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Abstract

Computer games have become one of the most important parts of entertainment industry. Due to a tremendous reach, particularly among important customer groups such as adolescents and young adults, this media is recently considered as an appealing channel for advertising. However, little is known about the effectiveness of advertising in computer games. Its interactive nature comes with a fundamental difference in the perception of advertisements compared to traditional media such as television. The intense user interaction in computer games interferes with players' memory and attention, as players primarily focus on the current performed task. Information such as advertisements billboards which is not directly related to the gaming task remains unnoticed. This behavior, known as inattentional blindness, is a main problem for the optimal placement of information (e.g. game-relevant messages) or advertisements in the game's virtual environment.

This thesis will review the history, current methods and issues of advertising in computer games. It will particularly discuss the perception of embedded advertisement billboards and propose one way to break through inattentional blindness, in order to make advertisements which are embedded in an action game's environment more visible. The underlying approach is based on Wolfe's theory of Guided Search, which provides a fairly reliable model for top-down controlled visual attention during visual search tasks. Since computer games frequently involve visual search tasks, we hypothesize that this model can be applied in a "reverse" direction to increase the saliency of some advertisements on a cognitive level, to get noticed even in the presence of a strong task.To validate this hypothesis, a computer game was implemented to conduct a user study for testing the memory effectiveness.

Kurzfassung

Computerspiele sind zu einer der wichtigsten Branchen der Unterhaltungsindustrie geworden. Aufgrund der enormen Reichweite, vor allem bei den wichtigen Konsumentengruppen, den Jugendlichen und jungen Erwachsenen, wird dieses Medium mittlerweile als attraktiver Kanal für Werbetätigkeiten angesehen. Jedoch weiss man noch wenig über die Effektivität von Werbung in Computerspielen, da im Vergleich zu traditionelle Medien, wie z.B. Fernsehen, die interaktive Natur dieses Mediums einem wesentlichen Unterschied in der Wahrnehmung bedingt. Die intensive Interaktion des Benützers interferiert mit seiner Wahrnehmung und Aufmerksamkeit, da die Spieler primär auf die gegenwärtig auszuführende Aufgabe fokussiert sind. Daher werden Informationen, die nicht direkt mit der Aufgabe des Spiels zusammenhängen, wie z.B. Werbebanner, nicht bemerkt werden. Dieses Verhalten, bekannt als “inattentional blindness” (Blindheit durch Ablenkung) ist ein Hauptproblem für die optimale Platzierung von Informationen (insbesondere spielrelevante Nachrichten) oder Werbung in der virtüllen Umgebung des Spieles.

Meine Diplomarbeit wird einen Rückblick auf die Entwicklungsgeschichte, einen Überblick über gegenwärtige Methoden und Themen von Werbung in Computerspielen geben, wobei inbesondere die Wahrnehmung von in die Spielumgebung eingebetteten Werbebannern diskutiert wird und eine Methode vorschlagen wird, um die “Inattentional Blindness” zu durchbrechen um solche Werbebanner im Spiel sichtbarer zu machen. Der zugrundeliegende Ansatz basiert auf Wolfe’s Theorie der “Guided Search”, die eine relativ verlässliches Modell für top-down kontrollierte visuelle Aufmerksamkeit während visueller Suchaufgaben bietet. Da sich in Computerspielen häufig visuelle Suchaufgaben ergeben, ist unsere Hypothese dass dieses Modell auch in “umgekehrter Richtung” angewendet werden kann, so dass die Salienz einiger Werbebanner soweit erhöht wird dass sie vom Spieler gesehen werden, auch während dieser Aufgaben erledigt die seine Aufmerksamkeit besonders in Anspruch nehmen. Um diese Hypothese zu Testen, wurde ein Computerspiel implementiert und eine Benutzerstudie durchgeführt, wo der Effekt unsere Methode mit einem Gedächnistest überprüft wurde.

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CHAPTER 1

Introduction

1.1 Motivation

1.1.1 Marketing Importance of In-Game Advertising

Video games have become one of the most important entertainment media of our time. A marketing survey of ESA[sa10][1] revealed that 67% of American households consume computer or video games. Schell[2] believes that computer games have found their acceptance from people of every age and demographic group. Since everybody is a potential computer game player, computer games are evolving like species on the market adapting to particular preferences of various audience groups. In-game advertising, a form of advertising which is grounded on video/computer games grows together with this new kind of entertainment. Compared to traditional media, computer games have many inherent advantages. The report of ESA showed that the average game player is 34 years old. 60% are males and 40% are females. 49% of them are between 18 and 49 years. This determines computer game is a very effective way to touch the young people who will simply accept new things and have also strong consumption ability.

Current research suggests that, due to the high popularity of video games, also in-game advertising tends to be widely accepted by young people. This new way of advertising looks very "cool" and may increase a computer game's realism, which has high influence on young consumers.

[1] ESA:Entertainment software association

[2] J. Schnell: instructor of entertainment technology at Carnegie Mellon University

1.1.2 Inattentional Blindness in Computer Games

Due to the popularity of the computer entertainment medium, in-game advertising is appealing to the marketing industry and has many advantages compared to traditional kinds of advertising. However in-game advertising is a rather new field of marketing posing novel challenges for the design of advertising campaigns.

Unlike traditional media as passive behavior(e.g. watching TV, listening to the radio), game playing requires interactive behavior between human and computers. The strong focus on a task of computer playing makes a big difference from passive media consumption, like watching television. Every computer game imposes an intensive task, especially action games.

Scenes become more and more complex in modern games, this process brings a high perceptual workload. However, because of the human capacity is very limited, not all visual information can be processed when the perceptual workload is too high. Some visual information will be ignored by players even though it has been received by players' optic organ (retina).

A typical bottleneck of perceptual performance is "inattentional blindness". A phenomenon which was first identified by Mack and Rock[J.M98]. Most of times a task determines behavior, people's attention is strongly task-focused. The term Inattentional Blindness refers to the inability to recognize objects and events which are not related to the task being currently executed, filtered by attentional selection. Inattentional blindness can be the reason for even embarrassing situations, for instance, overseeing a very good friend crossing unexpectedly our ways while we are focused on searching for a restaurant in town.

1.2 Scientific Contribution

1.2.1 Reducing Inattentional Blindness

To improve the effectiveness of in-game advertisements, we will propose a simple but effective strategy to manipulate visual attention of players to achieve that particular in-game advertisements to be recognized and remembered. We assume that for the execution of typical game tasks many visual search tasks have to be performed. For instance, in typical action game tasks there is the goal of staying alive, which requires to recognize enemies and to find health items for recovery.

Based on this assumption, we utilize the theory of Guided Search[J.W94]. This theory accounts for top-down processes involved in visual search. Top-down processes guide human attention to find and select the targets of interest according to the viewer's goals. If human searching behavior during playing corresponds to Wolfe's model, we will have the possibility to design an object which is searched frequently (e.g. health item). It's a way that Guided Search predicts a fixation on a desired target advertisement, which shall become a false positive of guided search. And we also assume that the target in-game advertisement will be noticed by players when they perform a false positive fixation on it. The particular strategy we propose to achieve this effect is to use similar features (e.g. color, orientation, curvature) for the texture of the search item as occurring on the target advertisement. When this simple design rule is applied, the Guided Search model predicts that the human visual system is not able to distinguish a search target from the respective advertisement without an eye fixation.

1.2.2 Experimental Validation

To test our hypothesis, we designed an experiment with one test and two control conditions. 38 participants attended in the study. All played a 2D shooting game which contained in-game advertisements and performed a memory test, where they had to recall the advertisements they remembered in the game. In the test condition the health item was textured with similar features as one (target) advertisement in the background of the game scene. For the control conditions we used the same game with the only difference that the health item was textured with dissimilar features (1st control condition) or the target advertisement was replaced by an advertisement with dissimilar features (2nd control).

The results clearly show that participants remembered the target advertisement much better in the test condition than in both control conditions.

1.2.3 Conclusion

Because the topic of in-game advertising becomes more and more popular and important for advertising industry, this topic has recently increasingly attracted interest from academia. However, most previous work is related to the Marketing field and most research has been carried out with marketing surveys evaluating effectiveness and acceptance in a rather broad and general fashion.

We believe that to evaluate the effectiveness of in-game advertising only through questionnaires or sample survey methods is not sufficient. Because the results are too general and not necessarily provide particular insights how advertisements have to be designed and placed in the game environment to optimize their recognition. To accurately evaluate the effectiveness of in-game advertising, we think it is also important to investigate the perception of advertisement elements by means of carrying out experiments and studying directly with the players' behavior in particular computer games.

From the rather few experimental studies in previous work, we know the effectiveness of in-game advertisings is not as promising as suggested by results of marketing surveys. As mentioned above, the main problem is the low perceptual visibility of in-game advertisements.

Previous work has shown that virtual billboards should be the best object for in-game advertisings' Placement. But to further improve the perception of in-game advertisements we need not only the experience from marketing and computer graphics, also the knowledge from cognitive psychology.

One contribution of this work is that we approach the problem from an interdisciplinary perspective. After sketching the history, conception, importance and benefits of in-game advertising for marketing and the computer games industry, we will discuss the reasons why in-game advertisements are poorly recognized by the players based on theories from cognitive psychology. Then from this discussion we will develop from this discussion our leading hypothesis of how we can increase the effectiveness of in-game advertising. Our proposal is then evaluated by means of an experimental study which was realized by implementing our own computer game customized for the experimental objectives.

Our study not only provides a great basis for future work, it also proposes a promising research direction headed by the idea of applying cognitive models to control a user's perception in computer games by game and content design.

1.3 Overview

In chapter 2 we will start with a general consideration how computer games and marketing can be related by in-game advertising. There, we will basically emphasize the importance of in-game advertising for the advertisement industry. It will introduce some background knowledge about computer games and advertisement, i.e., the history of computer games advertisement. It will includes particularly in-game advertising, as well as forms of in-game advertising, game genres, and the relation between game genre and suitability as advertisement platform. Finally we will discuss current problems with in-game advertising.

The third chapter discusses the role of perception in in-game advertising. We will first discuss previous experimental work done in this field. It then introduces the background of cognitive psychology, in particular memory and visual attention, which we hypothesize it is the key to improve the effectiveness of advertisements in computer games. Based on that we will develop our hypotheses how the effectiveness of in-game advertising can be increased by manipulating visual attention.

The fourth chapter presents the experimental validation of our hypotheses, including the description of development history of the experimental design, the final experimental protocol and the results with our interpretations.

In the last chapter, we conclude with summarizing the scientific contributions of our work, discuss the limitations and propose open issues and ideas for future work.

CHAPTER 2

Computer Games and Advertising

Computer games are one of the most important entertainment media for modern people. After nearly sixty years' development, computer games become more and more mature and derived many different genres suited for different user groups. With the widespread availability of the internet makes the number of computer game users increase explosively, and computer games became a very important and powerful medium to place advertisements.

On the other hand, advertisement is an important bridge between manufacturers and their potential customers. It is the best to reach them through media which are enjoyable, such as entertainment media. In the long course of history, advertisement has also developed a lot of forms on different medium.

While modern people spend more and more time in games (especially video games) instead of consuming traditional media, in-game advertising appeared as an important field for marketing. Compared to traditional forms of advertising, in-game advertising has a lot of advantages. However, even in-game advertising has been greatly grown with the development of gaming industry, it still remains lots of problems, such as a vast lack of experience about its effectiveness.

The following section will introduce the history and some basics knowledge about computer games and compare traditional advertisement. It will compare traditional advertisement and in-game advertisement. Finally we will discuss the importance of in-game advertising and evaluate its advantages and disadvantages.

2.1 Computer Games

2.1.1 History

Computer games are a kind of entertainment software. In general, the history of computer games can be considered as the history of hardware, software and internet.

Six years after the first vacuum-tube computer appeared, A. Douglas created the first graphic computer game "TicTacToe" on an EDSAC vacuum-tube computer in 1952.

In 1958, W. Higinbotham created "Tennis for two" on an oscilloscope and analog computer which allowed people to play against each other.

Around the year 1960, the first generation of computers was used by US universities. By using them supported the development of computer games because most of games were developed by individuals as a hobby. On this background, the first modern computer game "Space War" was programmed by Steve Russell et al on a DEC PDP-1, which was one of the most modern computer games at that time. "Space War" sometimes is also considered as the first real computer game in certain reference. However, because of the limited accessibility of hardware, computer games were still rudimentary at this time, compared to nowadays technology.

The 1970s were the golden age for computer game development. Because of the quick development of hardware, the costs for hardware decreased. The "father of video game" N. Bushnell created the first commercially available video game arcade in 1971. He founded the first commercial video game company "ATARI Corporation" in 1972. ATARI released "Pong" in the same year, which was the most successful "coin-op" arcade at that time. Two years later, ATARI released "Pong" further for home computers.

In 1977 Apple started selling "Apple II". It meant the coming of the real commercial time for video games. Various different game genres like "action game", "sport game", "adventure game" as well as the first "multiplayer online game" MUD (Multi User Dungeon) were founded at that time. However, due to the limited capacity of graphic hardware, the graphic of video games were still quite simple.

PCs became more and more popular during the 1980s and multimedia technologies have begun getting mature. Important development in this respect was that IBM introduced its first PC which offered two kind of graphic cards: MDA and CGA. These two graphic cards were the beginning of consumer graphic cards. After the appearance of IBM's VGA, the display of 2D computer game came into a splendid time. The 1980s became also the genre innovation time for the video game industry. The basic structure of the genres of computer was also built up during that decade. A very important event for the video game industry was the first 3D game "3D Monster Maze" that was released in 1981.

In the 1990s, because of the new technology of graphic hardware, the 3D game became more and more popular. Several game genres of video gaming like FPS (First person shooting) appeared. The 1990s became a great time for the internet. The widespread use of the internet has brought a strong impetus for computer games. MMOG (Massive multiplayer Online Game) appeared. Online games, especially MMOG (Massive multiplayer Online Game), are not only an important genre of electronic games, but also the fastest growing part of the electronic game sector. Due to the release of the "Ultima Online" game in 1997, the amount of game players increased up to more than 0.1million, and the sales of online games soared to more than $60 billion US dollars. 1997 is also a special year for cell-phone games. In this year, Nokia embedded the first commercial mobile phone game "Snakes" in the Nokia 6110. This creation opened the age of mobile games, which has a huge number of potential users.

The next decade, 2000-2010 was a time full of innovation for both PCs and consoles. As the portable game system got more and more popular, the game industry based on the PCs and consoles had to face a new competitive market. The user-created modification was the trend of time. Games like "Counter Strike" based on this modification were the most popular video games.

2.1.2 Game Types and Genres

There are many ways to categorize game types. Wolfgang and Ludger[W.T07] classify games as their different genres.

Generally, They can be classified as action games, adventure games, skill games, child and family games, quizzes and social games, racing games, role-playing games (RPG), simulation games, sport games, Strategy games and virtual world games.

- **Action games** are games that test human physical challenges requiring hand-eye coordination or reaction-time. A typical action game is the "Counter Strike".
- **Adventure games** are games in which the players play the role of a protagonist in an interactive story that is driven by an exploration or puzzle challenges. A typical Adventure game is the "Tomb Raider".
- **Skill games** are games that require mental skill and strategy to win like the "Super Mario".
- **Child and family games** are games that requires two or more persons to undertake with the purpose of pleasure. One typical example is the "Petterson and Findus". Quizzes and social games are like child and family games, but better suited for adults, for example the "Singstar".
- **Racing games** are games the players join in a racing competition. For instance the "Need for speed".
- **RPG games** are games that in which the players play the role of protagonist in an interactive story which is driven by various different challenges against computer or human. A concrete example is the "Final Fantasy" which was one of the most popular RPG game.
- **Simulation games** are games that simulate the aspects of a real or fictional reality, for instance "The Sims".

- **Sport games** are games with sport theme, such as the “FIFA”.
- **Strategy games** are games which require players thinking and planning very carefully and skillfully to achieve the victory. The “Command & Conquer” can be considered as a good example of strategy games.
- **Virtual world games** are games which simulate the real world. An example is the “Second Life”.

2.1.3 Users

Double fusion[Dou07] has an incomplete statistic which demonstrates that there are 320 million people worldwide who play computer games, and 90 million among them played games frequently in July of 2007. Besides, 217 million gamers play on-line games. Compared to 2006, the total amount of game players increased by 17%. Double fusion took also an American example to analyze the demographic of these players. The result showed that all players are over 12 years old and the trend is that players are going to become even younger in the future. 44% of American male adults and 33% of female play computer games. In addition, 80% of all teenagers and 90% of the teenage boys play video games. Many people in the age 12 to 17 normally spend an average 11.5 hours a week on computer gaming. People in the age 18 to 34 spent 8 hours a week for computer gaming in average. Hardcore gamers (those who play 15+ hours per week) increased 40% up to 17 million in 2007.

In additional, the current study which explored virtually un-researched area showed that 70% of college students were reported to play video games[Age07].

2.2 Traditional Forms of Advertising

2.2.1 Conception

Advertisement can be considered as the medium between advertiser and consumer (Figure 2.1). Simply to say, it is the intermediary which allows the manufacturers to communicate with potential customers. Advertisement aims at the consumption of both products and service. Advertisement embellishes the appealing messages with factual information to make customers buy the product or service. Every medium including television, radio, etc. is normally adapted to place advertisements and deliver these messages.

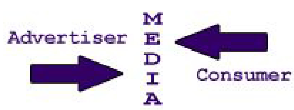

Figure 2.1: The relationship between Advertiser and Consumer

2.2.2 History

Generally speaking, advertising development is accompanied by the development of new media and the level of human knowledge.

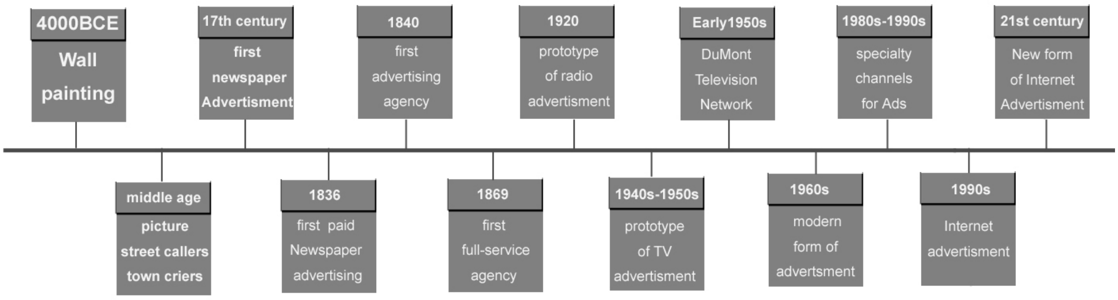

Figure 2.2: The advertising age time line

Bhatia[Bha00] claimed in his paper that the ancient Egyptians have already tried to use papyrus and "Wall painting" to deliver their advertisement message in 4000BC. Because a large amount of people in the Middle Ages could not read, advertisements were presented on pictures at that time.

Modern advertisement started in the 17th century when a new medium form, the "Newspaper", appeared. The first advertisement on a newspaper which was used to sell books and newspapers was published in England. In June of 1836, the commercial use of advertisement was set in motion by the French newspaper "La Presse".

Eskilson and Stephen[Esk07], who investigated the history of advertisement agencies, believed the first advertisement agency was opened by V. Palmer around 1840 in Boston. Soon N. Ayer & Son opened the first agency which offered full advertisement service in 1869 in Philadelphia.

After the first radio station "KDKA" was established in 1920, prototypes of radio advertisement were developed. Initially, the radio equipment manufacturers were just trying to sell more radio equipment by establishing many radio channels, but this behavior surprisingly led to the beginning of radio and television advertisement between the late 1940s and early 1950s.

The first mode of selling "advertising time" was built up by "Du Mont Television Network" in the early 1950s. In the 1960s, the advertisement was transformed into a modern form which produced unexpected messages to attract more consumers. As cable and satellite television programs became more and more prevalent in the late 1980s and early 1990s, specific advertisement programs emerged. Still many online servers tend to emphasize the context relevance (Figure 2.2).

2.3 In-Game Advertising(IGA)

2.3.1 Conception

As the name of in-game advertising suggests, it can be defined as an advertisement form which is placed in computer games. Or we can say in-game advertising is one way that manufacturers of the product communicate with potential customers with the computer game as the intermediary. Like traditional forms of advertisement, in-game advertisement also aims to the consumption of both, products and service.

2.3.2 History

It is hard to specify the exact point when third-party brands became a part of computer games. Since the whole in-game advertising industry is still in its infancy, there are very few references involved about this area.

An interesting reference is Ilya's diploma thesis[I.V06]. He found the first example could be an coin Pinball Machine, which was founded in 1964 in Chicago (Figure 2.3). This machine lists that 4,932 different units included images of the Mustang which used to describe the car culture. It is not clarified if Ford had published this advertisement for its new sport car, but this advertisement did contribute to the sales performance to Mustang.

Figure 2.3: Internet pinball mashine "Mustang" 1964 in Chicago

The first real in-game advertisement in the modern sense which was embedded in the video games was for "McDonalds". In the game by Digital Equipment Corporation in 1973 is called "Moonlander". If players landed in the correct location, a "McDonalds" restaurant will appear, then the astronaut will go inside to order a 'Big Mac' to go. But if players failed, they will be informed that they have just destroyed the only "McDonalds" restaurant on the moon.

This new form of advertising was more widely accepted because of the great expansion of gaming markets in early 1980s. Until 1983, many top companies like "Coca Cola" and "Pepsi" began to try this new intermediary's effect.

In the mid 1980s, video games as well as hardware have been greatly developed. The new games were more complex and popular and the new hardware was able to present more graphic details. This attracted more companies to integrate their brands into video games. “Signposts” and “billboards” which are adapted in sport games were used instead of old “character advertisements”. In that time, sport games were once considered as the most suitable game genres for in-game advertisements’ placement because they were based on real-worlds. In-game advertisements can either improve the realism of the game or could be easier to be accepted by players.

Attributed to the development of the hardware, game developers could display much finer images than before in video games. For instance, Ford designed the first person-driving simulator game called “The Ford Simulator” (Figure 2.4) in DOS System in 1987. This kind of in-game advertising was much more interactive than all previous other in-game advertisings. Players received not only the information regarding to the brand, but also some detailed information about the products. This new sort of in-game advertising is significantly different from Billboards.

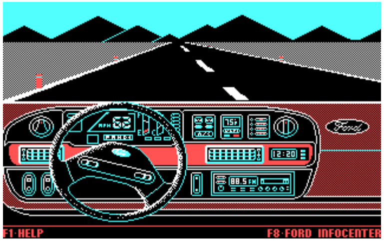

Figure 2.4: The ford simulator

Music tie-ins firstly appeared in 1989. The video game company “Sega” made a game named “Michael Jackson’s Moonwalker” (Figure 2.5). This game was sponsored by the movie “Moonwalker” and used to advertise for Michael Jackson and that movie. It was the first “cross-medium” game which was released for both consoles and arcades.

Figure 2.5: Michael jackson’s moonwalker

Until the mid 1990s, after nearly thirty years of continual development, in-game advertisings and games based on brands became ubiquitous. Marketing began to embrace and test with different formats of in-game advertisings in order to achieve a wide variety of objects. Some brands achieved a higher conversion of in-game presentation.

McDonald's was the first, who try to integrate their advertisement in the 3D (3-dimensional) game in 1972. They commissioned the "BrandGames" designed a 3D interactive game "Mr. Pibb" as a part of the company's back-to school campaign. Customers were required to pay cash to play the game that starred a major brand character. Finally, this in-game advertising had become a great successful as it sold out 750,000 copies of the game in only two months.

After the year 2000, the in-game advertising industry has grown strongly. Lots of different kinds of new intermediaries have been adapted in electronic games. Moreover, game designing has been extremely developed at the same time. It is becoming more and more common to use third-party advertisings.

In 2003 it was possible to scroll out in-game advertisings units, which resulted in the transition from the static in-game advertising to dynamic in-game advertising. This technique was maturely developed in "SWAT 4" until 2005.

Also in 2003 the game "Mall Tycoon 2 Deluxe" from "Take 2 Interactive" took the first attempt to integrate in-game advertisements in an On-line game. By using fast growing online-games especially MMOG (Massive multiplayer Online Game) fast growing, the income of in-game advertising on On-line games increased to $1 billion US Dollars until 2006.

Additionally, we will especially introduce the mobile game advertising. After the first mobile game was released in the 1997, the embracing of advertisers and mobile marketing is much faster than the embracing of advertisers and online advertising. Until 2010, the revenue of mobile game advertising is rapidly increased to $87 million US Dollars within ca.10 years.

2.4 Importance of IGA

2.4.1 Relevance for Marketing

Huge market expectations raised the importance of in-game advertising. To evaluate the importance of particular forms of advertising, it required evaluating its customer base, its technical feasibility and its acceptance.

Customer

As we have mentioned in the section 2.1.3, the increasing expansion of game players determined the rapid expansion of the computer games market. People spent more and more of their leisure time for game playing. Another important feature of the game user is that most of them are very young. These people can easily accept new things and very importantly they have also high spending power. These points make the in-game advertising market the most appealing market.

Technique

Double fusion's report[Dou07] also suggests that the new technique (DVR, computer, internet etc..) reduces the impact and potential of the traditional medium monopoly. For instance, due to the appearance of DVR, television programs cannot force customers to watch annoying advertisements anymore. Moreover, in video recorded TV programs, customers are able to skip the ads in which they are not interested.

Agencies reported[Age07] that 20% of households own DVRs, and the amount would be doubled by 2010. About 50% people aged between 18 and 49 use DVRs instead of watching live television programs. DVRs owners skip 92% of the ads. By the end of 2007, around 19 million people skip all the ads, which caused a decrease up to $6.6 billion dollars of commercials in the United States of America. This situation is getting worse because people spend more hours on games, 42% American decreasingly watch TV and 17% of them watch fewer movies, and about 25% among them own DVRs.

Due to these factors, advertisement publishers lost many consumers especially young people. Therefore, it is becoming necessary and urgent to find a new way to solve this problem. In-Game Advertisements and branded games could be two promising options to better reach customers.

Acceptance

In-game advertisements can be highly embedded within computer games. The players, within the game, will not only have a glance at the products, but also possibly keep them in mind, even positively intend to take them under the first consideration when to buy the similar products.

The report of Continental Research[Res09] suggests that in-game advertisings are widely accepted by young people. Together with Massive Inc, a part of Microsoft Advertising, they conducted 12 studies investigating the effectiveness of in-game advertising.

Across these 12 advertising's effectiveness studies, Continental Research found that 45% of the participants agreed that in-game advertisings have received their attention. 65% of the participants agreed that in-game advertisings made the game more realistic and 58% of the participants agreed that in-game advertisings fits in as a part of the game. 55% of the participants said the in-game advertisings "look cool" and 54% of the participants agreed that in-game advertisings made games more interactive (Figure 2.6).

In-game advertisings are regarded as innovative by 58% of the participants. Finally, they found many young people can accept in-game advertisings as a part of game and these young people are also partly influential consumers who will recommend products and brands to their friends. For more details see online reviews in Figure 2.7.

Since in-game advertising had so many advantages, its market now begins to grow explosively. The newest report from Metric[Met10] presents the following data (Table 2.1):

Microsoft's internal estimated they have got $56 million US Dollars revenue from in-game advertisings in 2005 and they further estimated that the total revenue of in-game advertisings should be about $1 billion US Dollars per year in 2010.

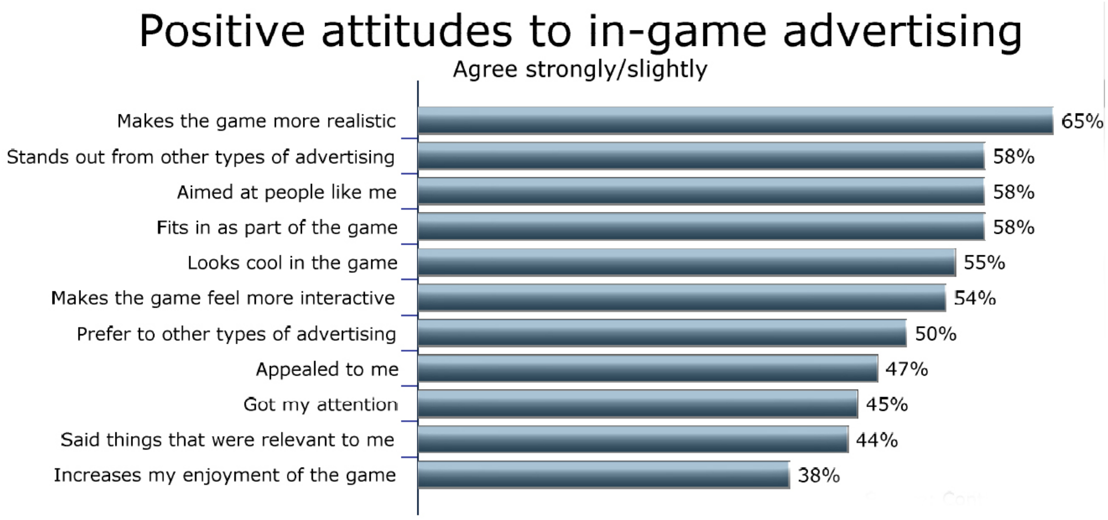

Figure 2.6: Positive attitudes to in-game advertisings [Res09]

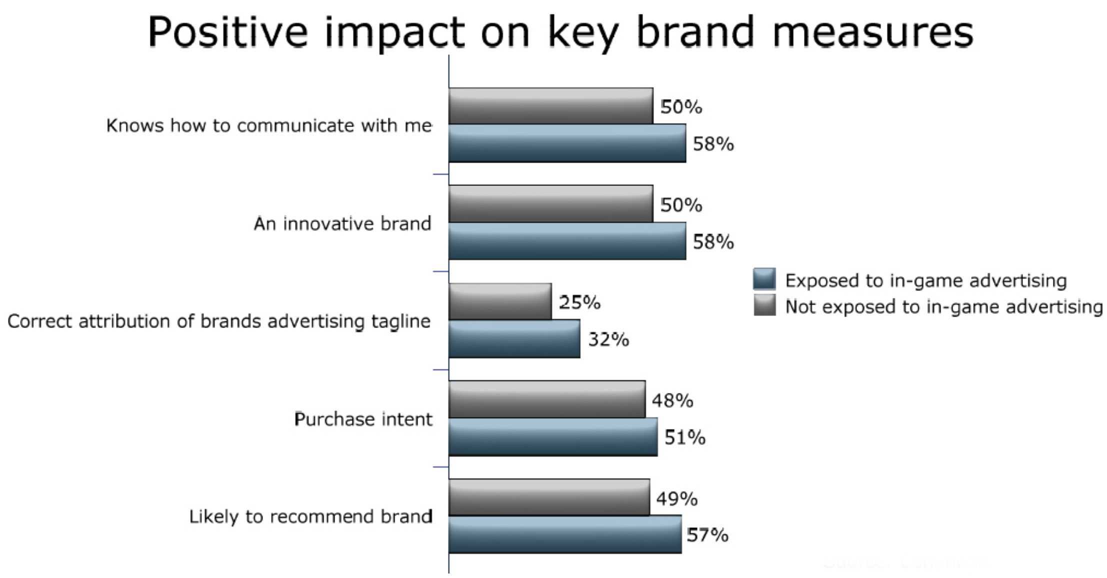

Figure 2.7: Positive impact on key brand measure [Res09]

The Yankee group claimed that the revenue of in-game advertisings was $34 million US Dollars. Their revenue increased to $56 million US Dollars at 2005. And the Yankee group pegged in-game advertisings' revenues at $732 million US Dollars by 2010.

Parks estimated that the revenue of in-game advertisings on PC was increased from $80 million US Dollars in 2005 to more than $400 million US Dollars at 2009.

The CEO of Massive Inc., Mitch Davis, estimated that the expenditure of putting real-world advertisements into the virtual world or games is between $1.6 billion and $1.8 billion US Dollars at 2010 in USA.

The revenue of in-game advertisings were $200 million US Dollars in 2006. In 2007 this sum was doubled to $400 million US Dollars. The revenue of in-game advertisings increased $100 million US Dollars again until 2009 and explosively increased over $1 billion US Dollars per year by 2010.

In-Game Advertising Market Size Estimates ($ Millions)							
	2004	2005	2006	2007	2009	2010	Note
Microsoft						1000	
Yankee Group	34	56				732	
Park Associate		80			400		PC in-game
Massive,Inc CEO						1600	$1.6-1.8B
Analysts			200	400	500	1000	

Table 2.1: In-game advertising market size [Met10]

Rawmeat[R.C09] claimed that "an examination of the in-game advertising industry and a survey of digital planners from GroupM's global agency network are both indicating that a combination of audience media consumption habits and the unique advantages of dynamic in-game advertising will drive the consumption over $1billion US dollars in 2014".

Moreover, this is still exclusive the huge market of mobile game advertisements. The report of Juniper Research[H.L11] predicts that marketers will spend $894 million US Dollars for the advertisements within mobile games in 2015.

2.4.2 Main Advantages

High Effectiveness in Reaching Young Customer Groups

For marketing managers it is a big challenge to reach the young customer groups. However, compared to traditional advertising media, computer games seem to yield a much higher effectiveness in reaching young people. As we have mentioned above, young people are spending more and more time on playing computer games while traditional activities become less important. Moreover, the acceptance of this type of media advertising has already been set on a relatively high level.

Increased Realism in Computer Games

Apart from the marketing value, in-game advertisements are also placed in computer game environments to increase the realism of computer games. For instance, in sport games, such as FIFA Soccer, dummy advertisements are used to achieve a similar visual appearance as in real soccer games shown in TV broadcasting.

Decrease of Development Costs for Computer Games

Another very important advantage of in-game advertising is the combination of advertisement industry and game industry. With this combination, Game developers have created a new revenue stream. This will help reducing the development costs for computer games and thus reduce the prices the customers have to pay.

2.5 Forms of In-game Advertising

Wolfgang and Ludger[W.T07] categorized in-game advertising into four types: branded games, static in-game advertising, dynamic in-game advertising and mixed forms. Moreover, Gaca[C.G08] and Andreas et al[V.A08] claimed that there should be another two additional in-game advertising forms: Content Guidance and Advertising Pause.

Branded Games(BG)

Branded games are video games which are used to advertise a product, an organization or a viewpoint (Figure 2.8). They are always planned and designed by the company's usern to deliver the intended messages. The brands and messages usually do not appear within the games directly, but they are transported to customers instead via the game's environment. Game Designers expect more perception of the company from customers during playing.

Additional, Sneaky[Gam10] categorized Branded games further into three types: ATL (Above the Line) Branded game, BTL (Below the Line) Branded game and TTL (Through the Line) Branded game.

- The typical **ATL branded games** are promotion software. The company puts the games on its website in order to keep the potential customers spending more time on the website or getting more impressions on their products. These games are to promote specific companies or some products.
- **BTL** branded games are through making a game regarding to the products or service and then distributing it to the customers. It is a very efficient approach because this advertisements are not intrusive and, more generally, the games can be so attractive for players that they nearly become addicted. However, these advertisements might be too subtle and consumers could only focus on the games without noticing the products advertisements.
- **TTL** is something between BTL and ATL Branded games, which is created by showing URL hyperlinks inside the game to attract players and to make them visit a webpage which contains BTL advertisements to some extent.

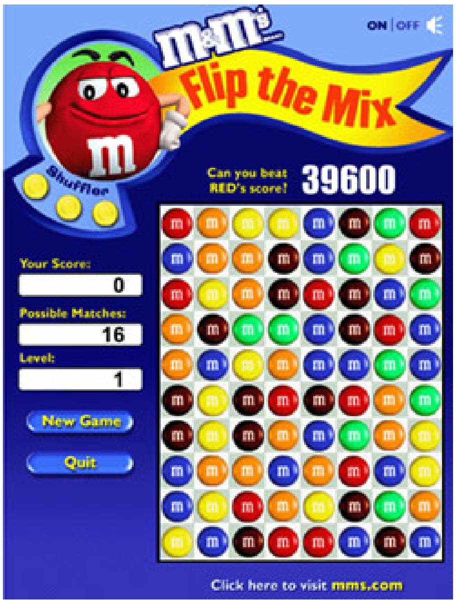

Figure 2.8: M&M branded game

Figure 2.9: Winning eleven

Static In-Game Advertising (SIGA)

Static in-game advertisings are in-game advertisements which are inserted directly into the game by artists or programmers and cannot be changed later. The typical example is the billboard in Sport games (Figure 2.9). Anyway, these in-game advertisements are not always efficient in catching the player's attention. The other example can be found in our experiment. We placed static in-game advertisements on the billboards on buildings, too.

Dynamic In-Game Advertising (DIGA)

Different from the static in-game advertising, dynamic in-game advertisements are not directly inserted into the game during the game development process. This new technique allows publishers to trace the time of the day and the geographical locations of the gamers. This information will be reported and allows the publisher to renew advertisements depending on the real-time information to present, so-called “real-time advertising”. Compared to SIGA, this form is much more flexible. However, some game players feel like being ‘monitored’, and insist these information would be private and should not be reported back to the publishers; therefore, they refuse to install these game packages. So, it’s very hard to tell whether SIGA or DIGA is “better” than the other. SIGA may be “good” because it is offering more “show time” for concrete advertisement, but it may bring no effectiveness for IGA, because it can be shown at a “wrong time” or “wrong place”. DIGA have improved these disadvantages of SIGA, but it may not be noticed by players because of its short “show time”.

Content Guidance (CG)

Content guidance tries to transmit the advertisement information by the content of the games, aiming to persuade customers through a more suggestive way. They are mostly RPG (Role-playing Game). The player acts with a different and unreal ID (IDENTITY) in a limited time in a virtual world, thinking and solving problems which may happen in the real world. It helps him gain experiences or gets him to absorb advertisement information.

Advertising Pauses (AP)

In the advertising pause form, advertisements will be only shown during the “game pause”. However, it reduces the possibility of the acceptance of consumers in the process of computer games, and at least it’s very rarely used when customers buy games.

In-game advertising can also exist as a mixed form of two or even more from above ones. For example, it applies, in particular, to on-line advertising in which the internet medium is considered as a platform for games. The gamers are supposed to spend more time on websites to obtain the brand’s perception.

2.6 Suitability of Different Game Genres

The computer game is a special advertisement medium. It is even more important to evaluate the suitability of the game genre for particular brands to be advertised, comparing advertisement in TV program.

Most brands will find suitable integration environments regarding target Audiences, and the content’s context is believable. The process to select a genre depends on the products and the tonality of their campaign.

Wolfgang et al[W.T07] examined the topic to find out the suitability level of different game genres concerning integrated in-game advertisements. 105 individual experts answered an online questionnaire between May and June 2007, about which genre of computer games they found are suitable for an integration of advertisement. Any classification of genres, of course, always carries the risk of misunderstandings and lacks the selectivity of the classification. To have a clear understanding about game’s genre and make a simple answer, examples with prominent and representative genres were provided. The results as average values are shown in Figure 2.10.

From this Figure, it shows that the highest acceptance game genre as an advertisement medium is “sport games” as well as “quizzes and social games”, and then closely followed by “racing games”. The other acceptable genres are “virtual world game” and “simulation game”. Their research claimed that Ego-Shooter is the worst game genre for in-game advertisings.

Nevertheless we decided to use an action game for our experiment, although it is less suitable for in-game advertisings. Action games play a very important role in the game industry. Many action games have a lot of players. Current research found that the most popular online game is still an Ego-shooter game called “Counter Strike”.

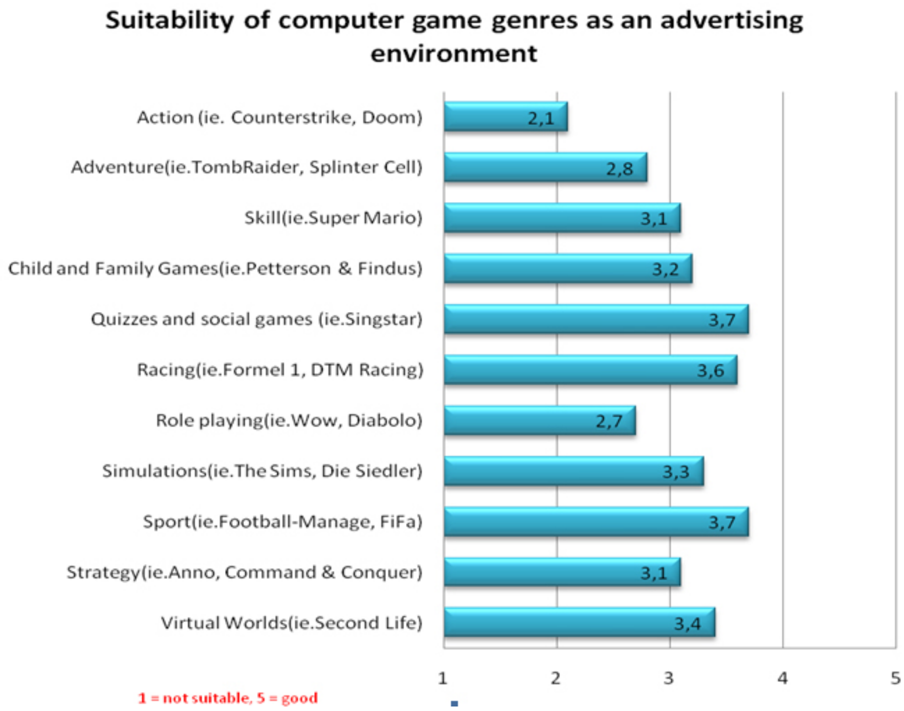

Figure 2.10: Suitability of computer game genres as an advertisement environment from the perspective of marketers surveyed

2.7 Current Problems

Computer game is a rather new medium for advertisement. As we motioned earlier, there is a lack of experience and there are still some considerable problems. These problems are not only on the technical side, but also in other fields like social and ethical as well. The following list summarizes the most important ones:

1. Many players do not like to share their information like location (IP) with the game pub-

lisher, especially in Europe, Australia and North America.

2. It is sometimes difficult to decide which game genre is suitable for which kind of advertisement.

3. Since most computer games impose a strong task, players exhibit inattentional blindness to advertisements.

4. In-game advertising may disturb players while playing.

5. It's not easy to balance the relationship of the visibility of in-game advertisements and the optimally disturbance to players. If advertisements are too obtrusive they may disturb the player, but if they are too subtle they will not be recognized at all.

6. It is difficult and expensive to integrate in-game advertisements after the development of a game.

7. It's hard to knows if in-game advertisings will have a positive or negative impact.

The scope of this work is mainly concerned with the 3rd problem. Our goal is to investigate how we can avoid inattentional blindness of in-game advertising. On the other hand, we also tested whether there is a negative effect on gaming performance when attention is directed more often to advertisements (4th and 5th questions).

2.8 Conclusion

Due to the great success of computer games as an entertainment medium, in-game advertising plays an increasingly important role in both, game and advertisement industry. With the wide spread of computer and networks today, in-game advertising showed many inherent advantages compared to the traditional advertising models. Though in-game advertising has a huge market and offers great development potential, current research about in-game advertising is still in its infancy, especially experimental work concerned with the perception of in-game advertisement. The effectiveness of in-game advertisements is thought to be still weaker than traditional advertisement for a variety of reasons. The main problem addressed in this work is the low attention to in-game advertisements in task-intensive games, such as action games. Increasing attention to advertisements by suppressing inattentional blindness will attract attention the full potential of in-game advertising. We think that the key to such improvement is to understand perceptual processes involved in the recognition of advertising in computer games.

CHAPTER 3

Perception of IGA

The objective of our work is to reduce inattentional blindness towards in-game advertising. This shall be accomplished by manipulating the player's visual attention. Therefore, we had to review previous experimental work and select knowledge from cognitive psychology, in order to understand the principle mechanisms responsible for the perception and memory of advertisements.

This chapter will first discuss how the effectiveness of in-game advertising can be measured, and summarize and discuss related experimental studies. Then, we will summarize selected work from psychology which helps us to understand memory and visual attention. We think these are the key issues which need to be considered when attempting to improve the effectiveness of advertising in computer games. Finally we will suggest how we can change attention in computer games or virtual environments.

3.1 Investigating the Effectiveness of IGA

By comparing the history of in-game advertising and traditional advertising we can find that the first group appeared nearly 6.000 years earlier than the first in-game advertising. In contrast to traditional advertising, in-game advertising is a very young field and little is known about its effectiveness. It requires more scientific investigation of this topic. Apart from marketing surveys, rather few experimental studies have been conducted on the effectiveness and perception of in-game advertisements.

3.1.1 Memory Tests

In section 3.1.2 we will summarize some previous experimental studies which investigated effects and factors, such as placement type or presence of violence. These studies could have a potential effect on the perception and effectiveness of in-game advertising. One typical variable to measure effectiveness of in-game advertisings is memory retrieval. In most scientific experiments we found, this was the dependent variable measured to score the effectiveness of in-game advertisings.

An important requirement is that memory test must not be expected by the participants. Otherwise the results would be biased, as participants will behave different if they know the purpose of the experiment in advance.

3.1.2 Previous Experimental Studies

The first study investigating the effectiveness of in-game advertising by means of measuring memory recall was carried out by Nelson at 2002[U.N02]. The study investigated the effectiveness of in-game advertisements which were placed in a racing game. After game playing they tested the memory recall for the in-game advertisements at two different times: directly after playing and 5 months later.

In his first experiment, he placed brands on billboards and also on cars which players drove to potential carry-over effects into the real world. The majority of players could recall both brands of cars and brands on billboards directly after game play.

In the second study, they tested only the memory recall for national in-game advertisements which were placed on the billboards in the game environment.

Overall participants were able to recall about 25 to 30 percent of in-game advertisements directly after game playing, but they could recall only about 10 to 15 percent of the in-game advertisements five months later.

Two years later, scholars of the University of London[I.C04] constructed another study to test the effect of brands being placed on billboards only.

A first person shooting game was chosen for this study. Three billboards for different products were inserted into the map. Each billboards featured products' image and its name in a clear textual format(Figure 3.1). The locations of the billboards were designed highly visible in areas where all gamers would pass. Exposure time was not controlled as it is determined by the player, however, a strategic positioning of the billboards ensured maximum exposure. Furthermore, players would repeatedly pass all three billboards throughout the duration of the session.

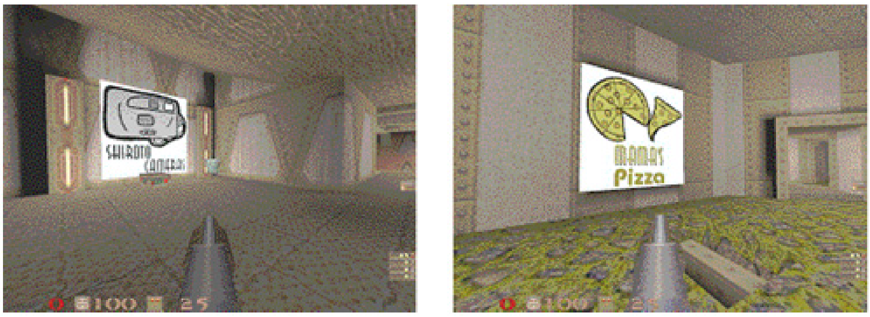

Figure 3.1: Screenshot of embedded advertising in the study of Chaney et al

After their experience, only one person could recall all products and the whole brand information, one quarter could recall one or two, and about half of the participants could not remember anything. We guess the only person who could recall all information knew or guessed the experiment's purpose.

Grigorovici et al[D.G04] investigated whether there is an impact of advertisement type and presence on brand effectiveness in 3D gaming immersive Virtual Environments.

In their study, they build a 2x2-factor (product placement vs. billboard high level of arousal: vs. low level of arousal) mix designed game to test the impact of different 3D advertisement types and different arousal levels in immersive virtual environments on brand recall, recognition and preferences (Figure 3.2).

Figure 3.2: Screenshot of low arousal IVE, with BMW product placement, Nokia cell phone billboard and the secondary reaction time object (yellow cube)

They measured the Player's reaction time and ratings of presence for each products and brands which was embedded within the environment. Finally, they tested the free and cued recall as well as the recognition of memory items.

Figure 3.3: Different conditions in Cobelens experiment

One hundred forty-four male and female participants took part in this study and were assigned into 2 levels of arousal groups.

They found that the advertisements placed on billboards were significant better recalled than the same advertisements placed somewhere else in the game environments, except the respective brands were related to automobiles. They also found that higher levels of immersion in the game interfered with players' recall for brands placed in the game.

S. Cobelens[S.C10] conducted for his master thesis an experiment to investigate the effectiveness of different in-game advertising placement types in a first person shooting game. The IGAs were placed on prominent billboards or subtle billboards. Furthermore, he also tested the effectiveness of prominent product placement, subtle product placement and an interactive placement. An interesting point is that he used bonus items to place interactive IGAs, so player could regain health points from it(Figure 3.3).

Thirty-two participants with game experience have joined his study and played the test game for 20 minutes. To measure the effectiveness of memory recall of the IGAs, participants were instructed to write down the brands they saw during the game after the game section.

After his experience, 69% of the participants could recall the in-game advertisements on the prominent billboard. The interactive and subtle product placements were 56% recalled by participants. The subtle billboards were recalled by 47% and the prominent product placements by 22%. 91% of the participants recalled at least one advertisement.

An interesting direction was explored by Melzer et al[A.M09] who designed a study to investigate whether game tension has an impact of brand memory. They hypothesized that the effectiveness of in-game advertising should be higher in non-violent games.

They built an analysis system consisting out of an immersive driving simulator combined with utilities for gaze and bio-signal recording, which they called “Ad Racer”. Moreover, the system ran a (surprise) memory test after each trial to measure the recall of brands which were placed in as billboards in the racing game environment. Ad Racer was used for multifaceted testing and in-depth analyses of game effects and in-game advertising efficiency.

A 2x2 (violent vs. non-violent x cued memory recall version of a brand clarification task vs. free recall of brands) mixed-factorial design was used to test if the independent factor violence could influence the performance in the memory recall of in-game advertisements. Two different memory retrieval tests were used to analysis separately in order to get more accurate results.

In the non-violent version, participants were rewarded for running over animated geometrical shapes distributed along the race track (Figure 3.4 left). In the violent version, participants were rewarded for running versus pedestrians (Figure 3.4 right). Both groups were then given surprise memory tests. Thirty-two different brand logos were randomly selected for each participant. Each logo was shown as 2D-billboard as and appeared three times during an individual driving session.

Figure 3.4: Ad-racer in non-violent (left) versus ad-racer in violent (right) mode

19 participants joined these experiments. They were assigned to play either the violent or the non-violent version of the racing game.

The order of the Memory tests was fixed: participants started with the clarification task (cued recall) and then proceeded with free recall.

The result showed that game violence did not at all impede memory for brands previously shown as billboard, and the participants in the nonviolent conditions perform also not better performance than the violent group.

3.1.3 Conclusion

Most studies (except Cobelens') investigating the perception and effectiveness of IGAs yield the same result: IGAs are barely attended and remembered by players, no matter players have a lot of playing experience or the game is easy to play. To explain this phenomenon, Chaney et al[I.C04] hypothesized the low recall of the billboards may be due to limited processing capacity as it is focused on game playing. Melzer et al[A.M09] attributed it to players' visual attention which has been attributed from the product information to the program itself. Participants playing the racing game pay attention to the task, but not to task irrelevant contextual features like billboards. Visual masking effects may have erased player's iconic memory. Furthermore, both studies from Grigorovici et al and Cobelens have proved billboard should be the best object to place IGAs.

We believe that the reason of low memory recall rate of IGAs is because a computer game is a kind of interactive medium. Players are strong game task oriented. Their attention is focused solely on the objects which are directly relevant to the task of the video game that they are playing.

The primary goal of advertising is that potential customers remember the information of brands or products. Hence, we assume that memory recall is the best measure for the effectiveness of advertisement. Therefore, we conclude that it is necessary to improve the player's memory of in-game advertisements. To this end, we need to discuss the fundamental theories about human memory, which will be summarized in section 3.2. There, we will also learn that, basically, it is attention which selects the content which enters the memory. In section 3.3., we will then focus on visual attention, which we conclude to be so important to understand why advertisements are remembered, or not. Moreover, in our opinion, understanding visual attention is the best starting point when attempting to increase the effectiveness of in-game advertising. From the models for visual attention, we will derive a fruitful strategy which allows us to manipulate human visual attention in such a way that some intended locations are recognized by the user (Section 3.4).

3.2 Human Memory

Memory is involved in remembering, maintaining and applying our experiences. It is the selection, encoding, storage and retrieval processes for information. There are three main stages in the formation and recall of memory from the information processing: encoding, storage and recall.

Processing contents of the memory is a very complex task and involves various types of memory.

3.2.1 Types of Memory

According to the modal model of Atkinson and Shiffrin[R.A89] memory can be classified into 3 types: sensory memory, short-term memory and long-term memory.

Sensory Memory

Sensory memory is the first level of the memory. It is the temporary buffer where we store all information that senses have received before they reach any cognitive process. Hence, it retains an exact copy of the incoming information of all senses. It has an unlimited capacity but it can last only for 300 milliseconds.

Sensory memory can be further categorized into iconic memory, echoic memory and haptic store, where echoic memory is used for processing of audio information and the haptic store retains physical senses of touch and internal muscle tensions. Our interest concerns only iconic memory which is involved when visual information is processed. Iconic memory can also be called visual memory. When visual information is coming, it will active the iconic memory and then further processed in the iconic memory. Iconic memory cannot hold any information for longer than one second. However, "the transference of information from the eye to the brain is preserved just long enough for the eye to move to the next point."[G.S05]

Short-Term Memory

Short-term memory is the second level of the memory. It has a very limited capacity. Only a small amount of information can be hold by it at the same time and it lasts only for a short period of time. Short-term memory is the workbench of human consciousness. Information which comes directly from sensory memory or is recalled from long-term memory has to enter short-term memory to reside in an active and readily available state to be accessed efficiently by cognitive processes. For instance, if we are looking for apple, we have to recall the stored representation of an apple from our long-term memory into the short-term memory and make representative features (red, round etc.) active and readily available. These active and readily available representations comprise only important visual information, such as the features red and round, which are delivered from sensory memory to short-term memory. This allows us, for instance, to search efficiently for the location of and apple as a minimum of visual information is involved. Hence, short-term memory is also in nowadays often referred as "working memory".

First experiments[G.M56] showed that the commonly-cited capacity of short-term memory is about 7 ± 2 elements. More recent work from Cowan et al[N.C01] suggests that the short-term memory's capacity can be increased through a process called chunking.

Information in short-term memory can last only for 20 to 30 seconds and it can last even much less sometimes, while constant attention or rehearsal can help to hold information for longer time in the short-term memory.

Mayer[R.M03]suggested that Short-term memory has three basic learning functions:

The first learning function is selecting. Because of the limited capacity of short-term memory, it is impossible that all information from sensory memory arrives at the short-term memory. To determine which information should send to the short-term memory and which should be ignored requires a selection mechanism. We call this selection mechanism “Attention”. If visual information is selected, we speak of “Visual Attention”.

The second learning function is organizing. The information which arrives at the short-term memory comes in pieces. Organizing is required to arrange incoming information pieces as a coherent whole.

The third learning function is integrating. As the example we have mentioned above. When we are looking for an apple, we need both, the information which we retrieve from long-term memory and the information we receive from sensory memory. The function of integrating is to establish the relationship between the new organized knowledge from sensory memory and the existing knowledge about apple from long-term memory. By integration, we can finally distinguish a red apple from other round or red objects.

Visual short-term memory is a sub-class of short-term memory. Unlike iconic memories are fragile, they decay rapidly, and are unable to be actively maintained, visual short-term memory are robust to subsequent stimuli and last over many seconds. Alvarez et al[G.A04] suggested that the capacity of visual short-term memory is not limited by the number of objects, but rather by their information load. That means if the informational load of an object increases, the number of different types of objects which may be hold in visual short-term memory decreases.

The study of Lee and Chun suggested[D.L01] that visual short-term memory can only encode multiple features when these features are integrated into a single object defined by the same coherent boundary (e.g., a colored, oriented bar). When the features are distributed into different “parts” then visual short-term memory treats these as they were from different objects. Thus, visual short-term memory capacity can also depend on how perceptual and attentional mechanisms parse the visual input into different objects.

Long-Term Memory

The last level of memory is long-term memory. It is the part where all of our memories are stored. Compared to sensory memory and short-term memory which have a time-limited storage capacity, information can be stored in long-term memory for few days until whole lifetime. The term “memory” as it is used in spoken language, usually refers long-term memory. If information cannot reach long-term memory, we can narrowly say it does not exist in memory. The storage capacity of long-term memory is almost unlimited. As we have motioned above, there are three main stages in the formation and recall of memory from the information processing: Encoding, storage and recall.

To memorize information, it has to be “encoded” at first, in order to be assigned to a meaning or index that can be retrieved again by searching this index. For instance, the logo of “McDonalds” can be encoded as “red, yellow M”. If someone cannot recall it spontaneously, then he or she needs to invoke one of the indexes that were used to encode it (such as “yellow M”) which should aid retrieval. Information will not be encoded alone, rather encoding happens in the context with other information, e.g. the environmental, cognitive, and emotional context. The efficiency of information retrieving is determined by how deeply the information is encoded. However, since content in long-term memory is still prone to fading in the natural forgetting process, information may be forgotten even though having been well encoded.

Storage is the actual process of keeping information persistent in the brain for long time. New information can be at first integrated in the short-term memory with pre-existing knowledge of the long-term memory. Storage in long-term memory can be then consolidated by association with this pre-existing knowledge.

The last basic stage of long-term memory is memory retrieval. Long-term memory works in this stage with short-term memory together. To retrieve information, our brain has to find the respective indexes with which it was assigned in the encoding stage, copy the information to the short-term memory in order to make them active and readily available for further usage.

Memory retrieval can be further divided into memory recall and recognition. Memory recall requires active information reconstruction. Memory recognition only requires deciding if one thing among others has been encountered before. Therefore, memory recall is much more difficult than memory recognition, because it requires the activation of whole neuronal networks involved in the memory to find the answer to the question, whereas in recognition processes a set of neurons has been activated by the question initially and this part may spread activation to other semantically related neurons in the network.

Basically, most memory tests (which have been used in previous work cited here) are recall tests, because participants are asked to remember which advertisements they have seen, but not asked questions which provide additional information, like "Was there a McDonalds advertisement in the game?"

Recall memory tests we consider as "active memory tests", because participants need to actively reconstruct the information required to answer these question. Whereas recognition memory tests, which use, for instance, yes-or-no-questions (as we will use for our experimental study), we will denote as "passive memory tests".

3.2.2 Memory and Visual Attention

A great amount of visual information is first received by our optic organs, and then was sent lossless to iconic memory. However, due to the limited store capacity of visual short-term memory, only visually attended information can be sent to visual short-term memory to be further processed there. In the last step, visual information will be sent to long-term memory and be stored there. The visual information is then ready to be retrieved in some future again. If the retrieval process is active, visual information will be temporary copied in from long-term memory to visual short term memory again and trigger the output stimuli (Figure 3.5).

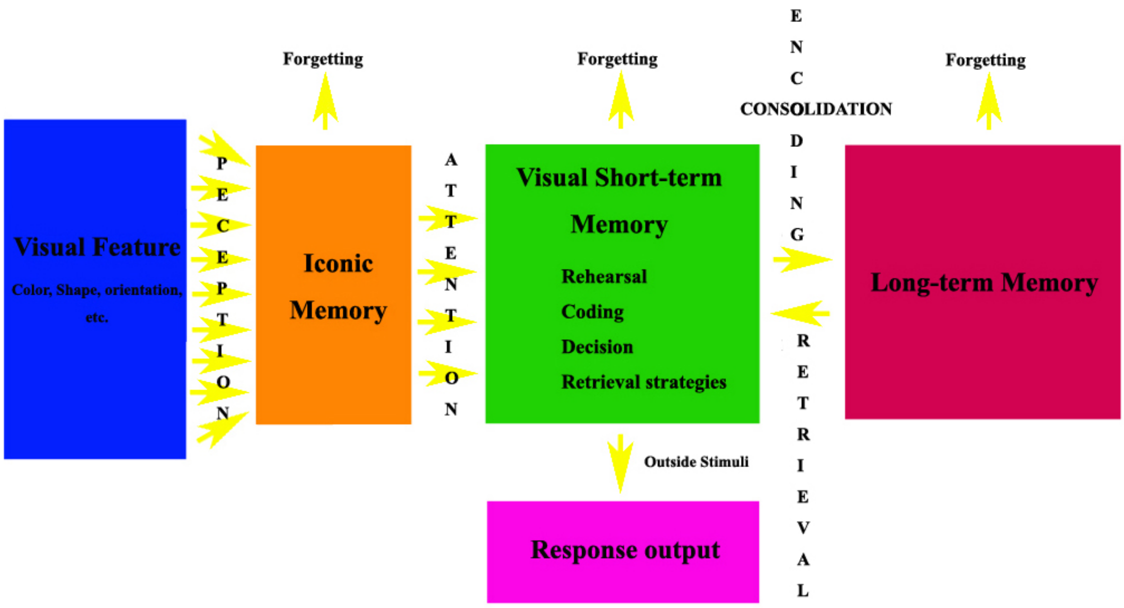

Figure 3.5: Visual information process in memory system

Concerning the relationship between memory and visual attention, we see that visual attention is very important for the whole memory processing, as it directly selects which bits of the visual information stream will enter the visual short-term memory. Only the visual information which reaches visual short-term memory can be stored in the long-term memory and be retrieved in future. Except between iconic memory and visual short-term memory, visual information can be lossless transported among the other memories. It is visual attention who determines what will exist in our memory. So, visual attention plays an essential role in the whole processing of visual information and its storage. Hence we will discuss visual attention in the next section in detail.

3.3 Visual Attention

Visual attention is the administrator of the human memory system and provides access only to those parts of incoming visual information which are important. Only information which passes this selection is remembered potentially. In this section we will try to understand how attention filters out the information supposed to be less important. Moreover we will introduce the mechanics of visual attention and eye movements. Eye movements are also important to be considered, because they determine which visual information will be sensed by the retina and arrive at sensory memory.

To understand the very basic mechanisms of visual attention, we will introduce two models: top-down and bottom-up where top-down is user-driven and bottom-up is stimulus-driven.

Based on these models we will explain why inattentional blindness occurs. Our hypothesis is that we can reduce intentional blindness by manipulating visual search. It is an essential function of the visual system which is guided by visual attention and will be one of the focused topics in this chapter. We will introduce two different models for visual search processes: serial search and pre-attentive vision. The first model is very important for our work, because it is the basic part where we try to manipulate visual attention to be more sensitive to advertisements.

Our main assumptions are based on Jeremy Wolfe's model for visual search which he denoted as "Guided Search". We will explain this model and also the Treisman's feature integration theory, which is its basic precursor.

In the last section of this chapter we will present some approaches how visual attention can be manipulated, and introduce our hypothesis how we can bias a players' attention towards in-game advertisements which is based on Wolfe's theory of Guided Search.

3.3.1 What is Attention

Attention has a complex meaning in psychology. The most famous and often cited attempt to define attention in a plain language was given by the famous psychologist William James[J.W90]:

"Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought Focalization and concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state which in French is called "Distraction", and "Zerstreutheit" in German."

Simply to say, since the world around of us bring us too much information more than our process ability, we should "ATTEND" only important information and ignore the huge of amount of other information being less importance. In the following we will summarize some classic models which attempt to answer the question how attention filters important information from less important information.

3.3.2 Understanding Attention as an Information Processing Filter

Most models of attention are based on the view that every form of cognition can be regarded as an information processing task. Based on this assumption, attention was regarded as an information filter. To simulate this filter behavior, psychologists constructed many different models. We can categorize these models generally into three classes: early-selection model, late-selection model and a mixed model.

Early-Selection Model

Early selection means that information is filtered on a low stage of perceptual processing before being further processed in higher levels of cognition. One early famous representant of this class of models is “Broadbents filter theory[D.B58]. This model proposes that sensory information is sent in several information channels into the sensory memory, but only one channel will be select to further sent to short-term store. The attention selection mechanisms can switch these input channels.

In 1964 Treisman[A.T64] extended Broadbent’s filter model to the “Modified filter theory”. She believed that not all unattended information will be complete blocked by attentional selection mechanisms. Some information should still be available for the encoding of the meaningful information even it might be impossible to retrieve it again.

Late-Selection Model

In contrast to early-selection theory, “Deutsch & Deutsch”[J.D63] stated a theory, which is called “late-selection theory” and assumes attentional mechanisms to take place at a later stage of information processing.

The late-selection theory advocates that the selection must occur after the information recognition stage. All attended and unattended information which arrives in sensory memory should pass through the same perceptual and discriminatory mechanisms. These mechanisms will segregate incoming information and assign it with different levels of importance. Only information with a high importance level is sent to attentional selection stage for further filtering.

Mixed Model

N. Lavie [Lavie95] proposed the so-called “Perceptual Load Theory”. This is a hybrid model of early and late selection, where attentional selection alternates between early selection and late selection. In this model information is divided into task relevant information and task irrelevant information. The attentional capacity for task relevant information is determined by the perceptual load, that is the number of task relevant objects and distractors. There will be early selection when perceptual load is high, and there will be late selection when perceptual load is low.

3.3.3 Visual Attention and Eye Movements

The visual system is the greatest cognitive apparatus used for processing of sensory stimuli. As vision is one of the most complex cognitive tasks, attentional selection is one of the key components allowing our brain to perform vision efficiently. Visual attention, which is closely connected to the movements of eyes, is a very special kind of attention and challenged tremendous research efforts throughout the history of research on attention.

Steinman et al[B.S98] defined visual attention as follows: “visual attention is as a mechanism which prioritizes our visual sensory input so that important or life-threatening information is enhanced, or processed more easily, and all other (relatively irrelevant) information is inhibited or ignored. Therefore, attention removes or filters our irrelevant information, allowing more important information through, so the higher cortical centers are not overwhelmed with more information than they can handle, while enhancing processing of that important information.”

Since the eyes are the sensory organs which actually receive visual information, their orientation towards the stimuli basically determines what we see and what we do not see. Hence, the visual system comprises a faculty in the brain stem dedicated to control our eye movements, which is guided by visual attention.

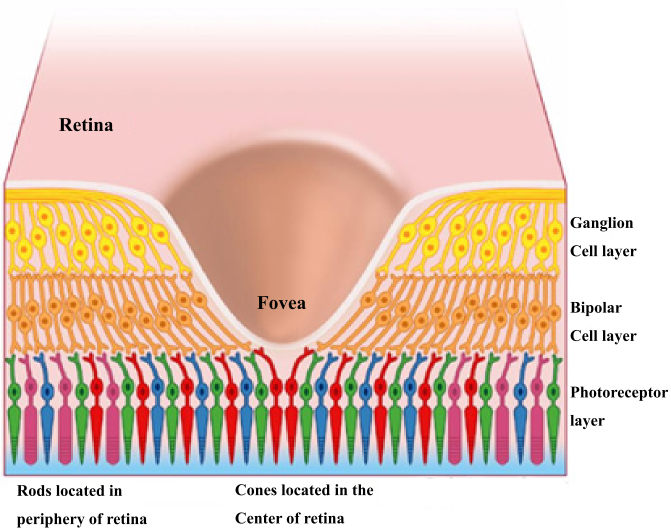

Figure 3.6: Central fovea of the human retina

The most important part of the eyeball is the retina. T.Montgomery[T.M], defines retina as follows: "Retina is composed of light sensitive cells known as 120 million rods[3] and 7 million cones (7 million) [4] interconnected by a complex mesh of neurons that provide early stage visual processing." The area at the center of the back of the eyeball is fovea. The fovea is completely covered by cones and the areas around fovea are covered both cones and rods, but the farer away from fovea the lower is the density of cones (Figure 3.6). Most rods cover the area where the retina is closest to the lens muscles. Due to this arrangement the view field has a sharp resolution only in the center of the fovea and the resolution decreases with increasing distance. Visual perception can be compared to a spot light which illuminates only a very small area in the center of fovea with enough light so that details can be resolved. If we want to resolve details outside this area, the fovea has to be shifted to particular locations of interest.

Consequently, the eyes work in two modes: fixation and saccade. The eyes have to maintain the fovea quite stationary on a stable location for at least 300ms to capture high-acuity visual information. After all relevant information has been extracted a shift of the gaze to the next interesting informative location can be performed. The mode when gaze stabilizes on a fixed position for some time, is denoted as **Fixation**. The shifting movement of eye is called **Saccade**. Visual attention determinates what will be fixated and how long, where will be the next location

[3]Rod cells have low spatial resolution and support vision only in low light. They are sensitive to objects' movement

[4] Cone cells function best in bright light, process acute images and discriminate colors.

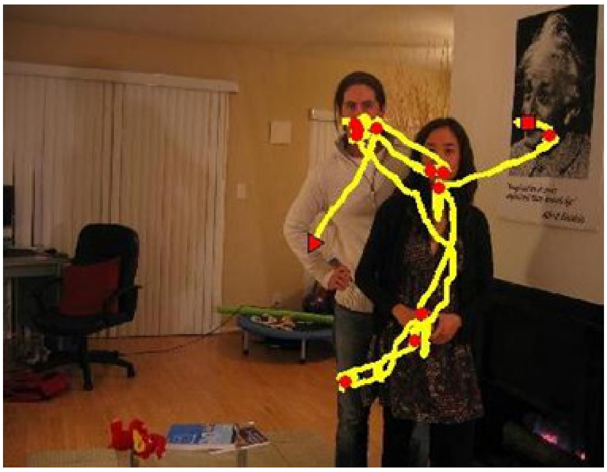

Figure 3.7: Visualized eye tracking data from Cerf et al[M.C09]: red points are fixation points and yellow lines visualize saccade paths between fixations.

to be fixated and guides the eyes to the respective locations. Saccadic movements cannot be performed without preceding shifts of visual attention. Figure 3.7 shows an example of visualized gaze data recorded by an eye-tracker where we can see fixation points and the saccadic movements between.

On the other hand, what we see must not necessarily correspond to what we attend to. That means it is possible that people fixate on one object while paying attention to another.

Actually, there are two modes of visual attention: overt and covert attention. "Overt attention" refers to the correspondence of the position of the attention focus and the direction of gaze. Whereas, the opposite case, when attention is directed to a location independent of the direction of gaze referred as "covert attention". H.Pashler[H.P98] claimed that covert attention shifting is done much faster than overt attention shifting, and it can enhance visual processing of selected areas. Furthermore, overt attention and covert attention are not in most cases strongly connected. Normally, shifts of covert attention are followed by shifts of overt attention. In the example in Figure 4.11, it could be that the beautiful girl had attracted the viewer's attention and then he moved his eyes to take a look at her.

3.3.4 Top-Down and Bottom-Up

As the early discussion about late and early selection that have been already indicated, attention can shift to various levels of perceptual and cognitive processing. Two models are commonly used, both assuming that the control of attentional selection starts at the two opposite ends of perceptual processing and is propagated in one direction: from the stimuli (=bottom) upwards or from high-level cognition (=top) downwards. Bottom-up and top-down are terms used to denote the different kinds of attentional control. "Bottom" is considered as typical sensory input

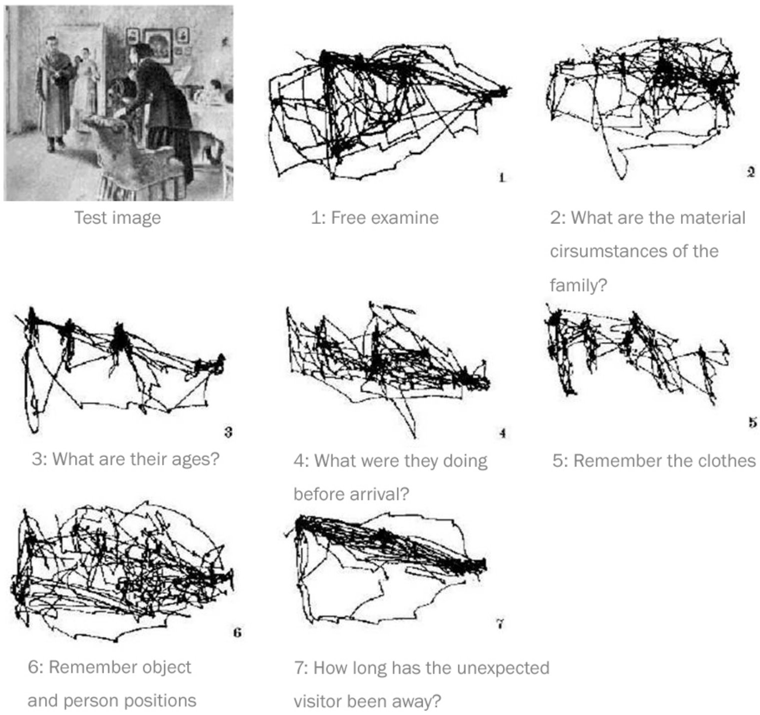

Figure 3.8: Yarbus's study about visual attention and eye movement[A.Y67]: Yarbus provided his participants a picture and asked them to carry out different task, such as estimating the ages of the people in the scene. He constructed one of the first eye-trackers to record the eye-movements in this experiment. The upper left picture shows the painting displayed to the participants and the other images the entire gaze path of one participant recorded for different tasks. This experiment revealed that there is a clear difference in the eye-movements path according to the task being performed.

whereas "Top" is considered as higher cognitive processes which have more information from other sources.

"Bottom-up" process is purely stimulus-driven. For instance, there is an image with thousands green balls and one red ball. Once people look at this image, the only red ball will capture his attention immediately on its location because red ball has a significant different feature compared to green balls. In this case people's attention was not contingent upon the knowledge of the red ball, but the red ball's stimuli attracted people's attention. Compared to the early models of attention, bottom-up process resembles best to early selection models. In contrast to "bottom-up" processes, "Top-down" control of attention is driven by cognitive processes or a subject's volition. Yarbus with his famous eye-tracking experiment[A.Y67] was the first who had shown empirically that eye movements can be also guided by the intentions and expectations of the viewer (Figure 3.8). In this experiment, Yarbus asked his participants some questions and tracking their eye movements.

The effectiveness of top-down processes depends, at least in part, on whether activation or inhibition can be limited to the set of target or non-target items respectively. This is likely to be determined by the similarity between target and distractor items. The following example can be considered as a typical top-down process: someone is looking for a red ball. In this moment he or she has already a cognitive representation in his or her head which tells him or her that a red ball has the two features red color and round shape. Hence the ball in the field of view appears to be salient. In computer game playing top-down attention is also dominating in most cases, since the current game task determines which information from the stimuli is required, and mechanisms such as visual search (Section 3.3.6), help the players to find these information as quick as possible.

3.3.5 Inattentional Blindness

The proportion of the overall capacity allocated to the main task, depends on its perceptual load, is determined by the number of task relevant units and the nature of processing required for each unit. If the whole capacity is required for a task, attention is restricted to task relevant visual information only and task irrelevant (visual) information tends to be fully ignored. In other words, top-down control dominates and only task relevant items are recognized and appear to be salient. As this effect of task focused information selection can be impressively strong, subjects appear to be “blind” to all other events and objects which are not related to the current task. This phenomenon was thus denoted as “Inattentional Blindness”.

Actually, “Inattention Blindness” occurs very frequently in our normal life. A husband focused on the beautiful face of his wife may not notice her new hairstyle. Or car drivers miss the exit of a highway, because they did not notice the exit signet while performing passing maneuvers.

Mack and Rock[J.M98] investigated this phenomenon in their study scientifically with an experiment. In this experiment they presented at first a cross brief on the display and instructed their participant to judge if the horizontal or vertical arm of the cross is longer. On the 4th trial they displayed an unexpected additional shape on the display and afterwards asked participants if they have noticed some other objects except the cross. Then they displayed only the cross (again) on the 5th and 6th trials, but on the 7th and 8th trials they put in the unexpected additional shape a second time. Additionally, they instructed their participants to focus only on the center area of the display. After 7th and 8th trials, they asked participants again if they had noticed anything except the cross.

The 4th trial was considered as the divided-attention trial whereas the 7th and the 8th trials were considered as the full-attention trials because unexpected additional shape appeared on the 4th trial for the first time, so it should be easier to be noticed by participants after the 7th and 8th trials when it appeared again (Figure 3.9).

Mack and Rock found that almost 75% of the participants miss the unexpected shape on the critical 4th trial. This result showed that in a condition without the instruction to look for new objects, participants have not yet got a conscious perception of the additional object, even if it

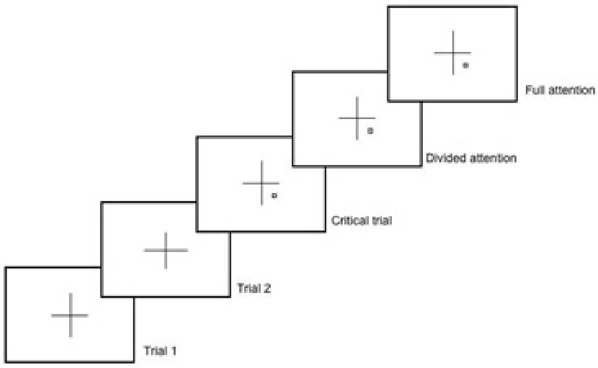

Figure 3.9: Example of Mack and Rock's study

appears in their view field.

The further study of Mack et al[A.M02] tried to control the properties of unexpected additional object in order to help reducing the inattentional blindness. They found that inattentional blindness will be reduced when the unexpected additional object is meaningful for the participants (such as a smiling face or the participant's name).

Simons et al[D.S99] conducted another interesting experiment to investigate "Inattentional Blindness", which has become famous through a very popular demo video clip on Youtube. In their experiment, participants had to watch a 75s video. In this film, there are 6 basketball players who were parted into 2 groups and are passing the ball to each other. One group is white clothed and the other is black clothed. The film modus was divided into a transparent condition (Two sets of people's images can be overlapping) and an opaque condition (Images between characters can be shelter each other). Between the 44s and 48s a person with an umbrella or a person dressed as gorilla ran through the scene. (Figure 3.10) The unexpected stimulus appeared for 5s on the display area and then moved outside the display area. Participants were instructed to count the number of passes between basketball players of one of the two teams.

The majority of participants did not notice the person with the umbrella or the person dressed as gorilla running through the scene. However, the number of participants who have noticed the person dressed as gorilla was significantly higher than the number of participants who have noticed the person with the umbrella. A reason for that could be that in cases where the unexpected stimulus has similar features as task relevant objects, then the likelihood to be recognized is increased.

Another result of their study was that the more complex the target is, the greater is the chance that inattentional blindness occurs. When the task is difficult and the perceptual load is high, people have to pay much more attention on the target (as e.g. counting the passes between the players).

Computer game playing can also be considered as strong task oriented. For most of the participants, the more complex the target is, the game is the more interesting. However, the

Figure 3.10: Screenshot of the video of Simons et al: two groups who dressed white and black clothes with a unexpected person dressed as gorilla

target is not always quite easy. According to the study of Simons et al, these properties determine that players have to focus the whole time on the game's target. This will cause inattentional blindness for the other target irrelevant objects, so that players have a very small chance to notice them. Particularly in-game advertisements can be considered as target irrelevant objects (unexpected additional objects). This explains why the in-game advertisements were barely noticed in another related work about in-game advertising.

However, we also found that the results of Simons et al are still very helpful for our study. It is because they found that the similarity between expected objects and an unexpected object can help to reduce the inattentional blindness on the unexpected object. In the following chapter we will propose our explanation which hypothesizes that this effect can be explained with models of visual search. In short, we hypothesize that most tasks elicit a series of visual search tasks.

According to established theories, visual search tasks are primarily feature-based. Task-irrelevant objects will be recognized, if they have similarities in the features used in visual search for task-relevant objects.

We will thus expand in the following sections on the theoretical background about Visual Search. It is supposed to be performed in pre-attentive stages of vision when attention is guided to regions in the field-of-view, which are supposed to potentially contain a search target.

3.3.6 Visual Search and Pre-Attentive Vision

In a visual search task, visual attention needs to be directed to objects or features in the scene which are candidates for the search target.

Visual search can be roughly divided into 2 modes: serial search and pre-attentive vision.

Serial search scans all candidate locations where a search target may be located and integrates several features of the current scan position in order to distinguish targets from distractors. It is a serial search process, because several saccadic eye movements are performed until an item of interest is found. After each saccade a fixation is performed to gather high-acuity visual information for each position in the scan path.

In a pure serial search, theoretically, each object in the field of view has to be scanned until the target is found. As this is very inefficient, there are other attentional selection processes which perform an efficient pre-selection of regions which have a high a-priory probability to bear the search target. These processes are denoted as pre-attentive selection and basically enhance the saliency of target candidate regions and attract eye-movements for an accurate inspection.

The most prominent model explaining pre-attentive vision is the Feature Integration Theory which will be described in Section 3.3.7. Then we will explain Guided Search an extension of this model which also accounts for top-down factors involved in visual search(Section 3.3.8).Guided search further provided the possibility to put feature integration theory into the practice.

A main property of pre-attentive selection mechanisms is that they work in parallel. A. Treisman[A.T85] defined pre-attentive processing as follows: "Pre-attentive processing of visual information is performed automatically on the entire visual field detecting basic features of objects in the display."

Treisman[A.T86] claimed that in the pre-attentive search processing, every individual features are firstly in parallel extracted from the visual environment, afterwards they will combine with concrete objects in human attention system later. Hence, pre-attentive search is done much quicker than the serial search because it does not need people to pay their attention to the features detection stage. A very simple example of a pre-attentive task is the detection of an object which had great different properties against the distractors. The viewer can find it at a glance.

3.3.7 Feature Integration Theory

Treisman's Feature Integration Theory[A.T80] is the most important model which explains pre-attentive vision. This theory proposes a schematic representation of visual attention. The feature integration theory divides the visual attention process into several phases. The first phase is the "pre-attentive level". It serves to detect perceptually important visual features which are useful for efficient scene recognition to facilitate basic vision tasks, such as search and edge or object detection.

An interesting phenomenon, which is very useful for understanding how and which features are extracted from pre-attentive vision, is the so-called "pop-out" effect. If the searched object has very typically different properties (features) against to the background, it can be found quickly, because these properties make it look like popping out of the background. These features could include the texture, color, shape, closure, fill, size, orientation or curvature and etc. (Figure 3.11)

Features are processed parallel to each other across the entire visual field. Finally, these

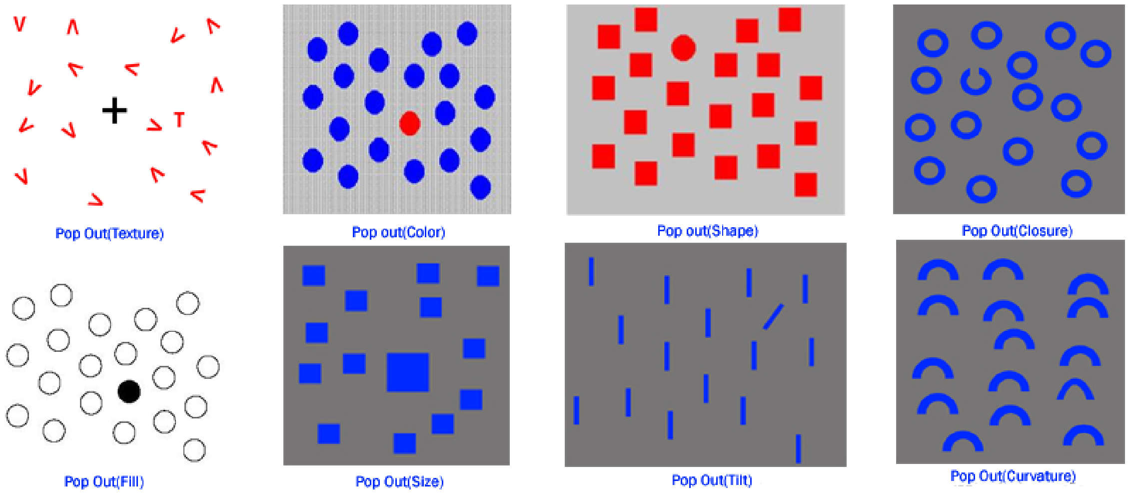

Figure 3.11: Pop-Out Example

independent parallel representations are integrated as limited basic visual features. We call it "feature maps". Feature maps would be able not to depend on all features, but depend on separate maps for each feature instead. Certainly, all features could also be represented in a single, multidimensional map.

The subsequent phase is object detection. With the help of visual attention, the features within the eyesight range will be combined and integrated within each of the objects. Then, this object will be stored in an object file and compared to the means of the objects' description for identification.

A famous concept in theories about visual search is the so-called "saliency map". A saliency map is a kind of simulation of feature integration theory. The saliency map can be considered as a combination of all feature maps in one topographical master map and is supposed to guide attention and eye-movements to visually important regions in the field-of-view. There are also computational models (i.e., algorithms) which simulate pre-attentive vision based on the feature integration theory and output saliency maps as 2D pixel arrays.

E. Niebur[E.N07] had given a short but precise definition saliency map as follows: "Saliency map is a topographically arranged map that represents visual saliency of a corresponding visual scene." We can also consider saliency map as the simulation of feature map in some special conditions.

E. Niebur[E.N07] introduced the process of establishing a saliency map: firstly, the different selective and attentive features will be extracted from the visual environment, and delivered in parallel, then finally combined into the same topographically oriented map. (Figure 3.12) Further, they simulated orienting of overt attention with a Winner-Take-All mechanism where the most salient position is predicted as the next attention target. Saliency map are hence used as attention predictors as they estimate the probability (e.g. intensity of the grey value) for each

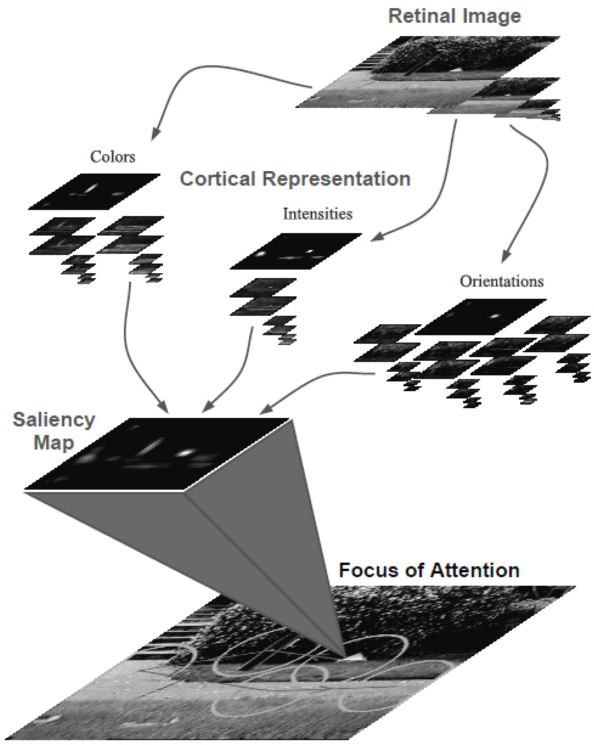

Figure 3.12: Bottom-up bias saliency map[L.I02]

location (i.e., pixel) in the field-of-view that attention is shifted towards the respective position. Therefore they are used to simulate eye movements (fixation location, saccade directions etc.).

Actually, saliency is determined by both bottom-up and top-down factors. In computational models, bottom-up saliency is estimated by the difference between the stimulus and its surroundings. Estimating top-down saliency is a rather hard problem as it is of a complex nature and is influenced by high-level processes of the mind, such as memory, thought and reasoning.

However, we can at least predict top-down saliency during visual search tasks. This works relatively well since during visual search we can make a clear assumption about the information which is currently important for the visual system. The most prominent model for visual search is an extension of the feature integration theory and denoted as "Guided Search"[J.W94]. This model introduces a top-down bias on those feature maps which are important to find a target.

3.3.8 Guided Search

Based on feature integration theory J. Wolfe[J.W94] introduced Guided Search theories explaining how observers perform visual search tasks efficiently. In Guided Search, features are modeled as differential activation of locations in each feature map. The greater the activation at a location is, the more likely it is that attention will be directed to that location. Figure 3.13 illustrates the basic architecture of this model. Analog to the basic visual search theory, guided search provided two models to describe the bottom-up und top down models.

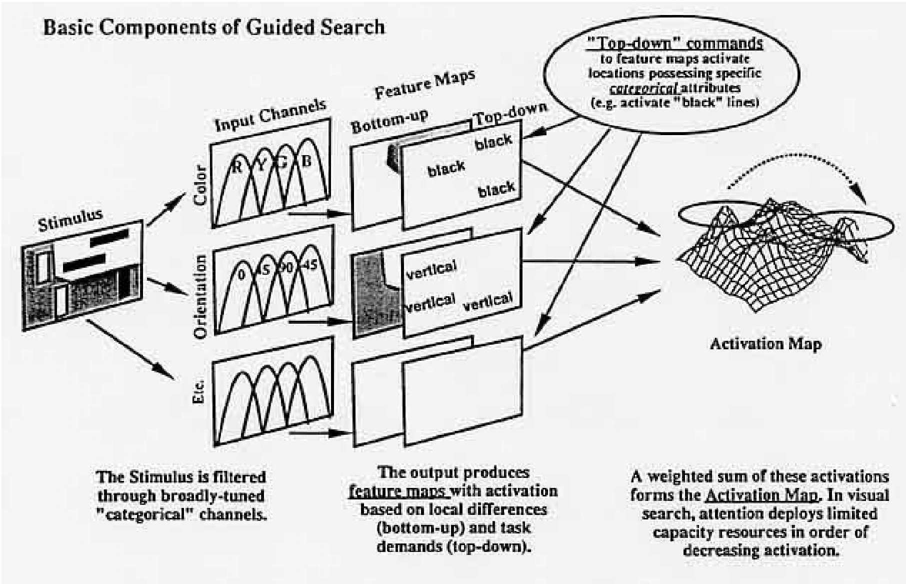

Figure 3.13: Basic components of guided search [J.W94]

Bottom-Up Processing

Similar to pure bottom-up models of visual search, the bottom-up part is also stimulus-driven. It can be considered as a passive attention process. The incoming visual information will be filtered through broadly-turned categorical channels, and then carried out as an activation map based on local differences as output.

Top-Down Commands

In early stages of visual processing the input visual stimulus is decomposed through parallel feature processing into a set of feature maps. Now, this basic model derived from the feature integration theory, is extended by the property that different weights are used to modulate the impact of different feature maps on the final saliency value. These weights are controlled by top-down commands and selectively increase those features which are characteristic for a search target. Combining the feature-maps by a weighted linear summation yields one master map which is denoted as the **activation map**. Since an eye-fixation may cover a larger fraction in the stimuli a low-pass filter is applied which smoothes the peaks of the activation maps and outputs the so-called “saccade map”. The peaks in the saccade map are then used to select the fixation positions in serial search (Figure 3.14).

This model predicts that distractors with have similar features as search targets will produce

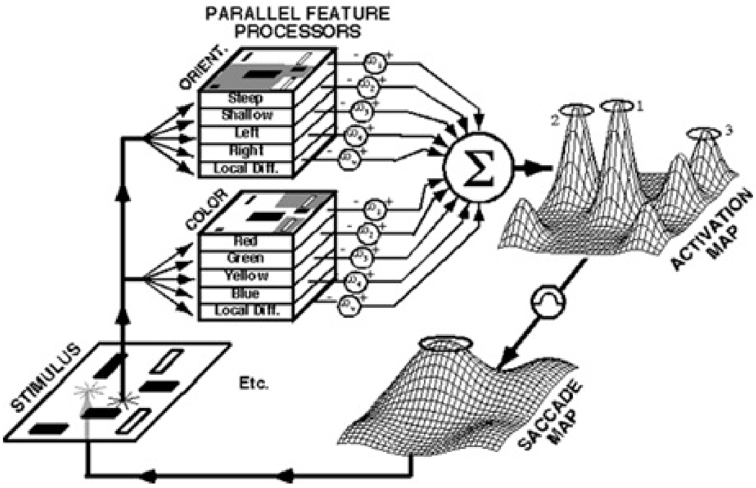

Figure 3.14: Top-down model [L.I02]

peaks in the saccade maps and thus increase the probability that eye-movements are directed towards their location.

This model has also found application in computer vision algorithms, such as illustrated in Figure 3.15, where the classical saliency map algorithm was extended to perform top-down biased visual search by selectively biasing the influence of certain feature maps when they are combined to a saliency map.

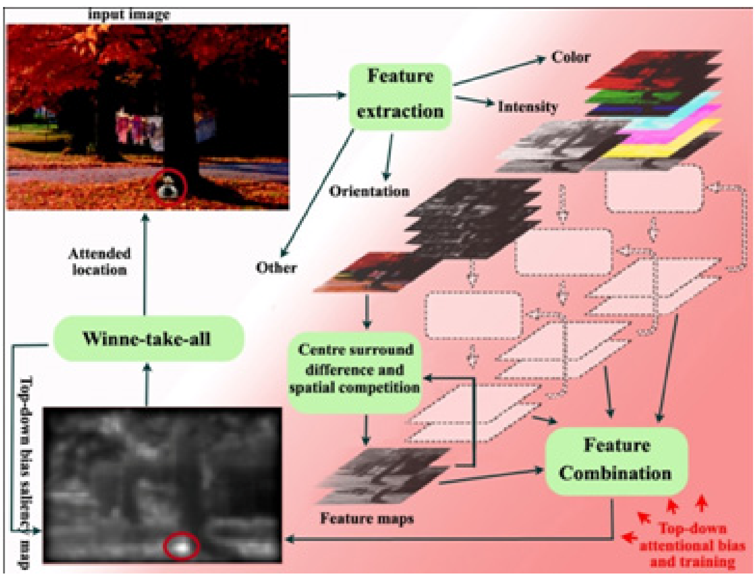

Figure 3.15: Top-down bias saliency map[L.I01]

CHAPTER 4

How to Increase Player's Attention to In-Game Advertisements

After reviewing some related approaches proposed in previous work, we will propose our hypothesized solution how attention can be manipulated in a computer game in order to increase the effectiveness of in-game advertising. It is based on models for visual attention and visual search we took from cognitive psychology.

Game-relevant objects as well as in-game advertisement information arrive as visual information at the players' sensory register and are further sent to the visual short-term memory. Due to the fact that the information processing capacity is limited, attention filters the majority of incoming information, and only what passes this filter arrives in short term memory and further stages of memory. Advertisements which remain unattended will be barely remembered and have a low effectiveness.

Therefore the effectiveness of in-game advertising can be increased significantly if a player's visual attention is directed to advertisements. A possible way to reduce the inattentional blindness towards in-game advertisements could be manipulate of visual attention. In the following section, we summarize some proposals attempting to manipulate attention in computer games and virtual environments. Then we will propose our approach, which is much simpler, but allows to effectively manipulate visual attention so that a player recognizes advertisement elements better.

4.1 Manipulating Attention in Computer Games and Virtual Environments

There are a lot of studies of computer games and virtual environments about the relationship between attention and computer games as well as virtual environment. Many of them try to find a method to improve computer games and virtual environments with the knowledge of attention. However, up to our best knowledge there are only few studies that really attempt to take active control of human attention.

El-Nasr et al[S.N09] have done some meaningful work in this direction. They built an "adaptive lighting design system" to direct player's attention to important elements in a fast paced 3D game. This system was designed to dynamically assign different light colors and intensities for different locations to increase the players' visual attention in the game's virtual environment. They assume there exist several focus areas within the screen area, and each area has a different importance level. System will at first decide the important levels of these areas then assign these area the suitable luminance features.

To test the effectiveness of this system, they conducted two experiments. 26 participants who wore eye trackers were grouped as two groups. The control group was instructed to play a first person shooting game with static light for 10 min and the main group was instructed to play the same game but with ALVA (adaptive lighting for visual attention) for 10 min.

After the experiment, they found that in complex 3D environments non-gamers, more than casual gamers, were not able to spot important characters quickly enough to respond. However, they are able to spot enemies faster with ALVA than without it.

Another study about improving the searching task's effectiveness was proposed by R. Bailey et al[R.B09a]. They tried to achieve their searching target by a new technique which operates the properties of pre-attentive vision. Their method is through the use of short luminance or warm-cool modulations of peripheral image space regions which is very sensitive and attracted to sudden changes in the periphery of the fovea to direct a user's gaze. To avoid conscious perception of theses modulations, an eye tracker was used in order to notify the system when a saccade to the modulated regions is triggered. If this is the case, then the modulations have to be stopped.

To evaluate the effectiveness of this new technique, R. Bailey et al carried out experiments which investigated whether performance in visual search tasks could be improved. In their study in 2008[A.M], they used twenty-four images which represent six different environments as stimuli for experiments. The search targets were small transparent spheres roughly distributed within the scene. Every image was presented for 14 seconds. Between the images switching, a black screen with white cross was presented in order to make participants refocus on the center of the screen. Eye-tracking was employed to record the view's eye movement and it output was served as input to trigger the modulations on targets that are not attended to.

The behaviors of target were grouped into three groups. In the no modulation group, no behavioral actions was applied to the target; in the subtle modulation group, subtle image mod-

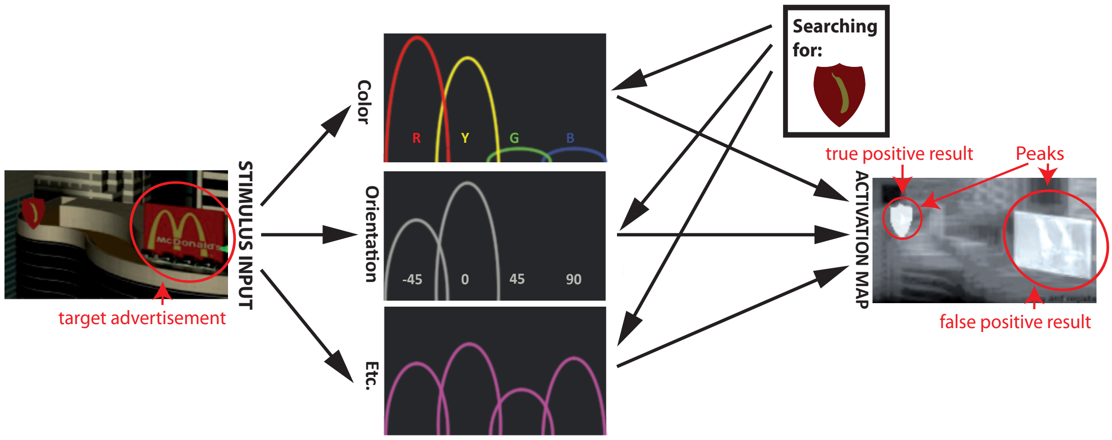

Figure 4.1: An illustration how applying visual search in reverse may work in the example game used for our user study: (This Figure is a modification of Figure 3.13)

ulations were used to highlight the target regions in an effort to aid in counting, but modulation was never applied to targets while they were being directly viewed; in the obvious modulation group, subtle behavior was exaggerated by increasing the size of the modulation so that the modulation were clearly visible. Eighteen subjects participated in this experiment and assigned into these three groups.

They found that using either subtle or obvious image modulations on the target regions improves the precision of a simple counting task. Surprisingly, the results also indicate that performance even increases in the presence of distractor modulations[R.B09b].

4.2 Our Method to Increase the Player's Attention on IGAs

Previous proposals to manipulate attention in virtual environments are not straight-forward and require an eye-tracker or invasive changes in the game and rendering engines. In contrast to that, our proposal has a big advantage that it requires only a few simple changes in the visual design and needs no modifications of the game engine.

Our approach is to direct a user's attention towards elements in the background of a game by applying the theory of Guided Search (Section 3.3.8). Since we know that a typical game task requires several times searching for a particular object, we apply this model in a "reverse" direction and provoke that during serial search an advertising element is "visited" before the search target is found by changing pre-attentive vision.

This is achieved by increasing the salience of advertising elements during visual search tasks. Important features have been made similar in visual search, both the texture of search target and the visual design of the advertisement. One way to do so is to use a texture for an important task relevant item ,searched frequently, shares some important visual properties (e.g. color or orientation) with the advertisement intended to be noticed. Conversely, another way to achieve the same effect would be to adjust the features of an advertisement so that it becomes similar to a task relevant game item.

As we illustrated in Figure 4.1, the basic strategy is to link search targets and advertisements by using a visual design causing peaks of a similar magnitude for search target (true positive peaks) and advertisement (false positive peaks) in the activation map (saccadic map) of the Guided Search model.

Further, we believe that the effectiveness of advertising using this strategy should be maximized if a target object is selected with the following properties:

1. It has to be searched frequently,
2. It appears on unpredictable position (e.g. spawning on random locations)
3. It has a positive meaning in the game (e.g. health point)

For a preliminary investigation whether this strategy works in principle, we performed an experiment with an action game. We applied these rules and constructed a case where the effect should be as strong as possible.

CHAPTER 5

Experimental Study

Parts of the work presented in this chapter will be published in the paper: "Manipulating Attention in Computer Games"[L.Z11].

In this chapter we will evaluate our hypothesis that we can manipulate visual attention by game design. The dependent variables we will measure is recall and recognition in a memory test. As assumed to memory tests to evaluate the effectiveness of IGA, increased scores in this test indicate a higher effectiveness of the advertisement we targeted with our method (Section 5.1).

We designed a test of 2D action game with a 3D background scene (Section 5.2) to validate our hypothesis. The experiment was run in three conditions. In the test condition we tested our proposal to manipulate attention. The other two additional conditions were controlling conditions to compare the results (Section 5.3). An active memory test and a passive memory test were used to measure the effectiveness of in-game advertisings (Section 5.4). To establish and improve the experimental design, we also conducted a small pilot study (Section 5.5). It is to test whether we can reasonably assume that our hypothesis goes in the right direction, to identify flaws in the current experimental design and to determine the sample size required to obtain significant results in the main study. As the results in the pilot were quite promising, we were encouraged to run a bigger and more expensive main study yielding enough data to carry out a sophisticated statistical analysis (Section 5.6).

5.1 Main Hypothesis

We assume that the effectiveness of in-game advertisings can be measured by a memory test. Our hypothesis is that due to the fact that a computer game is strongly task oriented and in-game advertisements are actually task irrelevant objects, players will show inattentional blindness for advertisements. We further hypothesize that we can avoid the inattentional blindness at least for one target advertisement by manipulating visual attention of smartly changing the set of target features important for visual search tasks elicited during the game-play. In particular, this is achieved by designing an important task relevant object so that its texture shares basic perceptual features (e.g. color and orientation) with the features contained on the billboard of the target in-game advertisement. When game relevant items and advertisements share some features , Wolfe's theory of Guided Search predicts that pre-attentive processes cause some saccadic shifts towards the location of the target advertisement and since it may become a "false positive" result of guided visual search. That visual information from an advertisement can reach a players' visual short-term memory and has the chance to further make its' way to the long-term memory, what we can then observe in a memory test.

5.2 Game Design

We programmed a 2D action game for this study because action games are very popular and impose an intensive task to cause a high degree of inattentional blindness. Chaney et al[I.C04] and Cobelens[S.C10] claimed that billboards have the best effectiveness on recognition. We also used billboards to place our in-game advertisements which are embedded in the game's background.

We used "Torque Game Builder" to build our test game, which is a powerful and easy-to-use 2D game engine. This engine can make our work much simple. The in-game advertisements were direct embedded into the game background in the game development stage. We used "Photoshop" and "3D Max Studio" to achieve this purpose.

5.2.1 Elements

The background story of our game is the film "Wall-E". The game includes six objects: good Eve (Avatar), bad Eve (Enemy), bullet from Avatar and enemy, fly mine (Mine) and health item.

Avatar

The avatar is a grey robot (Figure 5.1) which can shoot bullets in vertical direction from left to right and move into all directions in 2D. Its size is 56x76 pixels in screen-space, and its horizontal speed is 35pt/sec, its vertical speed is 25pt/sec.

Enemies

Enemies are green robots (Figure 5.2) shooting at random times in vertical direction from right to left. Their size is 60x83 pixels in screen-space, and their speed is between 15pt/sec and 30pt/sec. They move in a random path through the displayed scene from right to left and can be killed with one bullet. When an enemy is annihilated, it explodes and the player receives 10 additional game points. Get shot by an enemy's missile costs avatar 15 health points.

Mines and Bullets

Another threat to the health of the avatar is mines. Their size is 41x39 pixels in screen-space. They have a dark grey color (Figure 5.3) and fly on a random path from left to right of the game scene. Its speed is between 5pt/sec and 15pt/sec. Each time the avatar robot collides with a mine it loses 20 health points.

There is no collision between avatar's bullets (Figure 5.4 Top) enemies' bullets (Figure 5.4 Bottom). Enemies Bullets cannot be destroyed but need to be avoid by avatar. The speed of avatar's mission is 200pt/sec and the speed of enemies' bullets is 150pt/sec.

Health Items

Health items (Figure 5.5 or 5.6) are spawned on random position in the 2D foreground. They are static and each time the avatar moves over them they are virtually collected resulting in an increase of 20 health points for the avatar and 80 game points for the player.

Figure 5.1: Avatar

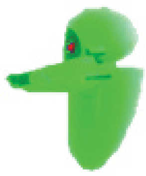

Figure 5.2: Enemy

Figure 5.3: Mine

Figure 5.4: Bullets

Figure 5.5: Health item (Design1)

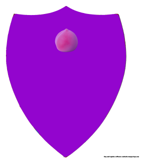

Figure 5.6: Health item (Design2)

5.2.2 Task of the Game

A player starts the game with three lives, each corresponding to 60 health points. The task is to keep alive as long as possible while trying to gather as many game points as possible. During the game, the frequency of spawning enemies and mines increases constantly. This has the effect that with survival time difficulty increases, while game points can be earned faster due to an increased frequency of potentially annihilated enemies.

However, since the number of enemies and mines increase very quickly, the game has a considerable difficulty causing a high perceptual load. To avoid a game-over the players must constantly search for health items and collect them to increase their health state. Health items are 80x53 pixels big in screen-space. (Figure 5.7) They are spawned at random positions in the 2D scene. They are static, and each time the avatar moves over one of them, it is virtually collected, resulting in an increase of 20 health points for the avatar and 80 game points for the player.

5.2.3 3D Background Scene

Although we built our test game as 2D, we built a 3D background to increase similarity with commercial games. For the draft version used for the pilot study a screenshot of “New York city” from the “3D google map” was served as background. Six well known brands in Austria used for the advertisements were pinned on the background by “Photoshop” (Figure 5.7).

Figure 5.7: Background image in pilot study

However, the ad-hoc design of the background had two main disadvantages we wanted to avoid in the main study. Firstly, the low resolution and poor quality of the image caused a low visual fidelity compared to commercial computer games. Secondly, billboards could only be added in screen space (by “photoshop”) so we could not render the correct illumination.

Therefore, we decided to build a virtual city with “3D Max studio” (Figure 5.8) for the main study. All in-game advertisings are embedded directly on the billboards which have been placed on the top of buildings in the modeling stage. Then we rendered a high resolution image from the scene and the billboards were thus shaded with the correct illumination.

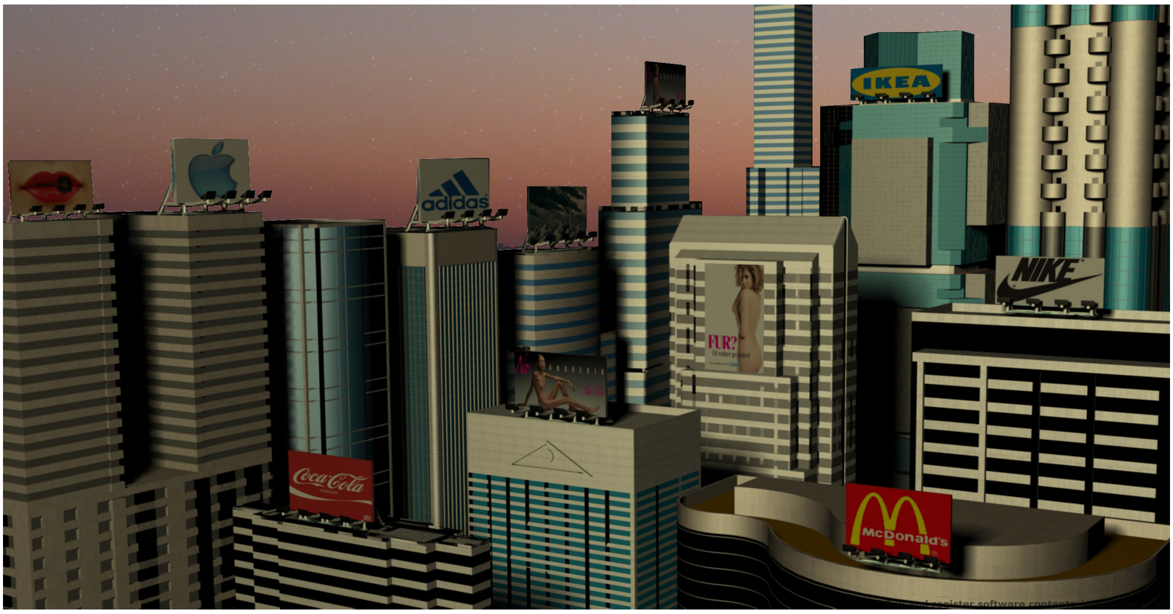

Figure 5.8: Background image in main study

5.2.4 In-Game Advertisements

For a pilot study we chose six advertisements which from six different areas as in-game advertisements. These areas are super market, automobile, fast food, piano, beverage and Electronics (McDonalds(McD), IBM, BMW, Plus, Coca Cola, Bösendorfer(Bösend)). While McDonalds served as target advertisement where we tested our method, the remaining five served as distractors.

However, the selection of in-game advertisements might have issues that we have ignored the effectiveness of brands themselves. Participants have also different interest areas e.g. some female participants had no interest about automobile or electronics. These factors may also influence the results of the study. So we tried to use a more balanced choice of in-game advertisements. Therefore, for the main study we used the momentum scores provided by the “BrandZ” report[Bra10] and chose six brands (McDonalds, Coca Cola, Apple, Adidas, IKEA and Nike) which had a similar and simple design (two colors and one characteristic logo) and an almost similar momentum score (between 6 and 8). Note, the target advertisement (McDonalds) had belonged to the group of adverts with the lowest momentum (= 6). Recall that the brand we chose for the target advertisement for both studies was “McDonalds”. Now we need an important game relevant object to attract players’ visual attention on McDonalds. We chose the health item because it is a task-relevant item which is searched frequently, which is spawned randomly on unpredictable positions and has a positive meaning in the game. Because McDonalds’ features can be simply divided into red back color and a yellow “M”, we designed the health item as a red shield with a yellow banana. The color of shield and banana was designed wholly same to the McDonald's back color and its M's color. The orientation and curvature of banana are also very similar to the parts of the M letter. (Figure 5.9)

Figure 5.9: Health item and target advertisement

5.3 Conditions

We designed three conditions in both pilot study and main study. Our method was applied in the test condition. Two control conditions were used as the reference for comparisons to the test condition. In each control condition there was one difference to the test condition, which we will describe in the following:

Test Condition

The test condition was the main condition used to test our method. In the test condition, we used the Target advertisement similar designed health item (Figure 5.5) and the background image with all in-game advertisements.

First Control Condition

In the first control condition, we used a new health item which does not share any feature with the target advertisement instead the health item of the test condition. The purpose of this control condition was to measure the self-effectiveness of target advertisement as well as other in-game advertisements (Figure 5.6).

Second Control Condition

The second control condition was used to test if the target advertisement with similar designed health item could influence the recognition of the target advertisement in the memory test alone, without the target advertisement being actually present during the game. Since the health item has similar features like target advertisement's logo, it might have an effect on the players' memory, or at least in the passive memory test a participant may falsely select the target advertisement due to remembering alone the features (Section 3.3.7). In such a case, the effectiveness of target advertisement was increased by the sole presence of similar perceptual features.

Another important purpose of the second control condition is that it allows us to control potential side effects which are due to the different design of health items. We used an IB-M advertisement (which actually has the same momentum with the target advertisement) for replacement (Figure 5.10).

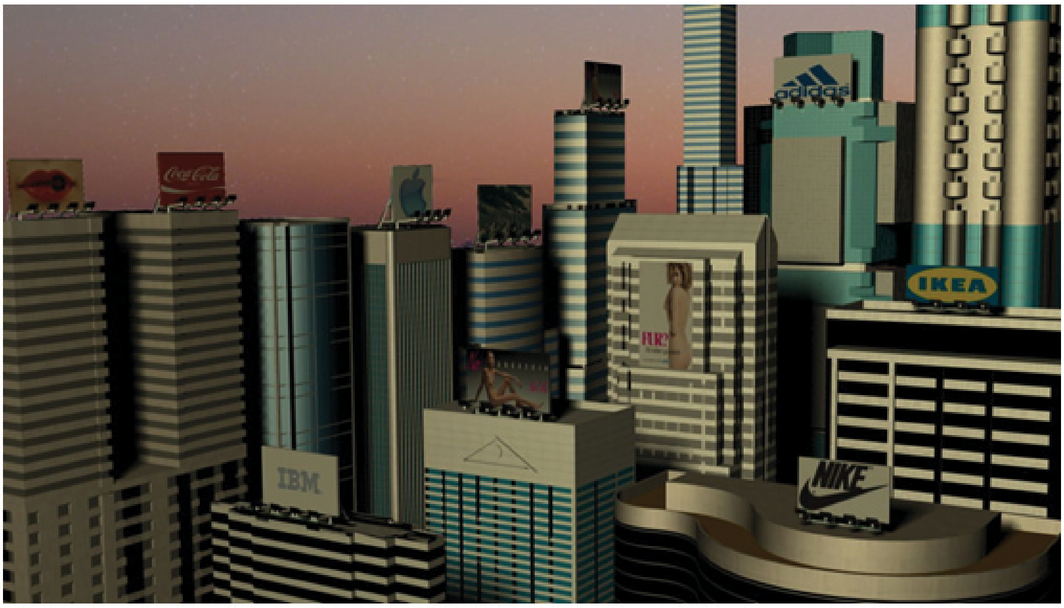

Figure 5.10: One back scene of second control condition in main study

5.4 Memory Test Application

We designed a passive memory test and an active memory test to measure the effectiveness of in-game advertisings. As we emphasized in the section 3.1.2, both memory tests were a "surprise" for every participant. In order to ensure that memory tests were surprised, no participant was informed about the real purpose of the study before the memory test.

In the active memory test, we asked participants to write down the name of advertisements that they believed they have seen in the game. We provided no additional information to participants in order to test their memory recall ability of the in-game advertisements.

We designed a passive memory test for the participants' memory recognition ability of the in-game advertisements. The passive memory test was designed as a force choice paradigm. Each trial involved three brands where one brand was in-game advertisement and the other two are distracters (Figure 5.11). All distractor advertisements were selected such a way that they have the similar momentum scores as the in-game advertisements (according to the BrandZ report[Bra10]. Participants were asked to choose the brand which they thought they might have seen in the game in each trial. If were not confident in remembering, they had to just guess to get into the next trial. Forcing a participant's choice should reveal also subconscious effects on memory.

Figure 5.11: Screenshot of one trial in the passive memory test application

5.5 Pilot Study

Prior to the main study, we conducted a small pilot study to investigate with a quick and dirty experiment a first hint whether we may yield promising results supporting our hypothesis, to study how participants will behave in the experiment and to early identify potential flaws in the experimental design.

5.5.1 Participants

Twelve music students with game experience were involved in this pilot study at the same day in an exercise room of "University Mozarteum Salzburg". Eight of them are female and the other four participants are male. All participants are older than 19 but younger than 25 (mean = 21.67 sd = 2.17). They are either Austrians or foreigners who have lived more than six years in Austria. In other words, every participant should be familiar with all advertisements used in the experiment.

They were randomly and equally divided into three groups correspond to three conditions. Each group involved one male and three females. The average age of test condition group is 22.25 (sd =1.38). The average age of 1st control condition group is 22.75 (sd =2.25). The average age of 2nd control condition group is 20.25 (sd =1.88).

5.5.2 Procedure

Experiment ran on a Sony VPCEB 1S1E notebook with windows 7. The display's resolution was 1366 x 788 pixels. The game ran in the display window of a resolution of 1024 x 768 pixels. Background image we have already motioned in the section 5.2.3.

The experimental protocol comprised three parts: Game playing, Dummy questionnaire and Memory test.

Game Playing

After the participants have been introduced to the game and its task by the person who conducted the experiment, the game was played for five minutes. The play time was monitored by a watch. Players were allowed to restart the game in case of a game-over before the end of five minutes.

Dummy Questionnaire

After game playing, participants were asked orally some irrelevant questions in order to empty their short-term memory. In order to ensure that their short-term memory has been cleared, we asked various questions about their study and their hobbies etc. The number of questions was variable and depended on how much time the participants needed to answer them. We stopped the dummy questionnaire after 6 minutes.

Memory Test

The passive memory test followed the dummy questionnaire. The passive memory test involved 72 trials. Since we chose 6 in-game advertisements from the six different areas (super market, automobile, fast food, piano, beverage and Electronics), we chose 12 other advertisements also from these six areas as distractors (KFC, Burger King, Porsche, Mercedes, Pepsi, Fanta, Yamaha, Steinway, Spar, Hofer, Microsoft and Apple). Every brand was presented 12 times (4 times at every three position).

After passive memory test, we asked participants if they have seen any brands in the game. If they answered "yes", we asked further which of brands they could remember. This memory test was considered as active memory test.

The results of the second memory test are potentially biased by running the passive memory test before. However, both possible orders of the tests caused a bias in the second test. Since our focus of interest was primary on the results of the passive memory test, we decided to run this test first.

5.5.3 Results

The results obtained in this small study were already promising and seemed to support our hypotheses.

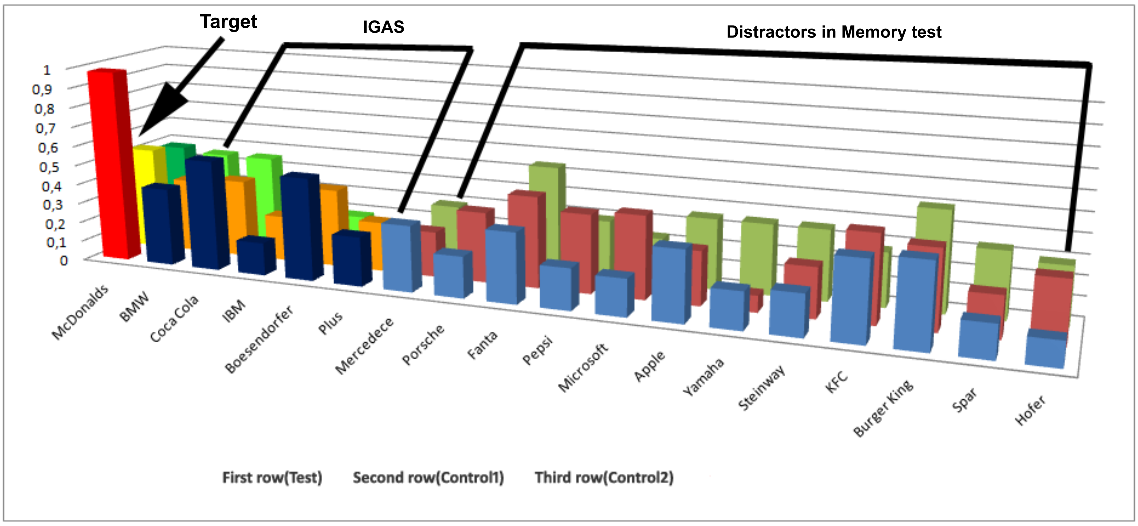

Figure 5.12: Histogram of the passive memory test results by condition and brand (pilot study)

Regarding the results shown in Table 5.1 there were basically two observations which had been predicted by our hypotheses:

1. In the test condition there was a clear positive difference in the recall scored observed for target advertisement (McDonalds) and other advertisements.

2. Their scores observed for the target advertisement are clearly higher in the Test condition compared to both control conditions.

3. If our strategy is not applied participants seem to perform around chance level in the memory test. In other words, inattentional blindness does in fact occur.

Condition	McD	Coca Cola	Bösend	BMW
Test	4	2	2	1
Control1	0	0	1	1
Control2	0	0	0	0

Condition	McD	Other IGAs
Test	97.9%	37.9%
Control1	52.1%	32.9%
Control2	47.9%	29.1%

Table 5.1: Results for the active (left) and passive memory test (right)

For the right table the average scores were computed seperately for McDondalds and all other avdertisments in the game pooled together. In the left table the number of participants who remembered a particular advertisment were counted per advertisment type and condition (Note, the advertisments not listed were remembered by nobody in all conditions).

5.5.4 Conclusion

The result of pilot study indicated that our hypothesis should be correct and that experimental design should work to provide promising results and encourage us to go ahead with a more expensive and bigger study. We could sample enough data to obtain results which should proof statistical significance. However, there are still some issues in the pilot study to be improved in the main study.

5.6 Main Study

Based on the experience of the pilot study, we further improved the experimental design to conduct the main study. The most significant change comes with the new design of the background scene (as described in Section 5.6.1), where we now assured that advertising billboards are well embedded and are shaded with the correct lighting of the scene. To counterbalance potential bias due to effects of position we also varied the position of the advertisements between participants in a systematic fashion.

We also found that there were too many trials in the memory test application. Participants were complaining and results did not change after half of the trials. So we redesigned the memory test application, and also removed some minor flaws. Another minor change was that we shortened the time a game has to be played from 5 to 3 minutes, since the game level was too simple and maybe got boring by playing it too long. Moreover we sampled 12 participants per condition (Section 5.6.2) in order be able to prove the significance of the effects to be measured. Some changes in the Procedure were also made (Section 5.6.3). Finally, we performed a full statistical evaluation to validate our hypothesis scientifically.

5.6.1 Redesign of the Background Scene

To solve the background image's problem, we redesigned the background scene. We used "3D Max studio" to build a virtual city with correct shading. The in-game advertisements were embedded directly on the billboards placed on the top of buildings in the modeling stage. We placed the camera view point on the position where the yaw of the billboards textured with advertisements varied with angles between -12 and +14 degrees to the image plane, whereas the pitch-angle was zero for all surfaces. Height and width of the advertising elements varied between (Xmin = 80, Ymin = 40) and (Xmax = 120, Ymax = 80) pixels in the screen space projection.

To counterbalance potential bias due to position effects, the position of adverts was shifted 6 times in a circle yielding 6 "sub-conditions" per condition. Finally, we rendered 12 times 2400x700 high resolution scenes (6 for test and first control conditions and 6 for second control condition where IBM was used instead of Target advertisement).

5.6.2 Participants

38 participants (31 male and 7 female) with and without game experience were volunteered for the main study. They were older than 17 and younger than 39 years of age (mean = 24.3, sd = 4.0). All participants had normal or corrected to normal vision. None of them had any type of color blindness.

As mentioned before, the memory test must be fully surprised. Otherwise, for example when participants should guess this purpose, they might exhibit an unnatural behavior as they perform additionally the task of memorizing the advertisements. In our experiment 2 participants expected the purpose we had to replace them and exclude their data from further analysis. So we actually evaluated the data of only 36 participants in our analysis.

Because we had three conditions and every condition involved further 6 “sub-conditions” in order to balance out effects of the brands’ positions, 36 participants were evenly distributed into 18 groups correspond to these 18 sub conditions. Each participant was assigned to one sub condition which was determined randomly before the participant showed up for the experiment.

5.6.3 Procedure

Once more in the experiment we used a Sony VPCEB 1S1E notebook with windows 7. The display’s resolution was 1366 x 788 pixels. The game ran in the display window of a resolution of 1350 x 700, and the other game relevant objects kept the same size like in pilot study.

The game was played for exactly 3 minutes. In case of a game-over the timer of the stop watch was withheld until the game was started again.

Dummy Questionnaire

In order to distract participants from their game experience, they had to answer a dummy questionnaire about their past experience with computer game. Some questions like about participants’ physic information, computer knowledge, game experience, will be asked. To enhance “forgetting” effectively, some questions required participants to access content of their episodic memory (e.g. “What was the first computer game you ever played?”).The overall time was 6 minutes.

Memory Test

The passive memory test was performed with the application described in Section 4.4. after the questionnaire. Referenced to “Top100 Most valuable global brands 2010[Bra10]” , we chose another 12 brands (Budweiser, Nespresso, Burger King, Siemens, Orange, Allianz, T-Mobile, Ebay, HP, H&M, Microsoft, Dove) which have the same momentums as in-game advertisings in the main study as distractors. Although IBM was integrated in the 2ndcontrol condition as replacement for the target advertisement, it did not appear in the memory test, to keep the number of trials equal in all conditions.

To avoid participants tired and bored by memory test, we shortened the number to 36. Like the pilot study, each trial presented a brand of the six in-game advertisings with two distractors. Each in-game advertisement was presented 6 times (2 times in each of the three possible positions).

Additionally, the participant should actively report which of the brands she or he can remember at the last step. This memory test was considered as the active memory test and should test the participants' recall ability.

5.6.4 Results

Concerning our main hypothesis we were particularly interested in the differences between the

- target advertisement and other advertisements in the same condition
- target advertisement in test and first control condition
- target advertisement in test and second control condition, and the
- target advertisement in the test condition and other advertisements in both control conditions

For a first research we visualized the means and distributions of the passive memory test as shown in Figure 5.13. The left plot shows the mean memory test result and the right plot shows the distribution memory test result as box plots. The result of the mean memory test clearly demonstrated that the target advertisement (McDonalds) had the highest recall rate in test condition, and also the best scores in comparison to other advertisements. The distribution of the recall scores shows a cluster near 1.0, showing that, apart from one outlier, all participants from the test group could remember the target advertisement. In this result there is also a clear correspondence to the scores obtained in the active memory test, where all participants, except one, were able to report the target advertisement.

Table 5.2. shows the results of the statistical evaluation of our (alternative) hypotheses, derived from our main hypothesis. We performed pair-wise comparisons of the scores between test and control conditions, and between target advertisement and other advertisements, respectively. Statistical significance for all comparisons was evaluated with nonparametric tests (Wilcoxon Rank Sum). Normality or equality of variance could not be assumed in all cases, which is also obvious from the distributions visualized in Figure 5.13.

These tests confirmed that all results concerning our main hypothesis were significant or highly significant:

- the difference between target advertisement and other advertisements in the same condition is significant ($p < 0.018$)

Figure 5.13: Results of the passive memory test: (left)pooled results of all participants (right) box plots to illustrate the distributions across different participants. The dotted line in the backgrounds corresponds to the expected value for random guessing.

- the difference between target advertisement in test and first control conditions is highly significant ($p < 0.003$)
- the difference between target advertisement in test and second control condition is highly significant ($p < 0.0001$)
- all differences between target advertisement in the test condition and other advertisements in both control conditions are highly significant ($p < 0.004$)

Moreover, the scores for IKEA ($p < 0.022$) and Coca Cola ($p < 0.007$) in the test condition are also significantly better than in 1st control condition. We have also separately compared the McDonalds in test condition to IKEA and Coca Cola in all three conditions. The result is also significant to indicate that McDonalds was clearly better recognized.

The results obtained in the active memory test are shown in Table 5.3. The scores reported in the cells of this table were obtained by counting each brand in each condition the number of participants who reported to remember the respective brand. We used a chi-square test to evaluate the significance of the recall scores in pair-wise comparisons between Test and one of the Control conditions. Therefore we build 2x2 comparison tables with 2 rows for the respective two conditions combined with one column for the number of participants who could remember the respective advertisement and one column for the number of participants who could not remember the respective advertisement. For instance, the chi-square test comparing the results between

test vs controls (exact Wilcoxon rank sum test one-tailed, N = 2x12)			
Altern. Hypothesis	Advertisement (1st and 2nd color)		
TEST>CONTR.1	McDonalds (target)	IKEA (blue/yellow)	Coca cola (white/red)
	W = 127.5 p = 0.0003	W = 106.5 p = 0.022	W = 113.5 p = 0.007
(same advert)	Adidas (blue/white)	Nike (black/white)	Apple(blue/white)
	W = 94.5 p = 0.096	W = 84.5 p = 0.24	W = 67.5 p = 0.62
TEST>CONTR.2	McDonalds (target)	IKEA (blue/yellow)	Coca cola (white/red)
	W = 136.5 p < 0:0001	W = 92.5 p = 0.12	W = 91 p = 0.14
(same advert)	Adidas (blue/white)	Nike (black/white)	Apple(blue/white)
	W = 81.5 p = 0.30	W = 78 p = 0.37	W = 63 p = 0.37
target versus other (exact Wilcoxon rank sum test one-tailed, N = 2x12)			
Altern. Hypothesis	Advertisement		
Target>other	IKEA (blue/yellow)	Coca Cola (white / red)	Adidas,Nike,Apple
(TEST TEST)	W = 105 p = 0.018	W = 112.5 p = 0.007	$W \geqslant 115$ p $\leqslant$ 0.003
Target>other	IKEA (blue/yellow)	Coca Cola (white / red)	Adidas,Nike,Apple
(TEST,CONTR.1)	W = 127.5 p = 0.003	W = 139.5 p < 0.001	$W \geqslant 129$ p $\leqslant$ 0.0002
Target>other	IKEA (blue/yellow)	Coca Cola (white / red)	Adidas,Nike,Apple
(TEST,CONTR.2)	W = 114 p = 0.004	W = 134.5 p < 0.001	$W \geqslant 132$ p $\leqslant$ 0.001

Table 5.2: Statistical evaluation of the effects of condition for the results of the passive memory test: Since normality can not be assumed, the exact Wilcoxon rank sum test (the nonparametric equivalent to Student's t) was performed to compare our test results against the control conditions, listing W-values and the resulting probability p. Comparisons were performed between conditions for all advertisement (top) and between results for the target advertisement in the TEST condition and other advertisements in the same, or control conditions, respectively (bottom). To emphasize potential effects of color similarity (with the yellow/red bonus item), we denoted the colors of the respective advertisements.

TEST and CONTROL1 for the target advertisement (McDonalds), the input was a table with one row with the cells [11,1] (TEST) and a second row containing the cells [1,11] (CONTROL1).

Also in the passive memory test we obtained similar results which support the expectations specified at the beginning of this section.

An interesting phenomenon we found is that the memory test scores were increased also for other advertisements (except Apple) in the test condition compared to the control conditions. This gives us a hint that even the effectiveness of other in-game advertisements can be

results active memory test			
cond./H1 test	number of remembering participants		
	McDonalds (target)	IKEA	Coca cola
TEST	11	5	3
CONTR.1	1	2	0
CONTR.2	0 [1)]	3	0
TEST≠CONTR.1 χ^2-test, $dof = 1$	χ^2 = 13.5 p = 0.0002	χ^2 = 1.81 [2)] p = 0.40	χ^2 = 3.76 [2)] p = 0.09
TEST≠CONTR.2 χ^2-test, $dof = 1$	- -	χ^2 = 0.75 [2)] p = 0.65	χ^2 = 3.76 [2)] p = 0.09
	Adidas	Nike	Apple
TEST	2	0	0
CONTR.1	0	0	0
CONTR.2	0	1	0
TEST≠CONTR.1 χ^2-test, $dof = 1$	χ^2 = 2.18 [2)] p = 0.48	χ^2 = 0 p = 1	χ^2 = 0 p = 1
TEST≠CONTR.2 χ^2-test, $dof = 1$	χ^2 = 2.18 [2)] p = 0.48	χ^2 = 1.04 [2)] p = 1	χ^2 = 0 p = 1

[1)] result for replacement of A

[2)] with simulated p-value (2,000 repetitions)

Table 5.3: Results from the active memory test: the first two rows list the number of participants who recalled a particular advertisement. For all comparisons of proportional data, a χ test was computed on the corresponding 2x2 tables. In those cases where the expected value for one cell was below 5, a Monte-Carlo simulation with 2,000 repetitions was run to compute the χ^2 value.

increased, if only one advertisement which shares features with a game relevant object is placed in their neighborhood. We believe that, once a player has noticed there is an advertisement in the background, The player will be more aware that “there is something” in the background and consequently also other features, billboards and objects may receive at least some attention as inattentional blindness has been “broken up”. However, the current work does not provide enough data to prove this speculation. Probably, many more participants or the use of an eye-tracker would provide further confirmation on a statistically significant level. However, this is a very interesting hypothesis which can be addressed in future work.

Effects of Other Potentially Relevant Factors

Saliency: To evaluate the role of bottom-up factors, we used the “Neuromorphic Vision Toolkit” from Professor Itti’s “iLab” to compute the saliency scores for each advertisement. Corresponding to 12 background images, rendered for six variations of advertisement position with two different sets of advertisements (test and 1st control versus 2 control), we computed 12 saliency maps (see one of them in Figure 5.14) and computed for each advertisement the mean value over the region covered by the respective advertisement. The mean salience values for each advertisement averaged over all conditions are listed in Table 5.4.

	McDonalds	IKEA	Coca cola	Adidas	Nike	Apple
mean salience	788	776	645	675	701	618

Table 5.4: Saliency values by advertisement: since there are contextual effects on saliency, we computed average salience values for each of the 6 positions. The table reports the means from the 6 samples for each advertisement (in micro Amperes).

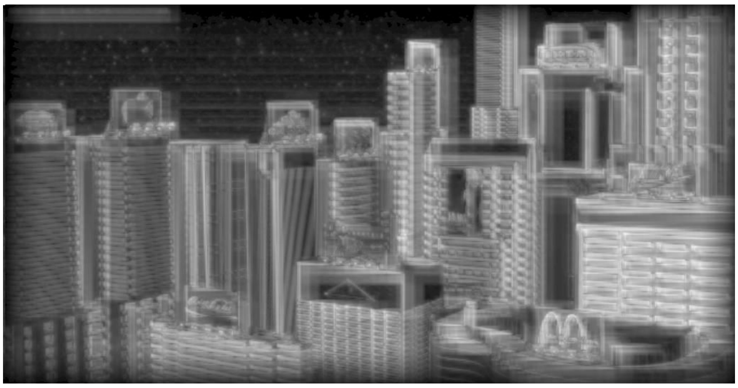

Figure 5.14: A saliency map of the background image

IKEA and McDonalds both have the highest saliency values. To quantify the impact of saliency, we used the non-parametric Kendall correlation measure, which we computed between scores in the passive memory test and saliency values corresponding to the position of a particular advertisement seen by the respective participant (Table 5.5). We found the correlation was significant for the data of the test condition, the pooled data for test and second control conditions (same background image), and the pooled data of all condition. However, the correlation was not significant for the data observed for the first control condition, the second control condition and the pooled data of the first and second control conditions. This result indicates that high saliency might be a necessary but not sufficient requirement for the recognition of in-game advertisements. We believe that saliency influences the effectiveness of in-game advertisements only if a player is not "inattenionally blind" to the background scene where the advertisements billboards are placed. Hence, salience may be also an important factor for the effectiveness of our method. This is also predicted by the guided search model, in which the activation map is essentially a linear summation of salience values from different feature channels which are weighted by the importance of each feature channel for the current search target. But in the absence of top-down processes which attract a players' attention to some concrete locations on the display, the activation map corresponds to the activation map of a pure bottom-up model which is simulated in the saliency map algorithm. However, the latter case is rather rare in computer games which are inherently task intensive. The normal saliency maps is not sufficient as a help to optimize the placement and of in-game advertisements. Using top-down biased saliency maps, i.e., implementations of the Guided Search model, should be a better recommendation for this purpose.

testing potential influence of other independent variables			
variable / test	condition / pooled conditions /selections		
saliency (uncontrolled) Correl.: Kendall	TEST	CONTROL 1	CONTROL 2
	ι = 0.317 p = 0.0003 N = 6x12	ι = 0.12 p = 0.172 N = 6x12	ι = 0.104 p = 0.288 N = 6x12
	TEST+CONTR.2	CONTR. 1+2	ALL
	ι = 0.201 p = 0.001 N = 2x6x12	ι = 0.117 p = 0.007 N = 2x6x12	ι = 0.3 $p<0.0001$ N = 3x6x12

Table 5.5: Effects of saliency on results of memory test: since normality could not be assumed in any case, only non-parametric measures were used, listing absolute test values alongside with the resulting probability value p. The correlation between saliency and memory test scores was measured with a (non-parametric) Kendall correlation test. N specifies the total number of samples.

Effects on Gaming Performance

As we expected a negative side effect of distracting a player's attention towards advertisements, we tested if there is an effect of condition (and hence attentional manipulation) on the gamers' playing performance. Surprisingly, the number of game points was highest in the test condition (Table 5.6), though the effect of condition was not significant (ANOVA: F(2;33) = 1.41; p = 0.24, normality and equality of variance could be assumed).The differences in the number of game-overs were also not significant (Kruskal-Wallis: c2 = 0.1; p=0..95, normality could not be assumed), but marginally lowest in the first control condition. These results indicate that, at least for the type of game used for our study, attentional manipulation has no negative effect on gaming performance and thus may not cause a serious reduction of game fun.

	TEST	CONTROL 1	CONTROL 2
points	2465 ± 249	2296 ± 512	188 ± 376
number of game-overs	1.27 ± 0.8	1.17 ± 0.9	1.25 ± 1.0

Table 5.6: Effects of saliency values bias results of memory test

CHAPTER 6

Conclusion and Future Work

6.1 Contribution

This work hypothesized that the predictions resulting from models guided visual search can be applied in a "reverse" direction to manipulate visual attention, that a user of a task-intensive computer game will recognize advertisements during performing a visual search task. This hypothesis was validated with an experimental study where we showed that the recognition and recall in a memory test is effectively increased, if an advertisement shares perceptually relevant features with an item which has to be searched for succeeding with the game's task. If this effect, which has been revealed in our primary investigation, can be further generalized for other game settings and visual features in future work, it can have tremendous importance for the in-game advertising industry. It would determine the value of in-game advertisements in two ways:

1. Advertisements which are similar to important search targets are much more effective than others.

2. Conversely, advertisements which are dissimilar to task-relevant objects are much less likely to be attended and have significantly lesser or even no effectiveness.

This could be a meaningful issue when prices for advertisement are negotiated. However, the results also indicate that once one advertisement shares features with a task relevant search target attention can be also increased for advertisements in its neighborhood. But we should be careful with this speculation since our results concerning this hypothesis were not significant yet and wait for a scientific validation in future work.

6.2 Limitations

It has to be emphasized that this work presents a preliminary investigation. The experiment was designed as such that the strength of the effects was maximized in order to get a first idea whether our hypotheses can be correct. But the results were very clear and should generate motivation for including further factors which are relevant for commercial computer games and may have an impact on a user's attention.

An significant limitation is that we used a 2D game for our experiment. Though the advertisements were placed in a 3D background, the actions in the game were in 2D, and most importantly the camera had a fixed view point. If the camera moves and health items are 3D objects, it may improve the behavior of a user during visual search. And also the perception of the features of a 3D object may vary to a certain extend when it is seen from different viewpoints.

However, due to the clearness of the results we expect that the method should in principle also work for the full 3D case, though there is a need for further experiments to support this hypothesis.

Another caveat to our method is that the manipulation of attention actually contradicts with the goals of a player. Players want to find task-relevant items very quickly and may be annoyed if they find advertisements instead. Although we could not observe a negative effect on the performance in the game task, we nevertheless need to assume that there are also cases where there are negative effects on gaming performance - at least if the method is used too intensively. We think that this may strongly depend on how frequently a user's attention is "misguided" to advertisements. Future work should investigate into the extent of attention distraction towards advertisements is tolerable for both, the user's acceptance and the performance in game tasks.

An obvious limitation is that attention can be directed to only one type advertisement at a time. But there might be smart ways to direct attention to different advertisements throughout a large game. For instance in each level other variations of search items can be used to link them to advertisements with different features.

6.3 Future Work

To maximize the strength of the effect, we designed the heath item shared almost all important features with target advertisement (1st color, 2nd color, orientation and curvature). However, the theory of guided search also predicts false positive fixations when similarity is less obvious (similarity in fewer feature dimensions, other feature combinations), as long as the peaks in the master activation maps are equally strong for target and distractors. A series of further experiments should investigate how far we can use other features and more subtle similarities between features of search items and advertisements. Therefore we should investigate the impact or importance of different kinds of features (e.g. color versus shape). Moreover, it is important to study a full 3D case where the camera is moving. Particularly games with a first-person navigation, where camera movements are fast-paced, will provide a challenging case to test whether our approach can be generalized to 3D games.

We also believe that eye-trackers are a good measurement tool for visual attention which should be used for future studies. Tracking the eye-movement of the participants should allow us to perform a more fine-grained evaluation than with memory tests. One important advantage is that it enables us to observe the attentional behavior of a user directly when the game is played.

6.4 Final Conclusion

In this work, we investigated how in-game advertising can be made more effectively. We discussed the topic from an interdisciplinary perspective and introduced relevant knowledge from various backgrounds including marketing, computer graphics and psychology. This work emphasized that visual attention is a key issue to improve the effectiveness of in-game advertising. We claimed that one important reason why in-game advertisements may have a low effectiveness is that, computer games usually impose an intensive task and only few perceptual resources are left for the recognition of task-irrelevant information, such as advertisements. We stated that a phenomenon denoted as "Inattentional Blindness" explains this behavior, that in-game advertisement is barely recognized when a game task is performed. We then proposed one solution to avoid inattentional blindness and validated the success with an experimental study. Overall this work gave an example how models and knowledge about visual attention can be successfully applied to improve the effectiveness of in-game advertising and should stimulate further research in this direction.

Bibliography

[Age07] Agencies. Half of dvr users skip ads, study says. *Agencies*, 2007.

[A.M] C.Grimm A.Mcnamara, R.Bailey. Search task performance using subtle gaze direction with the presence of distractions. *In APGV'08: Proceedings of the 5th symposium on Applied perception in graphics and visualization*, pages 51–56.

[A.M02] M.Silverman R.Gay A.Mack, Z.Pappas. What we see: Inattention and the capture of attention by meaning. *Consciousness and Cognition*, 1:488–506, 2002.

[A.M09] U.Hofmann A.Melzer, B.Bushman. When items become victims: Brand memory in violent and nonviolent games. *Lecture Notes In Computer Science*, 5309:11–12, 2009.

[A.T64] A.Treisman. The effect of irrelevant material on the efficiency of selective listening. *American Journal of Psychology 77*, pages 533–546, 1964.

[A.T80] G.Gelade A.Treisman. A feature integration theory of attention. *Cognitive Psychology*, 12:97–136, 1980.

[A.T85] A.Treisman. Computer vision graphics and image processing. *Cognitive Psychology*, 31(2):156–177, 1985.

[A.T86] A.Treisman. Features and objects in visual processing. *Scientific American*, 225(5):114–125, 1986.

[A.Y67] A.Yarbus. Eye movements and vision. *Plenum Press*, 1967.

[Bha00] Bhatia. Advertising in rural india. *Language Marketing Communication and Consumerism*, 2000.

[Bra10] BrandZ. Top 100 most valuable global brands 2010. 2010.

[B.S98] S.Steinman B.Steinman. Vision and attention. i: current models of visual attention. *Optom Vis Sci*, 75(2):146–155, 1998.

[C.G08] C.Gaca. *Markenmanagement in video- und computerspielen*. Verlag Dr.Müller, 2008.

[D.B58] D.Broadbent. Perception and communication. *Pergamon Press*, 1958.

[D.G04] C.Constantin D.Grigorovici. Experiencing interactive advertising beyond rich media: impacts of ad type and presence on brand effectiveness in 3d gaming immersive virtual environments. *Journal of Interactive Advertising*, 5(1), 2004.

[D.L01] M.Chun D.Lee. What are the units of visual short-term memory:objects or spatial locations. *Perception&Psychophysics*, 63:253–257, 2001.

[Dou07] Doublefusion. Who is the gamer. *Doublefusion*, 2007.

[D.S99] C.Chabris D.Simons. Gorillas in our midst:sustained inattentional blindness for dynamic events. *Perception*, 28:1059–1074, 1999.

[E.N07] E.Niebur. Saliency map. *Scholarpedia*, 2(8):2675, 2007.

[Esk07] Stephen Eskilson. *Graphic design: a new history*. Yale University Press, 2007.

[G.A04] P.Cavanagh G.Alvarez. The capacity of visual short-term memory is set both by visual information load and by number of objects. *Psychological Science*, 15(2):106–111, 2004.

[Gam10] Sneaky Games. What kind of advergame is it. *Sneaky Games*, 2010.

[G.M56] G.Miller. The magical number seven, plus or minus two. *Psychological Review*, 63:81–97, 1956.

[G.S05] G.Sperling. The information available in brief visual presentations. *Psychological Monographs*, pages 1–29, 2005.

[H.L11] H.Leggatt. Are accidental clicks inflating mobile in-game ad success. *Juniper Research*, 2011.

[H.P98] H.Pashler. Attention (studies in cognition series). *Psychology Press*, 1998.

[I.C04] J.Chaney I.Chaney, K.Lin. The effect of billboards within the gaming environment. *Journal of Interactive Advertising*, 5(1), 2004.

[I.V06] I.Vedrashko. History of advergames and in-game advertising. 2006.

[J.D63] D.Deutsch J.Deutsch. Attention: Some theoretical considerations. *Psychological Review*, pages 80–90, 1963.

[J.M98] I.Rock J.Mack. Inattentional blindness. *The MIT Press, Cambridge*, 1, 1998.

[J.W90] J.William. *The principles of psychology 1890*. New York Holt, 1890.

[J.W94] J.Wolfe. Guided search2.0. *Psychonomic Bulletin&Review*, I(2):202–238, 1994.

[L.I01] C.Koch L.Itti. Computational modeling of visual attention. *Nature Reviews Neuroscience*, 2(3):194–203, 2001.

[L.I02] L.Itti. Modeling primate visual attention. *CRC Press*, pages 635–655, 2002.

[L.Z11] M.Bernhard L.Zhang, M.Wimmer. Manipulating attention in computer games. *IEEE IVMSP: Workshop: Perception and Visual Signal Analysis, Ithaca, NY*, June 2011.

[M.C09] C.Koch M.Cerf, P.Frady. Visual search and stimulus similarity. *Journal of Vision*, 9(12)(10):1–15, 2009.

[Met10] Metric. In-game advertising-sizing the market opportunity. *Metric2.0*, 2010.

[N.C01] N.Cowan. The magical number 4 in short-term memory. *Behavioral and Brain Sciences*, 24:97–185, 2001.

[R.A89] R.Shiffrin R.Atkinson. Chapter: Human memory: A proposed system and its control processes. *New York: Academic Press*, 2:89–195, 1989.

[R.B09a] C.Grimm N.Sudarsanam R.Bailey, A.Mcnamara. Subtle gaze direction. *In APGV'08: Proceedings of the 5th symposium on Applied perception in graphics and visualization*, pages 1–14, 2009.

[R.B09b] N.Sudarsanam C.Grimm R.Bailey, A.Mcnamara. Improving search task performance using subtle gaze direction. *ACM Trans. Appl. Percept.*, 6(3):1–19, 2009.

[R.C09] R.Cowboy. In-game ads poised for primetime. 2009.

[Res09] Continental Research. In-game advertising: not mass market -but massive in its market. *Continental Research*, 2009.

[R.M03] R.Mayer. *Learning and instruction*. Prentice Hall, 2003.

[sa10] Entertainment software association. Enssential facts about computer and video game industry. 2010.

[S.C10] S.Cobelens. Effectiveness of advertising in first person shooter games. *Master Thesis, Leiden University*, 2010.

[S.N09] C.Rao J.Zupko S.Nasr, T.Vasilakos. Dynamic intelligent lighting for directing visual attention in interactive 3d scenes. *IEEE Transactions on Computational Intelligence and AI in Games*, 1,2:115–134, 2009.

[T.M] T.Montgomery. Anatomy, physiology&pathology of the human eye. *Optometric Physician*.

[U.N02] U.Neisser. Recall of brand placements in computer/video games. *Journal of Advertising Research*, 42(2):80–92, 2002.

[V.A08] H.Gregor V.Andreas. *Product placement in computerspielen*. Verlag Dr.Mueller, 2008.

[W.T07] L.Stammermann W.Thomas. *In-game advertising-werbung in computerspielen*. Gabler, 2007.