase decisions. Mostly, the effect of advertising on purchase decision occurs through consumers' memory (Tellis & Ambler, 2007). This makes the ability to predict the potential of an advertisement to leave memory traces important. The modulation of eye vergence has been found to have a predictive value for memory in lab experiments and has the potential to be useful in practice. This leads to the main question: Is the modulation of eye vergence a reliable predictive value for the effectiveness of advertisement? And is it an improvement on the currently used fixations? The goal of the current study is to apply the measurements of Puig (2013, in press) to see if this leads to comparable results as found in earlier studies. The first expectation is that the modulation of eye vergence has a predictive value for memory and that it adds value

to current eye tracking measurements. This expectation is tested by showing the participants advertisements while measuring the modulation of eye vergence. The second expectation of the study is that when manipulating advertisements the modulation of eye vergence will change. This will be a first step towards creating a tool. The goal is that this tool can be used in marketing research to test the potential of advertisements creating memory traces and thus the effectiveness.

As stated before, the effectiveness of an advertisement is dependent on the retention of the brand name and the message. The retention for these two elements will be measured separately from each other. This leads to the first hypothesis:

- Higher modulation of eye vergence predicts the ability to retrieve the brandname and the message in advertisements.

In line with most research, Lee and Ahn (2012) have studied the relationship between attention and memory by measuring the total fixation frequency and duration in participants looking at animated banners. A higher fixation frequency and duration would lead to more opportunity to encode and store information. Results showed that fixation duration was indeed a predictor for memory and fixation frequency was not. Even though these duration of fixation measurements theoretically should not necessarily be correlated with traces of memory (because only sensory memory) this is the best predictor right now. By using the modulation of eye vergence as a predictor it may be possible to draw more accurate conclusions. This leads to the second hypothesis:

- The modulation of eye vergence is a better predictor for retention of the brand and the message in advertising than the total duration and/or the frequency of fixation.

As stated before, the second part of this study has the goal to create a marketing tool. The goal of this tool is to test whether the modulation of eye vergence can be manipulated by making

changes in the design of an advertisement. In practical situations an advertiser wants to know which version of the advertisement is the most effective.

Salient elements draw more attention and are more often processed than elements that are not (Xu & Zhang, 2015). Saliency is created by adding higher contrast images, increasing the size of the text or brand, and adding faces (Palermo & Rhodes, 2007). Increasing the saliency of advertisements has a positive effect on memory and thus a higher modulation of eye vergence will follow. This leads to the last hypothesis:

- The modulation of eye vergence can be positively manipulated by increasing the saliency of the advertisement.

Method

Participants

The sample consisted of 33 participants. Participants were selected (no exclusion criteria) at the University of Leiden (compensation of 1 credit or €3,50) and at a company in Delft (on voluntary basis). To obtain usable data the participants needed to be successfully calibrated. This means a calibration accuracy score of less then one visual degree. Six participants were excluded because of insufficient accuracy scores resulting from the calibration. This resulted in 26 participants with usable data, of which 8 were male (30%) and 18 were female (70%). The age ranged from 19 to 39 (M=24.93, SD=3,97). Most identified themselves as students (70.6%), and others as employed (29.6%). In the fourth block the participants were divided in two groups. Participant 1 through 15 was in the first groups and participant 16 through 27 was in the second group.

Design

The design of the study is a between subjects' design, where the independent variable is the state of retrieval (remembered/not remembered) and the dependent variables are the

modulation of eye vergence, frequency of fixation and duration fixation. Depending on the retention of the brand or message the signal (the modulation, frequency and duration) was placed in the group ‘remembered’ or ‘not remembered’.

Procedure and Stimulus

Before taking part in the experiment participants had to sign the informed consent. Participants first started calibration (See Eye recording below) and if the calibration was successful the participants were instructed to keep their head still. The experiment was started and the participants were instructed to look carefully and try to remember the advertisements.

Participants were exposed to three blocks of 15 trials. During these three blocks with trials no response from the participant was needed. The blocks were designed in the exact same way, but with different advertisements. Each trial consisted of a single advertisement and lasted for 4 seconds and each trial directly follows the former. The 15 trials within the blocks were randomized in every block. The blocks were not randomized amongst each other (For an overview see Appendix A). Since there are no studies that report the effect of top-down factors on the modulation of eye vergence new advertisements were created in Pixelmator. This to avoid brand familiarity or recognition, which could possibly have an influence on the modulation of eye vergence. All advertisements (See appendix C for examples) consisted of a message, an image and a non-existent brand logo (See Figure 3), which varied in location, form, size, colour and content without any systematics. After each block retention was tested by a survey, which was created with the online survey tool Limesurvey. The surveys were implemented in EventIDE to avoid the need for participants to take their eyes of the screen and wipe out the calibration settings. After the third block and the third survey, the fourth block automatically followed, which consisted of 35 trials. Each trial consisted of one advertisement from an existing brand. Among the 45 advertisements there were 12 pairs of the same brand and 11 not-paired brands. The pairs consisted of the original

advertisement and a manipulated advertisement, creating more or less saliency (see Figure 9). To correct for an order bias the participants were divided in two groups. The order of the pairs was different in both groups. For example, group one saw the more salient version of the D-reizen advertisement first and the less salient advertisement second. The second group saw the less salient advertisement of D-reizen first and the more salient advertisement second.

After the experiment finished the participants were thanked for their participation and were presented with a debriefing, which contained a thank you, a recap of the experiment that was just performed, the goal of the study and why it was relevant.

Figure 6: Two versions of the same brand. The advertisement on the right is more salient than the advertisement on the left.

Timeframe

Appendix A presents the exact timeline of the experiment. Before the experiment was started the participants were calibrated. The maximum time for calibrating was ten minutes. Block one, two and three have taken six minutes each. These six minutes consist of the 15 trials (four seconds per trial) and filling in the survey (approximately five minutes), which consists of six questions. Block four took exactly two minutes and 20 seconds, and consisted of 35 advertisements (four seconds per trial).

Measurements

Eye recording. The stimuli were presented using the software EventIDE (Okazolab, Ltd, London, UK). The participants took place behind a computer screen at approximately 50

centimeters distance (1920x1080 res.). The eye tracker was attached to the bottom of the screen. The participants' eye movements were recorded with a Tobii Pro X2-30 eye tracker. The eye tracking device was calibrated (9 points) by each participant before the experiment was started. The eye tracker recorded 3D data of the eyes, the number and the duration of fixations on the computer screen.

Retention task (survey). The survey consisted of six questions: (1) Which brands were presented in the advertisements you have just seen? Where 20 options were given of which 15 were correct. (2) Which messages were presented in the advertisements you have just seen? Where 12 options were given of which 3 are correct. QParticipants were asked to check the boxes of the brands and messages they remembered seeing in the advertisements. Each survey contains one question in regards to the retention of the brand (20 options of which 15 are correct), and 5 questions in regards to the retention of the message (every question has 12 options of which 3 are correct).

Independent variable: state of retrieval (remembered/not remembered). Each pair (subject, brand/message) received a numeric value to represent if brand/message was recalled by the participant, where 0 means that the brand or message was not remembered and 1 means the brand or message was remembered.

Dependent variable: Modulation of eye vergence. The vergence signal for each block per participant was divided into 15 times 4 seconds, producing 1 signal for each trial.

We used a 30Hz eye tracker, which produces 30 frames per second. This resulted in 120 (30 x 4) data points per advertisement. It has been found that everyone produces different levels of eye vergence. To make sure the signals fell in the same range of values (-0.1;0.1) the data was normalized by the maximum per individual. Next, we made a comparison with the median. The median was calculated for the group 'remembered' and for the group 'not remembered' and presented in a simulation.

To test for significant differences between ‘remembered’ and ‘not remembered’ we used a permutation analysis. We approximated the distribution of the median difference for every data point and looked at the difference of the position of the median signal between both groups to approximate a p-value. This resulted in a simulation of p-values for 120 data points, which made it possible to create a simulation. Also, the average and the maximum of the modulation of eye vergence are calculated for every advertisement and every participant. By applying a regression analysis on the data will be determined if one, both or none is a predictor for the recall of brand or message. This will also be done for the frequency and duration of fixation. To test the significant differences between salient and not-salient advertisements in the second part of the study the same permutation analysis will be used.

Dependent variable: Frequency and duration of fixation. The frequency and duration of fixation was automatically calculated by the software program that was used. In the output of the program frequency and duration of fixation was given per trial.

Results

Survey

Brand recognition. The participants filled in three surveys, one after each block of advertisements. For the first survey, in total there were 390 options to give choose the correct brand (26 participants x 15 options) of which 181 have been answered correctly (46%). For the second survey 53% of the answers are correct and for the third this is 57%. This makes it possible to make a somewhat even comparison between ‘remembered’ and ‘not remembered’ in the data analysis described below. When checking for the probability that participants have been gambling (chance is 75%) none of the participants reach this percentage of correct answers. The average correct answers in all blocks combined is 39%.

Message recognition. Same as brand recognition, message recognition has also been

tested in 3 surveys. One after each block of advertisements. In survey 1, the total number of correct options (26 participants x 15 options) is 390 of which 223 is answered correct (57%). In the second survey the percentage of correct answers is 53% and in the third survey 64%. Again this makes it possible to make somewhat even comparisons between 'remembered' and 'not remembered' in the coming data analysis described below. When checking for the probability that participants have been gambling (chance is 25%) none of the participants reach this percentage of correct answers. The average correct answers in all blocks combined is 14%.

Fixation frequency and fixation duration as a predictor.

To see if the frequency of fixation variables (per trial) are fit to be combined into one scale, a reliability analysis has been executed which resulted in a high Cronbach's alpha (.947). The same has been done for the variable duration of the fixations (per trial), which also resulted in a high Cronbachs alpha (.929). Following, the duration, frequency, brand retention and message retention variables have been averaged per participant to be able to run a regression analysis with the independent variable being the state of retrieval and the dependent variables being the frequency and duration of fixation. Table 1 and Table 2 present the results. No significant results have been found.

Table 1: Multiple regression results for the prediction on the retention of the brand in advertisements. Block 1, 2 and 3.

	Coefficients				**R^2**
Variables	*B*	*SE B*	β	*p*	
Average frequency fixation	0.024	0.017	0.274	0.176	0.075
Average duration fixation	0.000	0.000	0.209	0.307	0.043

Note. *p <.05 Dependent variable: Average retention on brand.

Table 2: Multiple regression results for the prediction on the retention of the message in advertisements. Block 1, 2 and 3.

	Coefficients				**R^2**
Variables	*B*	*SE B*	β	*P*	
Average frequency fixation	0.005	0.022	0.042	0.840	0.002

Average duration fixation	-4.75E-5	0.000	-0.65	0.754	0.004

Note. *p <.05 Dependent variable: Average retention on message.

Modulation of eye vergence

Firstly, the eye vergence of 'remembered' and 'not remembered' trials are compared by the 120 median data point, which is explained in the above, to see if the two groups are significantly different from each other. Figure 7 shows the simulated modulation of eye vergence for block one, two and three together correlated with brand retention. The bottom simulation shows the significant differences (data points under the dotted line).

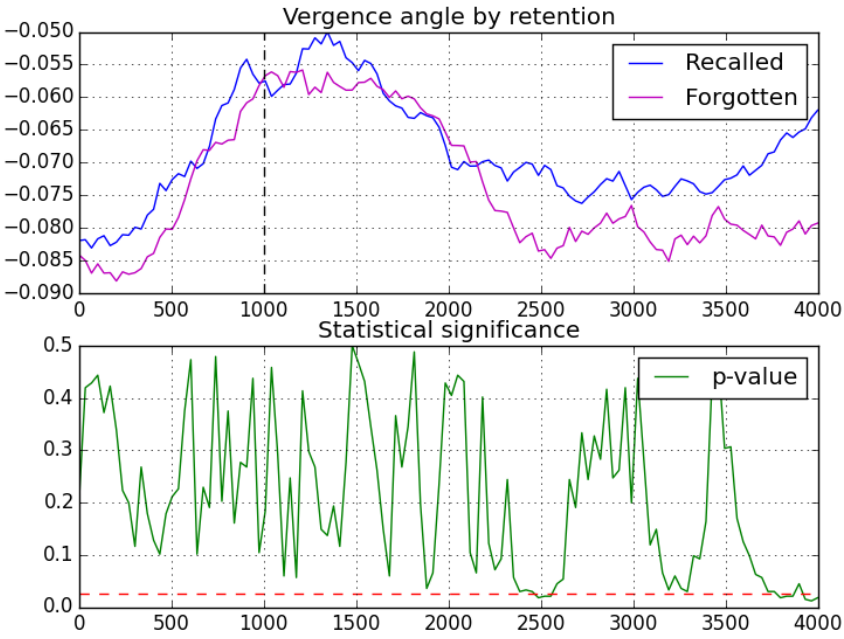

Figure 7: Simulation of the modulation of eye vergence correlated with brand recall for block one, two and three. With the x-axis showing the time (sec) of looking at the advertisements, against the change in modulation (in degrees) on the y-axis. Including the significance simulation (bottom).

When the modulation of eye vergence is correlated with message retention we see a different picture. Figure 8 shows the modulation of eye vergence for all blocks where the line that represents the 'not-remembered' group (forgotten) is higher than the line that represents the 'remembered' (recalled).

The average and maximum modulation have been, same as with the fixation measurements, averaged to one scale, which is possible because of a high Cronbach's alpha

(Average = .987, maximum = .986). Table 5 and 6 show the results of the regression analysis on the three blocks combined with the independent variable state of retrieval and the dependent variables the average and maximum of the modulation of eye vergence.

Table 5: Multiple regression results for the prediction on the retention of the message in advertisements. Block 1, 2 and 3.

	Coefficients				**R^2**
Variables	*B*	*SE B*	β	*p*	
Average modulation of vergence	0.030	0.033	0.187	0.360	0.035
Maximum modulation of eye vergence	0.006	0.031	0.042	0.840	0.002

Note. *p <.05 Dependent variable: Average retention on brand.

Table 6: Multiple regression results for the prediction on the retention of the message in advertisements. Block 1, 2 and 3.

	Coefficients				**R^2**
Variables	*B*	*SE B*	β	*p*	
Average modulation of eye vergence	0.083	0.039	0.400	0.043*	0.160
Maximum modulation of eye vergence	0.067	0.038	0.343	0.086	0.118

Note. *p <.05 Dependent variable: Average retention on message.

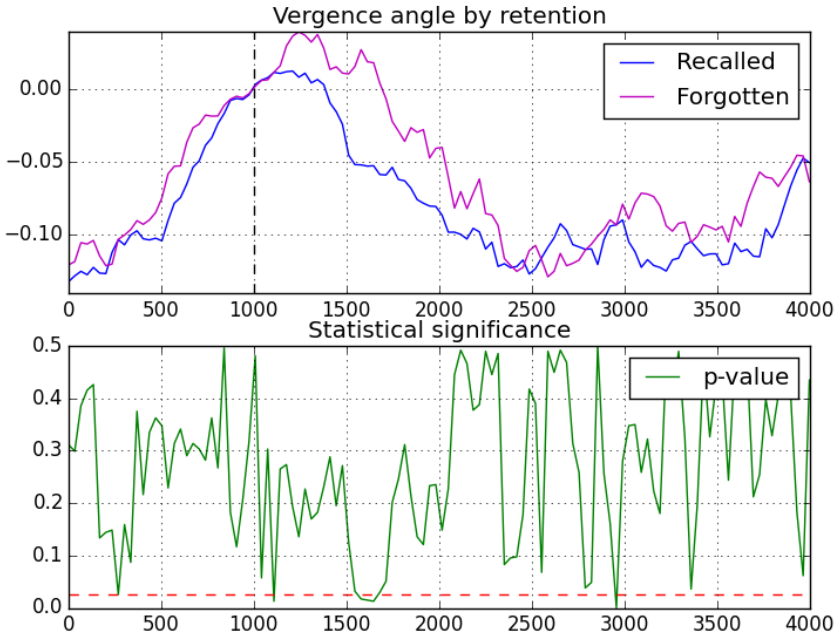

Figure 8: Simulation of the modulation of eye vergence correlating with message recall for block one, two and three. With the x-axis showing the time (sec) of looking at the advertisements, against the change in modulation (in degrees) on the y-axis. Including the significance simulation (bottom).

Manipulation of saliency in advertisement

In de fourth block of the experiment participants were presented with 12 couples of advertisement of which one was manipulated to be less or more salient than the other. Figure 10 presents the results of the modulation of eye vergence responses to salient advertisements and responses to not-salient advertisements. The simulation in the bottom presents the p-value within the 95% acceptance zone. No significant differences have been found.

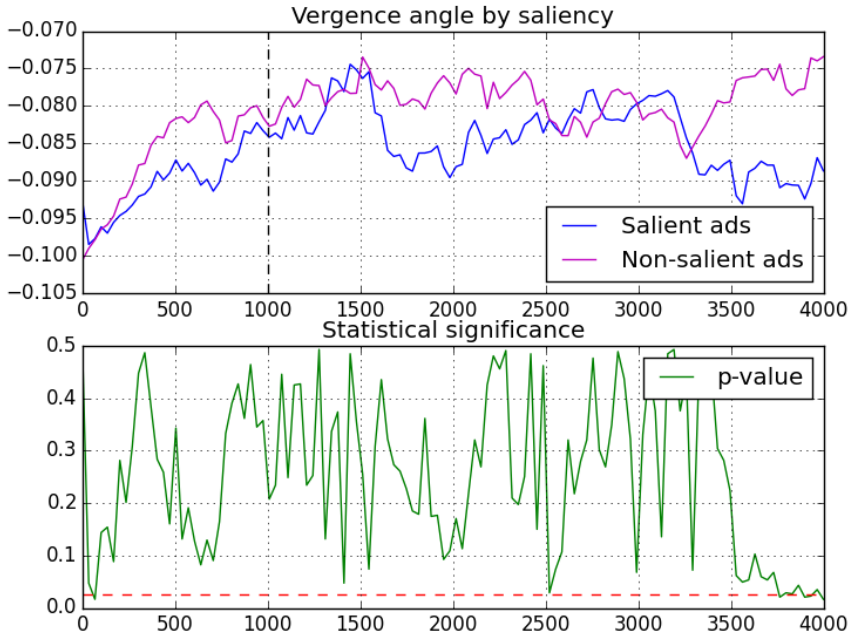

Figure 10: Simulation of the modulation of eye vergence correlating with saliency. With the x-axis showing the time (sec) of looking at the advertisements, against the change in modulation (in degrees) on the y-axis. Including the significance simulation (bottom).

Discussion

In the current study a new eye tracking method was applied, namely the modulation of eye vergence, which, according to recent research, is related to increased attention. The goal of the current study is to investigate if the modulation of eye vergence is a predictor for the retention of brand and message when participants look at advertisements. Furthermore, the goal was to compare this predictor to other predictors (frequency of fixation and duration of fixation). Lastly, the goal was to study if manipulating advertisements would also manipulate the modulation of eye vergence.

The first hypothesis stated that the modulation of eye vergence is a predictor for the retention of the brand and the message in advertisements. The results of the regression analysis show that neither the maximum nor the average eye vergence is a predictor. When the correlation between message retention and the modulation of eye vergence is simulated this shows a result opposite to what is expected. The line ‘forgotten’, which represents the

participants that did not remembered the message, indicates a stronger modulation than when the message is remembered. But, when the correlation between brand retention and modulation of eye vergence for ‘remembered’ and ‘not remembered’ are simulated it does show significant differences.

The second hypothesis states that eye vergence is a better predictor for retention of the brand and the message in advertisement than the total duration and frequency of fixation. Results show that the duration and frequency of fixation do not produce any significant results either. Since both, eye vergence and fixation measurements, do not seem to be predictors neither one of them can be appointed to be better than the other one.

The third hypothesis stated that the modulation of eye vergence could be positively manipulated by increasing the saliency of the advertisement. In the comparison of the modulation of eye vergence when looking at the not-salient advertisement and when looking at the salient advertisement no significant differences have been found. Which is in line with the results on the first hypothesis which shows that the modulation of eye vergence is not a predictor.

In the current study, we have tried to find a predictor for the retention of brand and message from advertisement by using the modulation of eye vergence, which was not successful. Still, the simulations show that, even though the average and maximum eye vergence have no predictive value, there is a significant difference when the modulation of eye vergence is simulated for the retention of brand. This does not apply to the correlation between message retention and the modulation of eye vergence, where the opposite of what is expected is happening. The difference between getting positive results in brand retention and negative results in message retention could be explained by the amount of content that must be remembered. Since brand names usually consist of one or two words this should be easier to remember than a whole sentence containing the message. A notable result that can be found

in the simulation of the correlation between brand and eye vergence is the significant difference at 2500 milliseconds and at the end of the simulation. This could indicate that some cognitive mechanism interacts with the modulation of eye vergence at a specific time but at this moment there is no clear explanation for this.

One reason of the negative results could be the difference in the way of asking the participants to recall information. In the study of Puig (in press) the way of testing the retrieval of images has been done by repeating the images, where participants had to answer with whether they have seen it or not. In the current study the participants had to remember written information. The study of Puig (in press) is based on visual recognition, which might be less prone to forgetting.

Another difference is the length of the experiment. Where the experiment of Puig (in press) used twenty trials, the current study used eighty trials. Since in general eye movement can be affected by fatigue, this might also be a reason that no significant differences have been found. Shorter experiments might deliver more positive results.

The statistical analysis also has its limitations. One of the assumptions of a regression analysis is that the data is independent. For this reason, the variables of frequency of fixation, duration of fixation, average modulation of eye vergence and maximum modulation of eye vergence had to be averaged instead of testing the data per trial. Because of this variance has been lost.

Since the modulation of eye vergence is a new research area it offers many possibilities for further research in many different contexts, including marketing. In this discussion we have limited ourselves to the marketing research field. First of all, the modulation of eye vergence can be applied in many different areas within the marketing sector. The current study focussed on printed advertisement but other visual stimuli like TV commercials, product packaging, websites etc. should be studied because these stimuli can have different

effects on the modulation of eye vergence. Also, the modulation of eye vergence can be applied to radio commercials because attention focussed on sound has similar effects as visual stimulation (Puig, 2013). Also, an interesting and mostly undiscovered topic is the possible effect that top-down influences might have on the modulation of eye vergence. In the studies of Puig et al. (2013, in press) top-down influences are corrected for by using non-affective stimuli. Results were depending on bottom-up stimuli. In the current study, we have corrected for brand familiarity in the first three blocks, but not in the fourth block to make a first step towards a product that can be used in real-life marketing research. Advertisements are affective stimuli because of personal preferences. Personal factors might cause the modulation of eye vergence to increase or decrease. Examples of personal influencers could be: attraction to the advertisement, interest in the product or message, affiliation with the brand, etcetera. To eliminate the possibility of the modulation of eye vergence being influenced by top-down factors future research should take these possibilities in mind.

Also, in further research the limitations described above should be considered. Several ways of recalling should be tested to see if other kinds of memory do correlate with the modulation of eye vergence. Also, studies should focus on the optimal time or number (less vs. fewer) of stimuli to present to participants. Lastly and most importantly, a better predictor or a better statistical analysis should be found.

Advertisers are constantly looking for a way to test the effectiveness of the advertisements they show to their consumers. The modulation of eye vergence has the potential to be a great objective measurement to see how potentional costumers react to specific advertisements but since it is such a new measurement which has barely been researched a lot more studies must be performed to research the exact correlation it has with increased attention.

References

Barnhart, A. S., & Goldinger, S. D. (2014). Blinded by magic: Eye-movements reveal the misdirection of attention. *Frontiers in psychology, 5*(1461), 1-9. doi: 10.3389/fpsyg.2014.01461

Basil, M.D. (1994) Multiple resource theory I: Application to TV. *Communication research, 21* (2), 177–207.

Broadbent, D. E. (1958) *Perception and communication.* London: Pergamon Press.

Beanland, V., & Pammer, K. (2010). Looking without seeing or seeing without looking? Eye movements in sustained inattentional blindness. *Vision Research, 50*, 977-988. doi:10.1016/j.visres.2010.02.024

Belch, G. E., & Belch, M. A. (2001) *Advertising & promotion: An integrated communications perspective,* 5th ed. Boston, MA: McGraw-Hill Irwin.

Bottomley, P.A., & Doyle, J.R. (2006) The interactive effects of colors and products on perceptions of brand logo. *Sage Publications, 6* (1), 63-83.

Deutsch, J. A., & Deutsch, D. (1963) Attention, some theoretical considerations. *Psychological Review, 70*, 80-90.

Duchowski, A. T. (2002) A Breath-first survey of eye-tracking applications. *Behavior Research Methods, Instruments, and Computers, 34*(4), 455-470.

Gray, P. (2007) *Psychology.* United States of America: Worth Publishers.

Higgins, E., Leinenger, M., & Rayner, K. (2014) Eye movements when viewing advertisements. *Frontiers in PSYCHOLOGY, 5.* doi: 10.3389/fpsyg.2014.00210

Kroeber-Riel, W. (1979) Activation research: Psychobiological approaches in consumer research. *Journal of Consumer Research, 5*, 240-250.

Kuhn, G., & Findlay, J.M. (2010) Misdirection, attention and awareness: Inattentional blindness reveals temporal relationship between eye movements and visual awareness. *The Quarterly Journal of Experimental Psychology, 63:1,* 136-146, DOI: 10.1080/17470210902846757

Kuisma, J., Simola, J., Uusitalo, L., & Öörni, A. (2010). The effects of animation and format on the perception and memory of online advertising. *Journal of Interactive Marketing, 24,* 269-282. doi:10.1016/j.intmar.2010.07.002

Lee, J., & Ahn, J. (2012) Attention to banner ads and their effectiveness: An eye-tracking approach. *International Journal of Electronic Commerce, 17,* 119-137.

Leven, W. (1991) Blickverhalten von konsumenten: Grundlagen, messung und anwendung in der werbeforschung. Heidelberg: Physica-Verlag.

Malhotra, N. K. (2008). *Review of Marketing Research*. New York, NY: M. E. Shape, Inc.

Nixon, H. K. (1924) Attention and interest in advertising. *Archives of Psychology, 72,* 5-67.

Norman, D. A. (1968) Toward a theory of memory and attention. *Psychological Review, 75,* 522-536.

Palermo, R., & Rhodes, G. (2007) Are you always on my mind? A review of how face perception and attention interact. *Neuropsychologia, 45,* 75-92.

Pappas, J. M., Fishel, S. R., Moss, J. D., Hicks, J. M., & Leech, T. D. (2005). An eye-tracking approach to inattentional blindness. *Proceedings of the human factors and ergonomics society 49th annual meeting, 49* (17), 1658-1662. doi:10.1177/154193120504901734.

Pieters, R., & Warlop, L. (1999) Visual attention during brand choice: The impact of time pressure and task motivation. *International Journal of Research in Marketing 16,* 1-17.

Pieters, R., Warlop, L., & Wedel, M. (2002) Breaking through the clutter: Benefits of

advertisement originality and familiarity for brand attention and memory. *Management Science, 48* (6), 765-781.

Pieters, R., & Wedel, M. (2004) Attention capture and transfer in advertising: Brand, pictorial, and text-Size Effects. *Journal of Marketing, 68,* 36-50.

Puig, M. S., Zapata, L. P., Aznar-Casanova, A., & Supèr, H. (2013). A role of eye vergence in covert attention. *Plos One, 8*(1), 1-10.

Purucker, C., Landwehr, J. R., Sprott, D. E., & Herrmann, A. (2014). Clustered insights improving eye tracking data analysis using scan statistics. *International Journal of Market Research, 55* (1), 105-130. doi: 10.2501/IJMR-2013-009

Rayner, K., Rotello, K. M., Steward, A. J. Keir, J. & Duffy, S. A. (2001) Integrating text and pictorial information: Eye movements when looking at print advertisements. *Journal of Experimental Psychology: Applied 7* (1), 219-226.

Rosbergen, E., Pieters, R., & Wedel, M. (1997) Visual attention to advertising: A segment-level analysis. *Journal of consumer research, 24,* 305-314.

Russo, J. E. (1978) Eye fixations can save the world: A critical evaluation and a comparison between eye fixations and other information processing methodologies. *Advances in Consumer Research,* 561-570.

Simons, D.J., & Chabris, C. F. (1999) Gorillas in our midst: sustained inattentional blindness for dynamic events. *Perception, 28,* 1056-1074.

Samu, S., & Krishnan, S. (2009) Brand related information as context: The impact of brand name characteristics on memory and choice. *Academy of Marketing Science, 38,* 456-470.

Tellis, G. J., & Ambler, T. (2007) *The SAGE handbook of advertising.* London: Sage Publications.

Treisman, A.M. (1960) Contextual cues in selective listening. *Quarterly Journal of Experimental Psychology, 12,* 242-248.

Treistman, J., & Gregg, J. P. (1979) Visual, verbal, and sales responses to print ads. *Journal of Advertising Research, 19* (4), 41-47.

Underwood, G. D. M., Chapman, P., Bowden, K., & Crundall, D. (2002) Visual search while driving: Skill and awareness during inspection of the scene. *Transportation Research Part F, 5*, 87-97.

Underwood, G. D. M. (2005) *Cognitive processes in eye guidance*. Oxford: Oxford University Press.

Wedel, M., & Pieters, R. (2000) Eye fixations on advertisements and memory for brands: A model and findings. *Marketing Sci., 19* (1), 297–312.

Witt, D. (1977) Emotional advertising: The relationship between eye-movement patterns and memory – emperical study with the eye-movement monitor. Ph.D. University of Saarland. Described in Kroeber-Riel 1979.

Xu, M., & Zhang, H. (2015) Saliency detection with color contrast based on boundary information and neighbors. *Vis Comput, 31*, 355-364.

Zhao, Q., Yuan, X., Tu, D., & Lu, J. (2015). Eye moving behaviors identification for gaze tracking interaction. *J Multimodal User Interfaces, 9*, 89-104. doi:10.1037/xhp0000062

Appendix A: Timeline experiment

Block 1 Advertisement (random)		**Block 2** Advertisement (random)		**Block 3** Advertisement (random)		**Block 4** Advertisement (random)	
1	4 sec	16	4 sec	31	4 sec	46	4 sec
2	4 sec	17	4 sec	32	4 sec	47	4 sec
3	4 sec	18	4 sec	33	4 sec	48	4 sec
4	4 sec	19	4 sec	34	4 sec	49	4 sec
5	4 sec	20	4 sec	35	4 sec	50	4 sec
6	4 sec	21	4 sec	36	4 sec	51	4 sec
7	4 sec	22	4 sec	37	4 sec	52	4 sec
8	4 sec	23	4 sec	38	4 sec	53	4 sec
9	4 sec	24	4 sec	39	4 sec	54	4 sec
10	4 sec	25	4 sec	40	4 sec	55	4 sec
11	4 sec	26	4 sec	41	4 sec	56	4 sec
12	4 sec	27	4 sec	42	4 sec	57	4 sec
13	4 sec	28	4 sec	43	4 sec	58	4 sec
14	4 sec	29	4 sec	44	4 sec	59	4 sec
15	4 sec	30	4 sec	45	4 sec	60	4 sec
Survey	00.05.00	Survey	00.05.00	Survey	00.05.00	61	4 sec
Time Total	00.06.00	Time Total	00.06.00	Time Total	00.06.00	62	4 sec
						63	4 sec
						64	4 sec
						65	4 sec
						66	4 sec
						67	4 sec
						68	4 sec
						69	4 sec
						70	4 sec
						71	4 sec
						72	4 sec
						73	4 sec
						74	4 sec
						75	4 sec
						76	4 sec
						77	4 sec
						78	4 sec

Timeline	
Calibration	00.10.00
Block 1	00.06.00
Block 2	00.06.00
Block 3	00.06.00
Block 4	00.02.20
Total	**00.30.00**

79	4 sec
80	4 sec
Time total	00.02.20

Appendix C: Examples of advertisements used in the experiment