Web Banner Influences on Recall and Recognition: A Neuromarketing Perspective

MSc Business Administration - Strategic Marketing & Business Information

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Abstract

Purpose: The purpose of this study was to examine web banner influences on memory.

Methodology: Participants had to complete a questionnaire before a facial detection test with fixed and dynamic web banners started. Thirty one people were grouped into a fixed or dynamic web banner condition. Afterwards they had to complete a questionnaire about personal preferences before they were instructed to look at a screen that displayed web banners while a facial detection device measured facial expressions. After the web banner display, a yes/no recognition task and recall test followed.

Findings: No difference between dynamic and fixed web banners was discovered for recognition. However, a significant difference between the two banner types for recall was found. Against predictions, negative and positive valence did not significantly influence recall and recognition performance. Friend recommendations and brand familiarity had a significant influence on recall.

Practical Implications: As dynamic web banner are better recalled, they should be used when targeting consumers who have to make fast decisions between low involvement products as those banners increase the likelihood that a certain brand gets to the top of the mind. Moreover, marketing departments and agencies should mainly penetrate relevant internet channels to increase brand familiarity of people who did not get in touch with a certain brand. As banner duration and animation rate have no influence on memory performance, long durations and high animation rates should be renounced to reduce costs while keeping the same memory effects.

Originality: To the best of the authors' knowledge, no research used so many web banners to assess differences between dynamic and fixed web banners. Additionally, no research used neuro marketing techniques to assess valence measures evoked by web banners.

Keywords: Neuromarketing, Web Banner, Recall, Recognition, Valence, Personal Preferences

Paper Category: Research Paper

Contents

Statement of Original Authorship

I declare that the materials contained in this thesis are my own work. Where the works of others have been drawn upon, whether published or unpublished (such as books, articles, or non-book materials in the form of video and audio recordings, electronic publications and the internet) due acknowledgements according to appropriate academic conventions have been given. I also hereby declare that the materials contained in this thesis have not been published before or presented for another program or degree in any university. In addition, I took reasonable care to ensure that the work is original, and, to the best of my knowledge, does not breach copyright law, and has not been taken from other sources except where such work has been cited and acknowledged within the text.

1. Introduction

Online advertisements gained more importance during the last years. In 2016, online advertising revenues reached a new record with $72.5 billion which is an increase of $12.9 billion (21,8%) in comparison to 2015 (PWC, 2017). Web banners, which are “on-line advertising space(s) that typically consists of a combination of graphic and textual content and contain an internal link to target ad pages (the advertiser’s information on the host site) or an external link to the advertiser’s Web site via a click through URL” (Chatterjee, 2005, p51), accounted for 31% of the total revenue ($22.6 billion) in 2016. Hussain, Sweeney & Mort (2010), researched advertisement typologies and identified two main categories – static and pop-up banner categories (*see Table 1*). Static ads do not move on a web page, pop-ups appear in a new tab or browser window. The most commonly used category is static ads, more specifically fixed, animated and dynamic ones (Hussain, Sweeney & Mort, 2010). Fixed ads consist of one image file (e.g. JPEG, GIF) and do not move nor change its content. Animated ads, on the other hand, consist of two or more image files which are rapidly shown after each other. Furthermore, dynamic banners are e.g. video-, java- and flash data that have graphic movements and sometimes auditory information included (Hussain, Sweeney & Mort, 2010).

Table 1a – Categories and Items of Banner Advertisement Types: Source: Hussain, Sweeney & Mort (2010)

Table 1 Categories and Items of Banner Advertisement Types

Banner Categories	Items
Static	Fixed
	Animated
	Dynamic
	Rotated
Pop-Up	Fixed
	Animated
	Dynamic
	Rotated
	Pop-Under
Other	

Researchers argued that web banner categories have little or no impact on memory. As web banners are embedded in websites, the online behavior of internet users is important to consider. A study by Pagendarm & Schaumburg (2001) found two navigation styles web users follow, when browsing in the internet – “aimless browsing” and “goal-directed searching”. Hamborg, Bruns, Ollermann & Kaspar (2012), based on Pagendarm’s findings concluded that web banners have little or no impact on memory if users are in a goal-directed mode. A reason for that could be a more effective website processing, especially for internet experts who have experience surfing in the internet (Drèze & Husshерr, 2003). Eventually, most marketers and marketing researchers accepted the idea that web banners have little impact on internet user’s memory formation due to the fact that internet users are mainly in a goal-directed mode when browsing. Thus memory effects of web banners were neglected widely. Nevertheless, in research on visual perception, Bouma (1970; 1978) and Estes (1978) found that within a visual display, target search difficulty increases if a specific target is closely surrounded by distractors. The closer a target was located to distractors, the worse the reaction time and the proportion of errors became in those studies. Kahneman, Treisman & Burkell (1983) added that search difficulty became even worse if a target was surrounded by irrelevant distractors. Based on that, Van der Lubbe & Keuss (2001) concluded that distractors claim attention and thus limit target processing. This phenomenon is called attentional masking. In other words, even though internet users are in a goal-directed searching mode, they unconsciously attend, process and thus store information (e.g., web banners). In addition to attentional masking, the mere exposure effect, which describes the human tendency to “develop preferences for things merely because they have become familiar with them” (Kindermann, 2016, p.418), is another argument to take possible memory effects of web banners into account. This effect is believed to reduce uncertainty of a previously encountered stimulus (Lee, 2001). Therefore, the issue of neglect of memory effects among web banners should be reconsidered and effects of different web banner types should be examined. Moreover, variables influencing memory in the setting of web banners should be identified and their impact evaluated. The aim of this research is to examine web banner influences on memory. Subsequently, influencing factors for memory were elaborated. For this research, especially those variables with low past research focus or past conflicting results were considered. The research question this thesis aims to answer is:

How is memory performance influenced by web banner characteristics?

The following paragraph provides the reader with a brief overview of questions that connects to this studies' research question. First, this study examined memory performance differences among fixed and dynamic web banner, as those are the two most common types of banners. As there might be an influence of animation rate and banner duration, the study measured possible differences, as well. Moreover, valence, brand familiarity, brand preference and friend recommendations in relation to a web banners' brand were seen as web banner characteristics that might influence memory performance. Therefore, this study delivered an answer to the question whether or not those variables influence memory performance.

2. Theoretical Background

2.1. Memory

In this study, the influence of web banners on episodic memory was investigated. In short, this part of long-term memory can be classified as the process by which information about experienced events is encoded, consolidated and retrieved (Daumas, Halley, Francés & Lassalle, 2005; Wilson & Criss, 2017). Encoding is the process of perceiving and the creation of a corresponding trace of an event or object (Tulving & Thomson, 1973). Consolidation "is the progressive post-acquisition stabilization of long-term memory" (Dudai, 2004, p. 51). In other words, consolidation alters and strengthens memories for the long-term memory. Retrieval "completes the act of remembering" (Tulving & Thomson, 1973, p. 352) by retrieving information from memory. This study investigated web banner and brand retrieval with recognition and free recall, respectively. Recall is related to a consumer's ability to retrieve previously learned information that was kept in memory (Keller, 1993; Reber & Reber, 2001) and can be measured as response probability, as Khana (1996) and Klein, Addis & Khana (2005) showed. Recognition on the other hand, measures the awareness that an object/event was previously perceived or taught (Reber & Reber, 2001). Stanislaw & Todorov (1999) proposed two measures for a yes/no task recognition tests: sensitivity and response bias. Recognition tests expose subjects to multiple signals and noise, thus solely measuring hit rates may not be enough as variations between two conditions could be related to sensitivity, response bias, or both. Stanislaw & Todorov (1999) explained that sensitivity measures the distance between the mean of the signal distribution and the mean of the noise distribution. This study used *d'* to describe subjects' sensitivity towards the recognition test. Moreover, Stanislaw & Todorov (1999) classified response bias as the favor to rate for either yes or no. This study used *c* as response bias as it stays unaffected by changes in *d'*. It basically is the distance between criterion and the neutral point where no answer is favored.

The following paragraphs covers several influential factors that may impact memory processes in the context of web banner advertisement. Although attention is not directly linked to memory processes, research suggested a high correlation between the two variables as attention is required for encoding information. High attention correlates with high memorability, as Yoo & Kim (2005) stated. Thus, this section will incorporate attention as linkage to memory. The first factor is web banner size.

2.2. Size & Design

Visual perception research found that stimulus size influences automatic attentional selection (Mizzi & Michael, 2016). In other words, salient stimuli trigger our attention automatically. In line with visual perception studies, research in the marketing domain argued that ad size has significant impact on memorability. Based on recall and recognition tests, Homer (1995) and Tayebi (2010) found in a study with non-online advertisements that ad size leads to enhanced memory. Therefore, a study design with equal banner sizes is important to gain valid results. Researchers determined multiple design elements of advertisements and web banners and its effects on attention. Research has found that most pictorial messages lead to increased memory performance (Edell & Staelin, 1983). Those findings support the "picture superiority-effect" (Lutz & Lutz, 1977), which states that pictorial messages with text are better memorized than text messages (Edell & Staelin, 1983). Consistent with those findings, images of humans (Bakar, Desa, & Mustafa, 2015), especially human faces have the ability to attract a user's attention rapidly (Bruce, Cowey, Ellis & Perrett, 1992; Young 1998; Cerf, Frady & Koch, 2009). Faces are processed and recognized faster and more accurately than other visual stimuli (Bruce & Young, 1986). The processing of faces can be even increased by adding emotional cues to it (Öhman, Lundqvist & Esteves, 2001). Faces of celebrities, according to Bakar, Desa, & Mustafa (2015), influence attention positively. However, Pieters, Wedel and Batra (2010) found in their study that high image complexity has a negative impact on attention. Additionally, ads with landscapes deliver poor recall rates thus decreasing memorability (Kuisma, Simola, Uusitalo & Öörni, 2010).

2.3. Shape & Language

A few studies about web banner shape were conducted. Banner shapes are characterized as length x height in pixels (px). Depending on the ratio of length and height, web banners can be a square (length = height), rectangle (length > height) or a so called skyscraper (length < height). Skyscraper banners, thus vertical ones, deliver higher liking results (Burns & Lutz, 2006), which might lead to an increased effect on memory (Aaker, Batra & Myers, 1992). Drèze X. & Hussherr F. (2003) found a weak difference in recall tests, favoring vertical banners over horizontal ones. A study of Flores, Chen & Ross (2013) revealed significant influence of language on perception. In their study, participants were shown different banners with English and Thai language content. Results showed that advertisers should carefully decide for which language they choose as humans mostly prefer their local language in web banners.

2.4. Location

Past research about the location of banners agreed on a positive influence of top web page positions on recognition. In line with those findings, Bernard (2001) and Hussain, Sweeney & Mort (2010) found banners located at the top of a web page are more easily recognized than those placed in the center. Janiszewski (1990) was one of the pioneers proposing processing differences in the brain's hemispheric lobes. Left hemisphere processes all stimuli from the right visual field whereas the right hemisphere processes all stimuli from the left visual field. Both hemispheres have different strengths and thus are better in processing stimuli of different types. Our left hemisphere has been described as unit-integrative that recognizes individual units and merges those (Ryu, Lim, Tan, & Han, 2007). Moreover, left hemisphere handles letters and words while being orally oriented (Ryu, Lim, Tan, & Han, 2007; Janiszewski, 1990). The right hemisphere, appears to be holistically oriented, handling pictorial, geometrical and non-verbal information (Ryu, Lim, Tan, & Han, 2007).

2.5. Duration

Literature about ad duration and its effects on memory found that long exposure to ads leads to increased memory performance. Important to note is that duration is a factor related to dynamic web banners as fixed ones do not have a duration. The longer a consumer is exposed to an ad, the more likely the stimulus will be remembered (Krugman, Cameron, & White, 1995). Those results were confirmed in 2003 by Danaher & Mullarkey who did a recognition and recall study with students. He found a difference in recall and recognition tests among the student sample with recognition rates being higher than recall rates. Contrary, Lin and Chen (2009), had controversial results for duration effects. They found that depending on the location of a website, duration effects on memory differ.

2.6. Animation

One of the most researched components of web banners is animation. Motion is considered to be of critical value for ads (Rieber, 1991). Research in the field of motion proposed that human beings have a preference for moving objects, thus consumers pay more attention towards a stimuli and process more information (Sundar, Kalyanaraman, Martin & Wagner, 2001). In the specific field of web banners, animation effects on recall and recognition are rather controversial ranging from a positive, to neutral and negative impact. Between the two memory measures of recall and recognition, researchers found differences and similarities.

Bayles (2002) found no correlation between animation and recall but a positive impact for recognition. Drèze & Hussherr (2003), Hong, Thong & Tam (2004) came to a similar conclusion that animation has neither a positive impact on recognition nor on recall. Burke et al. (2005) did a research, using 100 ads resulting in better recognition rates for fixed banners. Adding up to the findings, Lee & Ahn (2012) stated that animation in dynamic banners gains less attention than fixed banners but also reduced the positive affect attention has on recognition.

On the other hand, Yoo, Kim & Stout (2003), Yoo & Kim (2005), Nokon, Sundar & Chaturvedi (2001) and Li, Huang & Bente (2015) suggested a positive influence of animation and animation speed on attention. However, no effect on recall was discovered. In line with Yoo and Kim (2005), other researchers found similar results, favoring dynamic over fixed web banners, as animation yielded links to attention (e.g. Borse & Lang, 2000; Sundar, Narayan, Obregon, & Uppal, 1998; Yoo, Kim, & Stout, 2004). In 1999, Li and Bukovac found that animated banner ads resulted in better recall rates than non-animated banners, contrary to Yoo & Kim (2005). In case users are in an aimless browsing mode, animation is believed to gain users attention more easily (Hamborg, Bruns, Ollermann & Kaspar, 2012). Yoo & Kim (2005) and Kuisma, Simola, Uusitalo & Öörni (2010) came to the conclusion that animation increases attention which in turn might influence memory.

2.7. Valence

Researchers distinguish between two basic emotional dimensions – arousal and valence. Arousal describes how exciting or calming a certain stimulus is. Valence on the other hand describes stimuli in terms of positive, neutral and negative feelings (Adelman & Estes, 2012). Similar, Juvina, Larue & Hough (2017) characterized valence as the intrinsic attractiveness or averseness of an event, object or situation. In order to keep research design simple and controllable, arousal is not taken into account in this study.

Literature on valence revealed statistically influencing effects on memory (Graves, Landis & Goodglass, 1981; Cahill & McGaugh, 1995; Nagae & Moscovitch, 2002; Denburg, Buchanan, Tranel, & Adolphs, 2003; Adelman & Estes, 2012). Cahill & McGaugh (1995) performed a memory research with young adults and found significant influence of valence on memory processing. Denburg, Buchanan, Tranel, & Adolphs (2003) executed a similar study focusing on old adults with the same outcome. Both studies implied that positive and negative valence increase memory performance. Jennifer, Tomaszczyk, Fernandes & MacLeod (2008) did a similar study with young and old people and got a similar result. However, they found more in-depth results indicating that young adults are more likely to recall stimuli that evoked negative valence while older adults recalled more stimuli that evoked positive valence. In line with Denburg, Buchanan, Tranel, & Adolphs (2003) and Cahill & McGaugh (1995), Adelmann & Estes (2012) and Meng, Zhang, Liu, Ding, Li, Yang & Yuan (2017) found that extreme valence values (positive and negative) increase recognition rates. They concluded, based on their study that positive and negative stimuli work better than neutral ones while no evidence was found for superiority of negative stimuli. Mneimne, Powers, Walton, Kosson and Fonda (2010) found in their study about valence effects on memory that stimuli evoking positive valence lead to better results in both, recall and recognition. Stimuli that evoked negative valence were second best while neutral stimuli performed worst in this study setting.

2.8. Personal Preferences

As memory might be influenced by personal preferences, this study also takes those into account. This study splits personal preferences into brand familiarity, brand preference and brand recommendations. Nevertheless, all three variables will be treated as separate parts in the analysis. Huang, Lin & Chiang (2008) found in their study that color preference significantly affects recall accuracy. In their study they asked subjects to indicate their preference before they had to memorize a number of brand logos. Accuracy for high color preference was significantly greater than that for low preferences. Related to brand preference is brand familiarity. It was decided that consumers can only prefer brands if brand familiarity is given. The mere exposure effect, which is related to brand familiarity could positively influence memory processes. If a person is familiar with a certain brand, this increases preference which in turn could lead to increased memory performance. Furthermore, recommendations are considered as priming. According to Stark, Gordon & Stark (2008), priming is associated with a decrease in recall and recognition performance. However, their results did not reveal in significant results.

Past research in the field of memory studied the effects of advertisement size (Homer, 1995; Tayebi, 2010), advertisement design (Edell & Staelin, 1983; Bruce & Young, 1986; Bakar, Desa, & Mustafa, 2015), web banner shape (Aaker, Batra & Myers, 1992; Drèze & Hussherr, 2003; Burns & Lutz, 2006), web banner language (Flores, Chen & Ross, 2013), web banner location (Janiszewski, 1990; Ryu, Lim, Tan, & Han, 2007; Hussain, Sweeney & Mort, 2010), ad duration (Krugman, Cameron, & White, 1995; Danaher & Mullarkey, 2003), web banner animation (Bayles, 2002; Drèze & Hussherr,2003; Yoo, Kim & Stout, 2003; Hong, Thong & Tam, 2004; Yoo and Kim, 2005; Hamborg, Bruns, Ollermann & Kaspar, 2012) and emotion (Graves, Landis & Goodglass, 1981; Cahill & McGaugh, 1995; Nagae & Moscovitch, 2002; Denburg, Buchanan, Tranel, & Adolphs, 2003; Adelman & Estes, 2012). So far, no recall and recognition test, combined in one study, containing many participants and web banners was accomplished before. Another novelty is that neuro marketing tools are used to measure valence. The advantages of those tools are that they measure direct or indirect brain responses that are less likely to be controlled by participants. Thus, data could be more reliable as those tools measure brain instead of behavior responses. To the best of the authors' knowledge, only valence questionnaire test containing different Likert-Scales were used to assess valence. In fact, asking participants to rate their own feelings might yield in biased results as not all participants are able to assess their own emotions. Additionally, humans tend to answer socially acceptable which is another obstacle of the valence questionnaires. Another novelty is that web banner valence is researched. No study attempted to measure valence and memory in a web banner setting. Moreover, brand familiarity, brand preference and brand recommendations (together in this research called personal preference) in relation to memory performance within the context of web banners were not studied so far.

2.9. Hypothesis Development

In order to find out how web banners influence memory, recall and recognition were tested. As prior research provided conflicting results with regard to recall and recognition of web banner types, it was not clear what to expect from results. Although Yoo & Kim (2005) suggested that dynamic banners do not increase recall performance, they argued that animation increases attention and thus recall and recognition. Kuisma, Simola, Uusitalo & Öörni (2010) found similar results, postulating increased attention due to dynamic web banners. As stated above, attention is the fundament for information encoding, high attention yields in better memory processes. Li and Bukovac (1999), found positive influence of animation on recall. Rieber (1991) performed a more general study on motion concluded that humans prefer moving objects and thus pay more attention to them. Therefore, it is hypothesized that increased attention is linked to increased memory capability, more specifically recall and d' are expected to be significantly different between dynamic banners than for fixed ones, favoring dynamic web banners.

H_1: There is significant difference between dynamic and fixed web banners with regard to recall and d', favoring dynamic web banners.

In order to test for the influence of the previously mentioned factors of positive, negative and neutral valence, the following hypothesis were developed. Given the literature, especially Mneimne, Powers, Walton, Kosson and Fonda (2010), positive valence have significant positive influence on recall and d'. According to Cahill & McGaugh (1995), Denburg, Buchanan, Tranel, & Adolphs (2003), Adelmann &

Estes (2012) and Meng, Zhang, Liu, Ding, Li, Yang & Yuan (2017), negative valence has significant positive influence on memory. Therefore, significant positive influence of negative valence on recall and d' was postulated.

H_2: Positive and negative valence have a significant positive influence on recall and d'.

Mneimne, Powers, Walton, Kosson and Fonda (2010) found that neutral valence has no significant effect on memory. Therefore, it was hypothesized that neutral valence has no significant influence on recall and d'.

H_3: Neutral valence have no significant influence on recall and d'.

Having in mind the mere exposure effect mentioned by Kindermann (2016), brand familiarity increases preferences, which in turn might increases recall and d'. Huang, Lin & Chiang (2008) found, preferences can influence memory processes. Therefore, it was postulated that brand familiarity and brand preferences have significant positive effects on recall and d'.

H_4: Brand Familiarity and brand preferences have a significant positive influence on recall and d'.

As other people have influence on our behavior, their recommendations might influence our memory processes as well. Having in mind Stark, Gordon & Stark (2008), who found that priming (which is related to recommendations) decreases recall and recognition performance, it was assumed that friend recommendations have significant negative influence on recall and d'.

H_5: Friend recommendations have a significant negative influence on recall and d'.

Yoo, Kim & Stout (2003), Yoo & Kim (2005), Nokon, Sundar & Chaturvedi (2001) and Li, Huang & Bente (2015) found positive influence of animation speed on attention. Therefore, it is possible that memory processes will be influenced positively, as well. Thus, the hypothesis is that recall is significantly positive influenced by a higher animation rate. As all fixed banner are per se not moving, this hypothesis applies only for dynamic banners.

H_6: There is significant difference between high animation rate and low animation rate of web banners with regard to recall, favoring high animation rates.

Furthermore, Krugman, Cameron, & White (1995) proposed the longer a subject is exposed to an ad, the higher the recall rates are. As all fixed banner are have a fixed duration, this hypothesis applies only for dynamic banners.

H_7: There is significant difference between long duration and short duration of web banners with regard to recall, favoring long duration dynamic web banners.

Table 2_a provides a summary of all hypothesis in practical and statistical followed by a variable expression.

Table 2$_a$ – Summary Hypothesis

H Number		Hypothesis in Words
H_1	*Practical Words*	There is significant difference between dynamic and fixed web banners with regard to recall and d', favoring dynamic web banners.
	Statistical Words	The means of recall between dynamic and fixed conditions are not equal
	Variables	$H_a = \mu_1 \neq \mu_2$
H_2	*Practical Words*	Positive and negative valence have a significant positive influence on recall and d'.
	Statistical Words	The slope of the regression line is not equal to zero.
	Variables	H_a: $B_1 \neq 0$
H_3	*Practical Words*	Neutral valence have no significant influence on recall and d'.
	Statistical Words	The slope of the regression line is equal to zero.
	Variables	H_0: $B_1 = 0$
H_4	*Practical Words*	Brand Familiarity and brand preference have a significant positive influence on recall and d'.
	Statistical Words	The slope of the regression line is not equal to zero.
	Variables	H_a: $B_1 \neq 0$
H_5	*Practical Words*	Friend recommendations have a significant negative influence on recall and d'.
	Statistical Words	The slope of the regression line is not equal to zero.
	Variables	H_a: $B_1 \neq 0$
H_6	*Practical Words*	There is significant difference between high animation rate and low animation rate of web banners with regard to recall.
	Statistical Words	The means of recall probability between high and low animation rate are not equal
	Variables	$H_a = \mu_1 \neq \mu_2$
H_7	*Practical Words*	There is significant difference between long duration and short duration of web banners with regard to recall.
	Statistical Words	The means of recall probability between long and short duration are not equal
	Variables	$H_a = \mu_1 \neq \mu_2$

3. Methods

3.1. Ethics

To comply with current ethical restrictions and considerations, this research was approved by the BMS Ethics Committee (University of Twente), after assessing the ethical standards for this study. The BMS Faculty acts according to the Dutch code of ethics for research in the social and behavioral sciences. To comply with the Dutch code, all participants were informed about the hosting university, the research's purpose/aims/goals, the researcher, demands on participants (meetings, manipulation phase and duration) and confidential information processing in plain. Additionally, all participants got a form where their rights were outlined. Those rights contained withdrawing from this research without any need to explain why. If participants decided to stop participating, their data had to be deleted unless, their data could not be withdrawn/extracted from the wider sample of collected data and information. As a linkage between participant names and cannot be drawn, anonymization was guaranteed.

3.2. Independent Variable Operationalization

3.2.1. Ad Duration & Animation Rate

Ad duration was determined as the number of seconds from the beginning till the end of a dynamic banner. Ad duration was acquired via estimations as precise measurements were not possible. It is measured in seconds while leaving out milliseconds. Animation rate is the number of movements of a web banner divided by ad duration. Number of movements was calculated by manually counting each object or human being that changed position or moved from one place to another. If an object, text or human being moved, appeared or disappeared within an ad, this was counted as one movement.

3.2.2. Valence

This research attempted to measure valence with facial encoding (with iMotions software) instead of a traditional valence questionnaire. The device used for that will be explained in the apparatus section of this chapter. As this paper does not want to solely rely on findings from new technologies, a traditional valence questionnaire to examine and validate facial encoding outcomes of valence was conducted additionally. This validation, serves as indication of the facial encoding system's validity. However, differences in the two measurement methods are expected, as human beings usually have difficulties assessing and communicating their own feelings and emotions towards events, objects and situations.

3.2.3. Personal Preferences

Personal preferences refer to individual desire that varies from person to person. For instance a person might be about to prepare his/her garden for summer. Due to prior experiences, certain preferences within a person could exist. Therefore, personal preferences were divided into brand familiarity, brand preference and recommendations (by friends). In order to test for personal preferences, all banners were analyzed and categorized according to their brand. Based on banner categorization, a questionnaire was developed to identify each subjects' ratings for the named personal preferences variables. In the analysis, all variables were analyzed separately as it is not a tested construct.

3.2.4. Web banner type

Following the categorization and observations made by Hussain, Sweeney & Mort (2010), the most frequently used banner types were used in this study. Those types were static dynamic and static fixed web banners. As previously explained, fixed ads consist of one image file (e.g. JPEG, GIF) and do not move nor change its content, whereas dynamic banners are e.g. video-, java- and flash data that have graphic movements and sometimes auditory information included (Hussain, Sweeney & Mort, 2010).

3.3. Stimuli Collection

Over 250 randomly selected companies were approached and asked for their interest in participating in this research. Many approached companies did not want to reveal their web banners due to possible data infringements. In total 50 companies provided their web banners for this study. Unknown brands were prioritized as famous brands would have increased the number of influencing factors. In order to keep data collection conditions controlled, unknown and unpopular brands were selected.

3.4. Participants

3.4.1. Test Phase

In total, 40 subjects participated in the traditional valence questionnaire. 60% of all subject were male while 40% were female. The mean age was 27.7 years with a standard deviation of 7.67, ranging from 18 to 54 years. Overall, most of the subjects were German (50%) and Dutch (30%). Furthermore, there were 5% Italian and Turkish people and a total of 10% from other countries. Educational background was diversified with 15% having a master degree, 35% having a bachelor degree and 40% having a high school degree. Participants with a lower degree than high school were underrepresented with 10%. Based on a 5-point Likert scale, participants indicated a slightly better than intermediate language level for German (*M*= 3.55, *SD*= 1.6), almost upper intermediate for English (*M*= 3.75, *SD*= 1.06) and a lower than intermediate language level for Dutch (*M*= 2.95, *SD*= 1.663)

3.4.2. Induction Phase

In total, 31 participants took part in the induction phase (people who attended the test phase were not allowed to take part in this phase). Of those 31 persons, 10 (32.3%) were male and 21 (67.7%) female. As Fan et al. (2014), Duffy, McAnulty & Albert (1996) and McLeod & Peacock (1977) found, differences in cortical brain activity are related to age. In order to control for age, participants were selected from the age range of 18-44 with a mean of 22.97 and *SD* of 5.666. Research suggested that differences could be related to an increased reaction time and decreased sensory system capability. All participants were in a healthy mental and physical condition, without neurological and/or psychiatric disorders, without a head injury, normal or corrected to normal visual acuity, normal auditory system and right handed. Respondents were recruited with help of the SONA system of the University of Twente. The SONA system is a web portal were University of Twente researchers are able to find students who are willing to take part in an induction phase. Most of those students were psychology students. As no sufficient number of participants was found via the SONA system, additional participants were recruited outside the system. Concerning the participants' degrees, 35.5% previously obtained a bachelor degree and 61.3% a high school degree. One participant did not enter his or her last obtained degree. Advanced Dutch language proficiency had 32.3% while 45.2% of the participants claimed elementary language level (9.7% had an intermediate Dutch language level while 9.7% had an upper intermediate language level). Advanced German proficiency had 54.8% while 22.6% entered an elementary level (19.4% intermediate, 3.2% upper intermediate). Advanced English level was claimed by 54.8% while only 3.2% rated themselves with an elementary level (16.1% intermediate, 25.8% upper intermediate).

3.5. Stimuli

As stated above, all used web banners fell into the category of static ads (fixed and dynamic). Banners used in this research advertised many different products and services from B2B and B2C markets and diverse industries. In total, 31 fixed and 19 animated web banners (in total 50) were collected as most current online banners are comprised of this size. Due to the stated picture superiority-effect, no web banners solely consisting out of text were included. Additionally, to control for another design element, mainly banners displaying humans were used for the induction phase.

Moreover, banners with Dutch (43 in total), English (4 in total), Dutch/English (2 in total) and German (1 in total) language were included in this study. Having had a majority of Dutch advertisements with low language variation is beneficial as language has the potential to influence results. All stimuli were prepared with "After Effects" in order to convert them into the right format required by the iMotions software. The format contained a 300x250 pixels web banner, surrounded by black color and was centered in the middle to account for hemispheric processing differences proposed by Janiszewski (1990).

Average duration of dynamic web banners was 11 seconds while average animation rate was 1.38 movements per second. Based on this data, two duration and two animation rate groups were created. The short duration group contained all banners with a duration shorter than 11 seconds and the long duration group contained all banners with a duration longer than 11 seconds. A total of seven banners were included in the short duration group and nine were included in the long duration group. Similarly, the animation rate groups were created. All banners with a rate lower than 1.38 movements per seconds were included in the low animation rate group while all banners with a rate higher than 1.38 movements per second were included in the high animation rate group. In total, ten banners were found to be in the group of low animation rate, while six banners were found to be in the high animation rate group.

3.6. Apparatus

3.6.1. iMotions Software, Screen & Operating System

The study was performed using the iMotions software, more specifically version 7.0. This software enables researchers to integrate several biometric measurement tools (e.g. eye-tracking, facial encoding, EEG, GSR, ECG/EMG, API) in one study. In this research, facial expressions were measured using a facial encoding algorithm provided by iMotions. This technique is explained in the section below. It calculates, based on hidden algorithms, several output variables. The output variables used, were neutral, positive and negative valence. The researcher closely followed iMotions' instructions for experimental set-up. Set-up instructions for facial encoding can be retrieved at iMotions (https://imotions.com/guides/). As screen, a HP Compaq LA2306x with 23 inches was chosen. The screen had a reaction time of 5ms and a framerate of 60Hz. Screen resolution was 1920x1080 Full HD. The study was performed on a Lenovo Thinkpad L450 which ran on Windows 7 Professional with service pack 1.

3.6.2. Facial encoding

The hardware used for this research set-up was a Logitech HD Pro Webcam C920. The implemented algorithm was FACET. The researcher chose for this algorithm instead of AFFDEX, as FACET outperforms the AFFDEX in detecting basic emotions (Stöckli, Schulte-Mecklenbeck, Borer, Samson, 2017). Moreover, the researchers found that FACET (67% accuracy) is better than AFFDEX (57% accuracy) in detecting valence. In their study, they evaluated the accuracy of the mentioned algorithms based on the 7 basic emotions. If a maximal value of joy was shown, they valued this as positive valence. If a maximal value for anger, fear, disgust, contempt or sadness was reached, the researchers labeled this as negative valence. However, in their study they do not show any results for neutral stimuli. Furthermore, Stöckli, Schulte-Mecklenbeck, Borer and Samson (2017) found that the FACET algorithm without baseline correction is better in detecting negative valence (92% accuracy vs. 71% accuracy). With baseline correction, positive valence is more accurately detected (22% accuracy vs. 63% accuracy). In this study, the emotional baseline is collected via a neutral stimuli in the beginning of the study. The facial encoding hardware (camera) was attached to the upper centered middle of the screen's frame. The algorithm behind the software computing valence, counts positive, negative and neutral facial cues per frame and puts out a percentage per valence type. According to the algorithm, positive, negative and neutral valence cues may appear simultaneously.

3.7. Procedure

3.7.1. Test Phase

In the test phase, a valence questionnaire with the aim to validate the valence measures found during the induction phase was performed. Differences were expected, as human beings are no reliable evaluators of their own feelings. 40 participants took part in this questionnaire. The survey was constructed using Qualtrics LLC. All participants evaluated the same banners that were shown to the people who participated in the induction phase (16 dynamic, 15 fixed). In the questionnaire, participants had to indicate their feelings (positive, negative or positive) towards each of the 31 web banners on a 3-Point-Likert Scale. Subjects had to answer options ranging from “positive”, “neutral” to “negative”. Although the majority of researchers used 5 or 7-point Likert Scale for valence measures, the 3-Point Likert Scale was used, like Shunkwiler, Broderick, Stansfield and Rosenbaum (2005) did. Using this approach, more reliable answers and finalized questionnaires were expected. A 5-point Likert scale might have increased answer times drastically, resulting in a low response and finalizing rate. Thus, a small number of answer options, made it easier and faster for participants to decide for an answer as the brain needed to accomplish less cognitive tasks. Depending on the type of web banner – dynamic or fixed, a video (dynamic) or a picture (fixed) suited to the browsers requirements was shown to the subjects. After respondents rated each fixed and dynamic web banner, demographic data was collected by asking participants for their gender, age, country of origin, last obtained degree and language proficiency. In total, the questionnaire took 10-20 minutes of the respondent’s time depending on the speed of answering.

3.7.2. Induction Phase

The induction phase consisted out of three parts – a questionnaire aimed at getting insights into personal preferences (brand familiarity, brand preference and brand recommendations), a facial detection test aimed at gaining valence data and memory tests comprised of a free recall and a yes/no recognition test. The induction phase took approximately one hour depending on each participants’ speed. Before the induction phase started, each participant received an informed consent in which participants rights and the researchers’ obligations were explicitly explained. Moreover, the procedure was explained without mentioning the memory test at the end of the session. Additionally, each participant was offered a warm drink, coffee or tea in order to make the participant feel comfortable. While the hot drink was consumed, the researcher started a maximum five minute small talk in a topic where the respondent felt comfortable. Having finished this first part, the questionnaire about personal preferences started. This questionnaire first instructed participants on what they can expect. Then, they were asked which brands they encountered in the past (brand familiarity) to see with which brands participants are familiar with. Afterwards, participants had to indicate which brands they preferred by dragging up to five brands into a box. This question was followed by asking participants for possible brand recommendations received by friends. Brands for each question were comprised out of the 31 brands shown in the web banners plus ten brands that were not shown in the facial detection test. A survey logic was implemented to ease answering. For instance, only those brands were shown for the question of brand preference that were selected in the question for previously encountered brands. Additionally, only those brands were shown to participants in the satisfaction question that were selected as being purchased in the past. Having finished this questionnaire, another five minute small talk was initiated by the researcher (most conversations followed the topic of the small talk before).

After the personal preference questionnaire, the researcher asked participants to find a comfortable position on the chair in front of the screen, as one requirement was to sit still without moving for the time of the facial detection test. Having found a comfortable position, the facial detection camera was oriented towards the participant's face. After the set-up, a baseline for the facial detection system (operated under the iMotions software) was calculated based on a neutral stimuli that was shown to all participants. After the baseline calculation, participants were instructed to look at the screen where all 31 selected web banners were shown after each other without a break in between the banners. Web banners were centered in the middle, surrounded by black color. Animated web banners were displayed for the duration from the beginning till the end of the ad. Fixed ones, on the other hand, were displayed for six seconds as preceding tests revealed that three, four and five seconds were too short for participants to focus attention on the shown ads.

After the valence measurement, a ten minute break filled with conversations to distract the people was added. Then, participants had to perform a recall and recognition test. In the recall test, participants had to indicate all brands they were able to recall from the facial detection test. Next, a recognition test followed, in which participants expressed whether or not they have seen a certain web banner. The reason for including both, recall and recognition test, was to see whether there were any differences in dynamic and fixed banners with regard to recall and recognition. There was a chance that fixed banners are better recognized than dynamic ones, as all cues of each fixed web banner is shown in the recognition test. Contrary, only a fraction of all cues a dynamic web has were shown during the recognition test. On the other hand, recall tests did not rely on showing any cues and thus formed a more difficult test. The recognition test was divided into two groups. Group 1 were shown dynamic web banners (16) and group 2 were shown fixed web banners (15). Additionally to the 31 web banners, 19 banners were included in the recognition test as noise. As stated before, respondents had to indicate whether or not they have seen a certain banner. The test was created using Qualtrics LLC and showed a picture of each fixed and dynamic web banner shown in the facial detection test plus the noise web banners. Fixed web banners were already in a picture format thus the banner itself was used for the recognition test. Dynamic banners consist of graphic movements and therefore had to be converted into a picture. A random snapshot of each web banner was taken for the recognition test. An indication whether or not someone has seen as certain ad was done via a click buttons.

3.8. Pre-Treatment of data

3.8.1. Valence & Personal Preference Questionnaire

Positive, negative and neutral valence percentage per participant and web banner were calculated using SPSS. Subsequently, the averages per participant and per valence level (positive, negative, neutral) were calculated. In the personal preference questionnaire, the number of brands previously encountered (brand familiarity), preferred brands and brands' recommended by friends were summed up to a total number per respondent and per category. Brand purchases and satisfaction were excluded due to the small amount of answers. The small amount would have made an analysis obsolete as it would have had low external validity.

3.8.2. Facial Encoding Data

Due to accuracy issues, three respondents had to be excluded from the facial detection data. The three subjects had a facial detection accuracy of 0%, 0% and 42% resulting in poor quality data. According to iMotions', the data had an overall accuracy of 92% which is a reasonable proportion. Positive, negative and neutral valence percentage per participant and web banner was calculated using excel. Following this, the averages per participant and per valence level (positive, negative, neutral) were calculated, equal to the valence questionnaire.

3.8.3. Recall and Recognition Data

Recall data was transformed into dummy variables. If a participant recalled certain web banner the dummy variable got a 1. Not recalled web banners got 0 value. Finally, a total sum and percentage was calculated. Moreover, a recall proportion for web banners with low/high animation and short/long duration was computed. For the recognition test, signal detection theory was used for analysis. Total and group (dynamic and fixed) hit and false alarm rates were computed by dividing hit and false alarm counts by the number of signals and noise, respectively. Eventually, z-scores of the probabilities associated with hit (Hit) and false alarm (FA) rate distributions were calculated. The calculation was accomplished using Excel and its NORMSINV function where N(0,1). As extreme Hit and FA rates of 0 and 1 would yield in zscores of $-\infty$ and $+\infty$ z-scores, a way to deal with those values had to be chosen. Stanislaw & Todorov (1999) provided three solutions to deal with. According to them, the most used approach is to replace 0 values with $\frac{0.5}{n}$ and 1 values with $\frac{n-0.5}{n}$ where n is the number of signals or noise. Having calculated the basic measurements of Z(Hit) and Z(FA) rates, *d'* and response bias was calculated per participant.

Sensitivity was computed using the following formulae:

$$d' = Z(pHit) - Z(pFA)$$

Response bias was computed using the following formulae:

$$c = -\frac{Z(pHit) + Z(pFA)}{2}$$

3.9. Data Analysis

The first part of the analysis compared means between dynamic and fixed conditions for recall and *d'*. Additionally, recall proportion of short/long duration and high/low animation rate web banners were analyzed. Those analyses were accomplished with non-parametric tests, all data including outliers were used. More precisely, a Wilcoxon Signed Rank test for banner types, animation and duration influences was performed. Following this, multiple regression analysis was carried out to identify personal preference influences between valence/brand familiarity/preferences/recommendations and the dependent memory measurements of recall and d'. In total, three observations were excluded from the facial detection data as accuracy for those observations was low. Finally, to validate valence results, the valence questionnaire was compared with the valence data obtained via facial detection and the iMotions software. This analysis was accomplished using a Mann-Whitney U test as a normal distribution was not given.

4. Results

4.1. Factors Influencing Web Banner Recall

4.1.1. Web Banner Types

Table 3a shows summarized hit rates, false alarm rates and response bias C .The response bias indicates slightly conservative behavior meaning that respondents tended to answer with “no” to the question whether or not they have seen a certain web banner in the facial detection test. As *C* was comparable in both conditions it indicates similar response bias. Therefore, comparison between both groups are valid. No outliers were excluded from analysis. A graphical overview of response bias C values can be seen in *Figure 1a*.

Table 3a – Descriptive Signal Detection Measurements (hit rate, false alarm rate and response bias C per condition and total values)

Condition	Hit Rate	False Alarm Rate	Response Bias C
	Mean	Mean	Mean
Dynamic Condition (n=15)	.695	.105	.410
Fixed Condition (n=16)	.793	.098	.226
Total (n=31)	.746	.101	.315

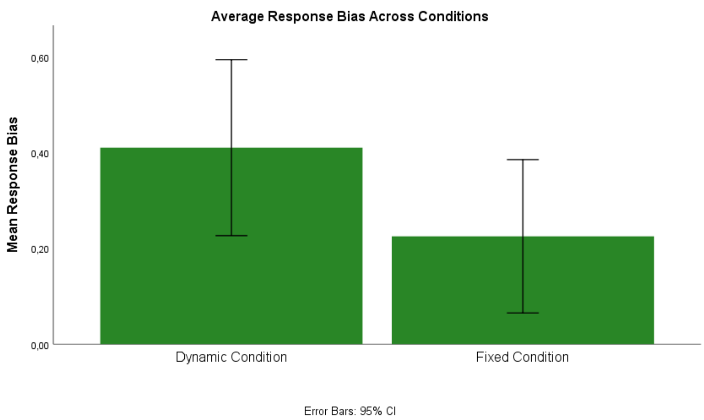


Figure 1a – Graphical SDT data (response bias C in each condition)

Table 3b shows, count and percentages of total recall for dynamic and fixed banners. In average, 2.9 brands were recalled per person. Each person recalled in average, 12.10% of all dynamic banners whereas only 6.45% of all fixed web banners were recalled. Standard errors in d’ and response bias C remain the same across both conditions.

Table 3b – Descriptive Recall Data (Recall of dynamic and fixed web banners in total numbers and percentage)

Recall (n=31)	Count		Percentage		
	Mean	SD	Mean	SD	Median
Recall Dynamic Banners	1.94	1.389	12.10	8.681	12.50
Recall Fixed Banners	.97	.836	6.45	5.573	6.67
Total	2.9	1.850			

To test recall differences among dynamic and fixed web banners, a Wilcoxon Signed Rank Test was performed. A non-parametric test was used as assumptions for a Paired Samples T-Test were not met. The Wilcoxon Signed Rank test indicated that recall probability of dynamic web banners (*mean rank*= 14.25) was significantly different from the recall probability of fixed web banners (*mean rank*= 8.00), z= -2.672, p= .006, favoring dynamic web banners.

4.1.2. Animation Rate & Duration

Table 3c shows the probability that a certain dynamic web banner category is recalled. One can see that web banners with long duration were recalled more frequently than web banners with a short duration. Moreover, web banners with high animation rate were recalled more often than low animation rate web banners.

Table 3c – Descriptive Recall Probability (short vs. long duration and low vs. high animation rate banners)

Recall (n=31)	Probability		
	Mean	SD	Median
Short Duration Web Banners	.078	.818	.090
Long Duration Web Banners	.090	.907	.100
Low Animation Rate Web Banners	.079	.681	.066
High Animation Rate Web Banners	.096	.112	.166

In order to test for differences in recall probability among high animation – low animation and long duration – short duration, Wilcoxon Signed Rank Tests were computed. The Wilcoxon Signed Rank Test was chosen as the normality assumption for a Paired Samples T-Test was not met. A Wilcoxon signed rank test showed that high animation recall probability (*mean rank*= 13.31) was not significantly different from animation recall probability (*mean rank* = 11.55) (z= -.661, p= .520). Another Wilcoxon signed rank test indicated that long duration recall probability (*mean rank* = 13.67) was not significantly different from short duration recall probability (*mean rank* = 11.80), z= -.773, p= .449.

4.1.3. Personal Preferences

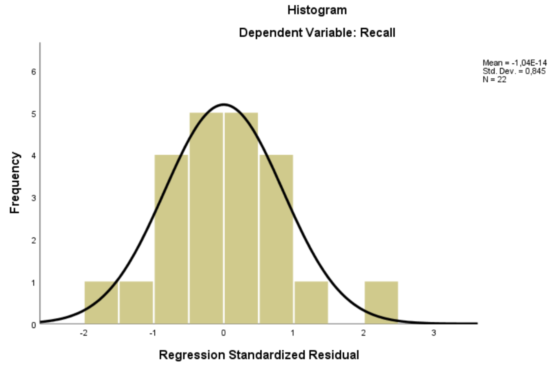
Several outliers were excluded from analysis. In detail, previously encountered brands, average neutral and positive valence (from the facial detection test) contained outliers. Previously encountered brands had one outlier with a count of 12. It was decided to exclude this observation and limit the included values to a maximum of 8. Average neutral valence had several extreme values, thus the range was limited to a minimum of 90. Average positive valence was limited to a maximum of 20 to prevent biased results due to influencing outliers. Minimum and maximum values for valence and previously encountered brands were chosen based on non-outlier values. The reason for excluding outliers was that sampling errors were assumed. In the case of previously encountered brands, there was a chance that a person accidentaly clicked on several brands without being aware of it. Valence measurments extreme values might have occurred due to the algorithm which might have had problems measuring facial expressions. After excluding all outliers, n for regression analysis became 22.

Table 3d – Descriptive Regression Analysis Data (after excluding outliers n=22)

Variable (n=22)	Mean	SD
Previously Encountered Brands	2.86	2.436
Preferred Brands	1.82	1.680
Brands Recommended by Friends	.73	.827
Average Neutral Valence	99.557	1.057
Average Positve Valence	2.068	4.841
Average Negative Valence	39.503	41.573
Recall Count	2.68	2.009

Table 3d represents the values used for regression analysis. The average of previously encountered brands is relatively low in relation to the total amount of brands included in this study (31). The same applies for average preferred brands per person. Average brand recommendation is below 1 indicating that not each subject got a recommendation for a brand by a friend. In average, each participant was able to recall 2.68 brands that was shown during the induction phase.

Normal distribution of residuals is given as can be denoted in *Figure 1_b*. Equal variance of residuals is provided as *Figure 1_c* shows.



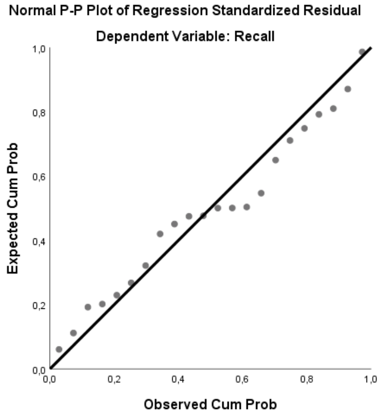


Figure 1_b – Residual Normality Recall Regression Model

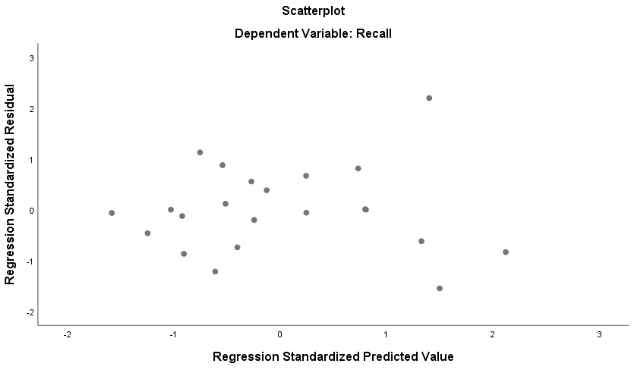


Figure 1_c – Equal Variance Recall Regression Model

As residuals are normally distributed and homoscedastic, linearity can be assumed. Moreover, the variable “previously encountered brands”, has the highest multicollinearity with a VIF of 6.179, which is under the acceptable threshold of 10 (Hair, Anderson, Tatham, Black, 1995).

A multiple linear regression analysis was conducted to predict number of recalled brands based on neutral, positive and negative valence, previously encountered brands, preferred brands and recommended brands. A significant regression coefficient was found ($F(6,15)= 4.947$, $p= .006$) , with an R^2 of .664, meaning that the six predictors explain 66.4% of the variance. Participant’s predicted number of recalled brands is equal to 61.424 + 1.081 x (number of previously encountered brands) - .508 x (number preferred brands) - 1.340 x (number of recommended brands) - .597 x (average neutral valence percentage) + .031 x (average positive valence percentage) - .014 x (average negative valence percentage) where previously encountered brands are measured as the total amount of brands encountered in the past, preferred brands are the number of brands rated by subjects as being preferred, recommended brands as the number of brands indicated as being advised to subjects by friends and all three valences as the average valence in percentage. The number of recalled brands increased 1.081 for each additional previously encountered brand and .031 for each additional percentage in average positive valence, decreased .508 for each additional preferred brands, 1.340 for each additional recommended brand, .597 for each additional percentage in average neutral valence and .014 for each additional percentage in average negative valence. It was found that number of previously encountered brands ($B= 1.081$, $p= .003$) and number of recommended brands ($B=-1.340$, $p= .020$) significantly predicted number of recalled brands. *Table 3_e* provides an overview of the results related to this regression analysis.

Table 3_e – Regression Analysis Results (n=22, dependent variable recall)

Source	B	SE	β	t	p
Neutral Valence	-.597	.383	-.314	-1.560	.140
Positive Valence	.031	.078	.075	.397	.697
Negative Valence	-.014	.010	-.289	-1.374	.190
Previously Encountered Brands	1.081	.307	1.311	3.525	.003
Brand Preference	-.508	.376	-.425	-1.352	.196
Brand Recommendations	-1.340	.513	-.552	-2.614	.020

4.2. Factors Influencing Web Banner d’

4.2.1. Web Banner Types

Table 4_a – d’ results for dynamic and fixed condition

Condition	d'	
	Mean	Median
Dynamic Condition (n=15)	1.959	1.872
Fixed Condition (n=16)	2.338	2.377
Total (n=31)	2.156	

d’ for the two groups was high and indicated that subject were able to discriminate between signal and noise. However, the fixed condition subjects were better in discriminating between signal and noise. *Figure 2_a* provides a graphical overview of d’ results.

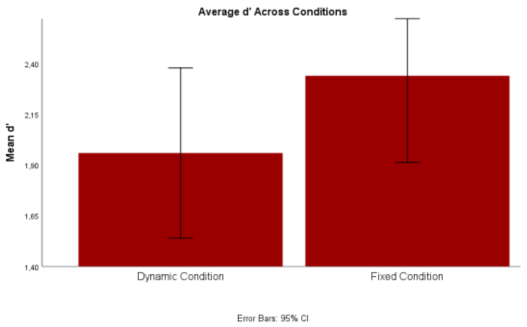


Figure 2_a – d’ mean for dynamic and fixed condition

As the normality assumption for *d’* does not hold, a Mann Whitney U test was performed to test differences in d’ between the two conditions. A Mann-Whitney U Test indicated that d’ was not significantly different between dynamic web banners (*Mdn*= 1.872) and fixed web banners (*Mdn*= 2.377), *U*= 90.000, *z*= -1.187, *p*= .235.

4.2.2. Personal Preferences

Table 4_a provides an overview of all values used for this regression analysis. Basically, all values are the same as in the previous regression analysis. Only d’ was added to this table. d’ displays participants ability to discriminate between signal and noise. This data shows that all participants were able to discriminate properly.

Table 4b - Descriptive Regression Analysis Data (after excluding outliers n=22)

Variable (n=22)	Mean	SD
Previously Encountered Brands	2.86	2.436
Preferred Brands	1.82	1.680
Brands Recommended by Friends	.73	.827
Average Neutral Valence	99.557	1.057
Average Positve Valence	2.068	4.841
Average Negative Valence	39.503	41.573
d'	2.163	.755

Residual normality is not as good as in the previous regression, however normality still can be assumed as residuals do not vary enormously (see *Figure 2b*). Equal variances of residuals is given as can be depicted from *Figure 2c*.

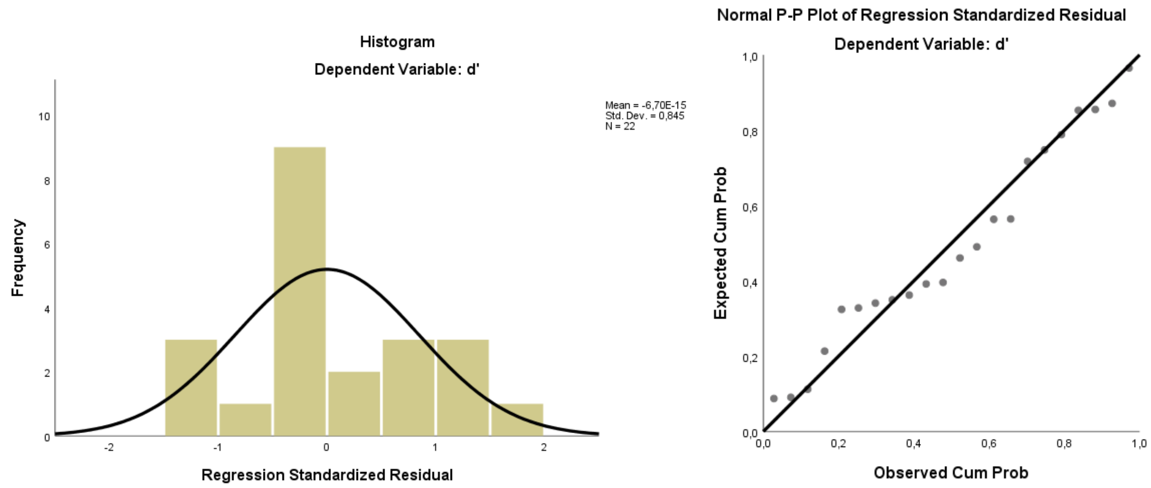


Figure 2b – Residual Normality d' Regression Model

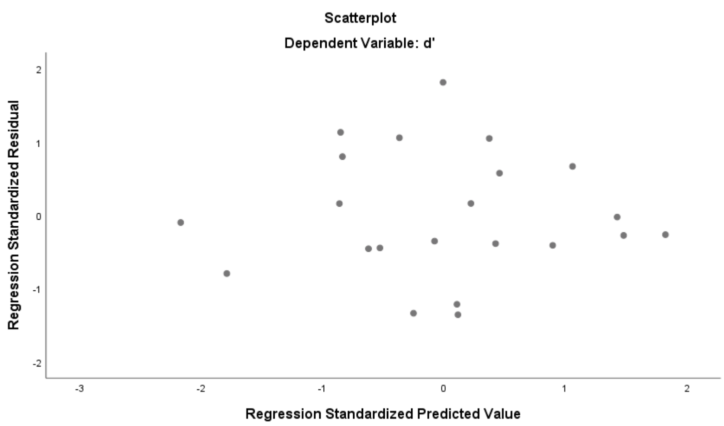


Figure 2c – Equal Variances d' Regression Model

As residuals are normally distributed and homoscedastic, linearity can be assumed. The Variable "previously encountered brands" has the highest multicollinearity with a VIF of 6.179, which is under the acceptable threshold of 10 (Hair, Anderson, Tatham, Black, 1995).

A multiple linear regression analysis was conducted to predict *d'* based on neutral, positive and negative valence, previously encountered brands, preferred brands and recommended brands. No significant regression coefficient was found ($F(6,15)$= 1.276, p= .326) , with an R^2 of .338, meaning that the six predictors explain 33.8% of the variance. Participant's predicted number of recalled brands is equal to 31.246 + .155 x (number of previously encountered brands) - .102 x (number preferred brands) - .574 x (number of recommended brands) - .287 x (average neutral valence percentage) - .002 x (average positive valence percentage) - .010 x (average negative valence percentage) where previously encountered brands are measured as the total amount of brands encountered in the past, preferred brands are the number of brands rated by subjects as being preferred, recommended brands as the number of brands indicated as being advised to subjects by friends and all three valences as the average valence in percentage. *d'* increased .155 for each additional previously encountered brand, decreased .102 for each additional preferred brands, .574 for each additional recommended brand, 287 for each additional percentage in average neutral valence and .002 for each additional percentage in average negative valence, .010 for each additional percentage in average positive valence. No variable was found to be a significant predictor for *d'*. *Table 4c* provides an overview of this models' variables.

Table 4_c – Regression Analysis Results (n=22, dependent variable d')

Source	B	SE	β	t	p
Neutral Valence	-.287	.202	-.401	-1.419	.176
Positive Valence	-.002	.041	-.014	-.051	.960
Negative Valence	-.010	.005	-.524	-1.777	.096
Previously Encountered Brands	.155	.162	.500	.958	.353
Brand Preference	-.102	.198	-.226	-.512	.616
Brand Recommendations	-.574	.271	-.628	-2.120	.051

4.3. Valence Validation

As *Table 4_a* shows, the valence questionnaire results were evidently different from both facial encoding results. This applies for neutral, positive and negative valence measurements. Facial encoding data with baseline showed no negative valence at all. As this might have occurred due to corrupted data or a result from an algorithm mistake, this data was not used for the analysis of this study.

Table 4_a – Descriptive Valence Data (Average neutral, positive, negative valence in percentage for valence questionnaire and facial detection with and without baseline correction)

Test	Valence	Mean	SD	Median
Valence Questionnaire Test (n=40)	Neutral	53.71	16.113	58.064
	Positive	28.63	10.153	27.419
	Negative	17.18	10.211	14.516
Facial Detection Test (n=28) with baseline correction	Neutral	96.360	9.532	95.801
	Positive	8.200	15.550	12.220
	Negative	0.000	0.000	0
Facial Detection Test (n=28) without baseline correction	Neutral	95.824	9.951	100
	Positive	5.810	15.462	0.160
	Negative	47.713	40.993	49.758

The reason is that the study setting and the task of looking several minutes on a screen portraying web banners without moving the body, should have induced some negative valence magnitudes. As this did not correspond with the data, data was believed to be corrupted. Facial detection data without baselines measurements provided more accurate data on the first glance as positive, negative and neutral valence was found. Moreover, the distribution appeared to be realistic with a lot of neutral valence, moderate negative valence and low positive valence. A graphical comparison between valence questionnaire and facial detection (without baseline) can be seen in *Figure 3_a*. The figure shows equal standard errors for valence measurements across conditions, except for the negative valence.

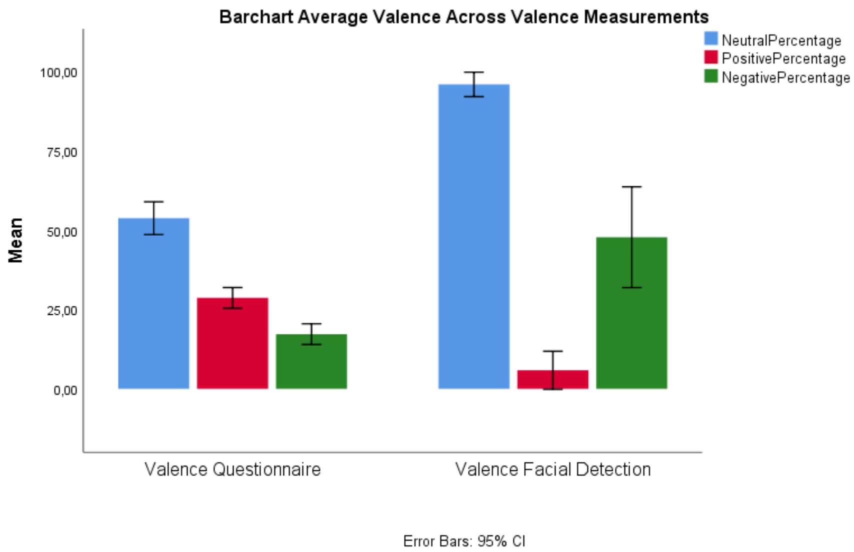


Figure 3$_a$ – Graphical Valence Data (Average neutral, positive, negative valence in percentage for valence questionnaire and facial detection test without baseline correction)

Although not part of the hypothesis testing in this study, it was decided to measure difference between the valence questionnaire and the facial detection data. For this test, all available observation were used, including outliers. As the data was not meeting the assumptions of an Independent Samples T-test, a Mann-Whitney U test was performed for all three valence categories.

Statistics indicated that the facial detection test (*mean rank*= 53.57) scored different in neutral valence in comparison to the valence questionnaire test (*mean rank* = 21.15). Mann-Whitney U-value was found to be statistically significant U = 26.00 (Z = -6.704), p < .001, r = -.812 ($r = z/\sqrt{68}$). This indicates that the valence questionnaire test with regard to neutral valence is different from the results obtained from the facial detection test. Moreover, SPSS indicated that the facial detection test (*mean rank* = 17.61) scored different in positive valence in comparison to the valence questionnaire test (*mean rank* = 46.33). Mann-Whitney U-value was found to be statistically significant U = 87.00 (Z = -5.929), p < .001, r = -.718($r = z/\sqrt{68}$). This indicates that the valence questionnaire test with regard to positive valence is different from the results obtained from the facial detection test. Statistics showed that the facial detection test (*mean rank* = 39.57) scored not significantly different in negative valence in comparison to the valence questionnaire test (*mean rank* = 30.95). Mann-Whitney U-value was not found to be statistically significant U = 418.00 (Z = -1.772), p = .076, r = .214 ($r = z/\sqrt{68}$). This indicates that the valence questionnaire test in terms of negative valence is not significantly different from the results obtained from the facial detection test. Results demonstrated that the valence questionnaire differed from the facial detection test (without baseline) in neutral and positive valence. Negative valence appeared to be not statistically different from each other.

Table 5$_a$, provides an overview of all hypothesis mentioned. H_1, was partially accepted as a significant difference between web banner types was supported for recall. Positive and negative valence did not influence recall and d' significantly, thus H_2 was rejected. On the other hand, neutral valence (H_3), did not influence recall and d' significantly, thus H_3 was accepted. H_4 was partially accepted as brand familiarity (variable previously encountered brands) significantly influenced recall positively. H_5 was partially accepted as recommendations by friends influenced recall and not d' results significantly. Both, H_6 and H_7 were rejected as no difference in recall and d' was experienced between animation rates and duration.

Table 5_a – Hypothesis Results (rejected and accepted hypothesis)

H Number	Hypothesis in Words	Result
H_1	There is significant difference between dynamic and fixed web banners with regard to recall and d', favoring dynamic web banners.	Partially Accepted
H_2	Positive and negative valence have a significant positive influence on recall and d'.	Rejected
H_3	Neutral valence have no significant influence on recall and d'.	Accepted
H_4	Brand Familiarity and friend recommendations have a significant positive influence on recall and d'.	Partially Accepted
H_5	Friend recommendations have a significant negative influence on recall and d'.	Partially Accepted
H_6	There is significant difference between high animation rate and low animation rate of web banners with regard to recall.	Rejected
H_7	There is significant difference between long duration and short duration of web banners with regard to recall.	Rejected

5. Discussion

This research sought to examine web banner influences on memory. Recognition and recall tests were used as memory measurements. Recognition was measured in *d'* which is the ability to discriminate between signal/noise. Web banner types, web banner animation/duration and personal preferences were used as independent variables. Personal preferences, on the other hand, was divided into previously encountered, preferred and recommended brands. All three divisions of preference were measured explicitly. The study included a valence validation which was used to verify facial detection results. Validation was accomplished by comparing a traditional valence questionnaire to valence data acquired with a facial detection device. A questionnaire during the induction phase measured brand familiarity, brand preference and brand recommendations, additionally. Valence data was obtained via facial detection while participants attended several web banners portrayed on a screen. Eventually, a free recall and recognition test followed the valence measurement.

5.1. Result Interpretation

As hypothesized, dynamic web banners were recalled significantly more often than fixed web banners. Due to the fact that dynamic web banners trigger more attention than fixed web banners, we might assume that dynamic web banners are better encoded in human memories. Another possible reason for the difference in recall results between dynamic and fixed banners is that dynamic banners are shown longer and provide more cues to remember a certain brand. This means that the chances are higher for a dynamic web banner to contain content that increases memory performance in humans as information density and information exposure is higher in comparison to fixed web banners.

Contrary to previous findings and the hypothesis, dynamic web banner with long duration were not recalled more often than short duration banners. Similar, high animation rate web banners were not significantly more often recalled than banners with low animation rate. A reason for the insignificance could be the fact that the gap between high and low animation rates and long and short duration, respectively, was not big enough to record significant differences. Another explanation might be the estimation of web banner duration which could not be accomplished with 100% accuracy.

Regression results suggested a significant regression coefficient for recall based on valence measurements and the personal preference measures (brand familiarity, brand preference and brand recommendations) of this study. Although there is statistical significance, results should be treated with caution, as the model is not grounded on a theory. Within the model, significance was found for the variables of number of previously encountered brands (brand familiarity) and number of recommended brands. Encountered brands increase the number of recalled brands significantly, while recommended brands decrease recall. The reason for better memorization of familiar brands might be the mere exposure effect, which describes the human tendency to "develop preferences for things merely because they have become familiar with them" (Kindermann, 2016, p.418). Familiar brands were already encoded and consolidated in a subjects' mind and therefore additional brand encounters add up to memory consolidation, enabling faster and better retrieval. As predicted, the number of recommended brands did have a significant negative effect on recall. This could be explained by Wagner et al. (2000), who proposed that priming reduces encoding variability and thus hinders explicit memory. In other words, priming might increase reprocessing of task-relevant features and decreases processing of other features. However, a replication study of Wagner et al. (2000) failed to prove the previously found result. Insignificance of valence on recall might have several reasons. One reason could be that the iMotions software and its algorithm did not work properly. For instance, stimuli of this study might have been too weak to evoke positive and negative valence leading to tiny facial expressions. Eventually, those tiny expressions were too small to be detected by the algorithm and/or the device itself. Assuming that the apparatus did work properly, measured valence amplitudes could be associated to other stimuli than web banners. For instance, a test effect might have influenced subjects. Due to the fact that people know their "emotions" were observed, their valence was associated with the environment they were in. Sitting in a plain white room containing only a desk, chair, screen, laptop and an unfamiliar researcher might have evoked biased valence results. Moreover, under the assumption that the software and its algorithm worked properly, there is an option that subjects' attention shifted from the facial detection test to something else, resulting in valence amplitudes related to those mind shifts. For instance a subject getting bored sitting in front of a screen watching advertisements of unfamiliar brands would probably start to think about something else than the shown web banners. Their mind could be dealing with relationship problems or the next exam without the researcher noticing those mind shifts. Continuing this way of thought, this could mean that web banners do not evoke any valence amplitude related to a specific banner. This could be explained with consumers' tendency to unmask web banners as advertisements. Thus, consumers' critical attitude towards advertisements might prevent proper web banner processing.

Not in line with the hypothesis, is the fact that there was no significant difference between banner types in relation to *d'.* A possible adjustment could be a study with more participants and more web banners to increase statistical power. However, one has to keep in mind that recall focused on brand retrieval while recognition concentrated on web banner retrieval. Assuming that dynamic banners are better encoded in memory, results should favor dynamic banners. Strangely, means of *d'* even suggested better recognition results for fixed banners, although not statistically significant. This could be explained with the study design, more precisely the task order as a recognition test followed a recall test. Additionally, another reason could be that fixed web banners were shown 100% similar in the facial detection test and the recognition test. Dynamic banners on the other hand, were shown as a snapshot in the recognition test, containing only a small percentage of the actual web banners' content. Therefore, this test design could be the reason for biased results as recognition difficulty for both banner types was not comparable. This biased result is in line with current conflicting literature. As stated in the beginning of this study, researchers were not clear about the effects of animation within web banners. Using recognition tests to compare the two banner types lead to biased results as recognition difficulty varies between banner types. However, the recall test showed significant differences among the two banner types, providing an answer for the ongoing debate about memory differences among banner types.

d' was not affected by valence or personal preference measurements at all, as tested in a regression analysis. Obviously, significant discriminating differences between signals and noise cannot be explained by the variables in this study. *d'* might be mainly influenced by cognitive capabilities and differences among subjects. Another explanation of the results is that the perceived difference between signal and noise was too small to explain influences of valence and personal preferences on d'.

The valence questionnaire was significantly different from the valence data obtained with facial encoding and the iMotions software. Neutral and positive valence data showed significant differences in its values. Negative valence results among the valence questionnaire and the facial detection device were not significantly different from each other. The reason for the differences in positive and neutral valence measurements could be the fact that human beings have difficulties to determine their own emotions and therefore their valence. A possible explanation for equality among negative valence could be that (young) human beings are better in assessing their negative valence than neutral and positive valence, as they are better in memorizing happenings correlated with negative valence. Thinking a step further this could also mean that older humans are better in assessing their positive valence as their motivations shift from negative to positive when they grow older. Those ideas are based on the findings of Jennifer, Tomaszczyk, Fernandes & MacLeod (2008) and Mather & Carstensen

(2005) who stated that young people are better in memorizing negative and old people are better in memorizing positive information, respectively. Another explanation is that the iMotions software did not measure accurately and precisely. The company responsible for the software did not provide open access to the algorithms. Therefore, we cannot exclude the possibility of a software inaccuracy. If this is the case, valence data obtained with facial detection are not valid and thus might explain insignificance of positive and negative valence results.

5.2. Practical Implications

Both, recall and recognition are brand awareness measurements. However, recall is a better predictor for purchase decisions than recognition as humans tend to purchase a top brand from their consideration set. As Solomon, Hughes, Chitty, Marshall & Stuart (2013) suggest, this is called top-of-mind awareness effect which is closely related to recall. According to Driesener, Paech, Romaniuk & Sharp (2004), this effect is especially relevant when consumers have to make a fast decision between low involvement products. Due to the fact that dynamic web banner are better recalled, they should be used when targeting consumers who have to make fast decisions between low involvement products as those banners increase the likelihood that a certain brand gets to the top of the mind (top-of-mind awareness effect).

As shown, brand familiarity had significant influence on recall. Therefore, the main approach of digital marketing agencies and companies advertising in the internet should be to penetrate relevant internet channels with web banners of a certain brand. Targets should be people who have not gotten in touch with a certain brand. Eventually those people will be more likely to memorize and form preferences for the specific brand, as the mere exposure effect predicts.

Dynamic web banner duration and animation rate did not influence recall. If this result would hold in other studies as well, a moderate duration and animation rate should be used when creating dynamic web banners. Companies should renounce producing web banners with a long duration and/or high animation rate as those kind of web banners have a higher production costs. By renouncing, the same memory effects can be achieved with less production costs.

Under the assumption that valence results are valid and the interpretation that web banners and/or ads do not evoke valence, practitioners could try to mask advertisements better and by that evoke emotions. A sports streaming service could mask its advertisements by providing a free demo of its service. For instance, there is a web banner on a regular page. To all viewers it is clear that those ads are actually ads. If this sports streaming provider would use web banners to show a live soccer game (or scenes of a live soccer game), customers might be less likely to unmask the advertisement resulting in valence amplitudes that do influence memory processes.

5.3. Academic Implications

For the academic world, the results add up to the debate about memory effects between dynamic and fixed web banners. So far, conflicting results dominated scientific literature. This studies' results showed that there is a significant difference between the two banner types for recall. Dynamic web banners were more likely to be recalled than fixed web banners while no significant difference was found between the two banner types and recognition. However, a tendency towards fixed web banner in recognition was discovered, which can be tested in future studies.

As the valence questionnaire and the facial detection test used in the induction phase differed significantly in positive and neutral valence, researchers should not rely on one approach to measure valence. In order to get precise measurements, several possible ways of measurements should be used to get a reliable result. As negative valence values did not differ significantly between the induction and test phase, questionnaires and facial detection devices running under the iMotions software could be used to assess negative valence.

5.4. Limitations

5.4.1. Apparatus & Participants

One of the studies' limitations is the fact that a commercial software for facial encoding was used. The iMotions software is not proven to measure valence accurately. This limitation is strengthened by the fact that iMotions is not willing to openly communicate the way their algorithm is programmed. Therefore, no one is able to control for the correctness of the results. As most subjects were recruited from the University of Twente, generalization is limited. Mainly young, students with a high educational background participated which do not reflect the whole population of people targeted by the advertisement industry.

5.4.2. Stimuli & Study Design

Mainly unknown brands were included in the study which could have impacted preference measures as Coates, Butler, & Berry (2006) found. A study with popular and more familiar brands could have revealed deeper insight into preferences and its influence on memory measures of recall and recognition. Moreover, web banners were taken from brands from many markets and industries. Industry types and markets and therefore product categories could have influenced recall and recognition outcomes.

All web banners were shown to participants in the personal preferences questionnaire which could have primed respondents. The study setting was not reflecting reality as participants were instructed to stay calm without moving a lot and looking at the center of a screen where all web banners were portrayed. In reality no internet users solely looks at a big web banner in the middle of the screen. Web banners are usually embedded in a website on which internet users go to when browsing with or without a certain goal. Again, this reduces generalizability. Time between the facial detection test and the recall/recognition test was short. A longer distance between those tests could have revealed a clearer and more valid result.

5.5. Future Research

For practitioners, a recall/recognition study focusing on influences of the two web banner types in a real world setting might be most interesting. Subjects could be divided into two groups. One group gets a search task while the other group does get the task to explore a website (referring to Pagendarm & Schaumburg's (2001) two navigation styles) while being exposed to different types of web banners. Finally, a recall and/or recognition test could reveal memory differences between dynamic and fixed web banners.

Another valence research could try to address the question whether or not consumers' tendency to unmask web banners as advertisements is the reason for insignificant valence results. Two conditions, one with clear advertisements and one with difficult to unmask advertisements should be used to investigate valence and memory effects. In the first phase, participants will be shown the advertisements of the corresponding condition while a facial detection device and software measures valence. Afterwards, a brand questionnaire to assess recall/recognition could be accomplished.

Results of this study indicated that negative valence was assessed more accurately than positive and neutral valence. As the mean age of the valence questionnaire test and the facial detection test were rather young, one might assume that young people are better in assessing negative valence (Jennifer, Tomaszczyk, Fernandes & MacLeod, 2008; Mather & Carstensen, 2005). This could mean that old humans are better in assessing positive valence which would be in line with the results of Fernandes

& MacLeod (2008). A future study could try to address this hypothesis by using stimuli that evoke strong negative and positive valence and let young and old humans rate those stimuli. Additionally, a valence test with a facial detection device could be used for comparison.

5.6. Conclusion

As this study showed, web banners influence memory performance in several ways. The type of web banner plays a role, as memory performance between fixed and dynamic web banner varies between conditions. We can conclude that dynamic and fixed web banners differ in the extent they evoke memory processes with regard to free recall. Dynamic banners are recalled more often than fixed ones. Recognition rates, however, did not vary significantly. Moreover, personal preference towards a web banners' brand – especially brand familiarity influenced memory performance in recall. On the other hand, recommendations were found to be negatively influencing memory.

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