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Department of Management, Economics and
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Pay attention to me

Quantifying attention to advertising through consumer neuroscience

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Abstract

Attention represents a crucial concept in advertising industry, appearing as a first step in major advertising processing models, without which all of the successive stages of customer journey are not possible. In today's highly distractive world, overflowed with advertisements, many of them fail in attracting consumers' attention, ultimately leading to wastage of resources. Current metrics, widely employed in advertising industry, are unable to tackle this issue, moreover, they are contributing to the problem. The possible solution to this problematic lies in adoption of attention based metrics. The present thesis explores techniques and tools for quantification of attention through Consumer Neuroscience. The study firstly explores the concept of attention, through academic literature analysis, where it aims in bringing more clarity to definition of attention, and its many facets. In addition, tools of Consumer Neuroscience were investigated, with focus on precise techniques for measuring attention in advertising utilized up to this point. Secondly, the study gives overview on current metrics of advertising industry, and pinpoints their limitations. Followingly, current industry efforts for transitioning towards attention metrics were presented. Disparities existing between academia based ways for measuring attention, versus industry ones were revealed, ultimately uncovering opportunities for the improvements in the industry. As a result, study offers a comprehensive set of attention metrics for quantifying attention and discusses their implementation, application fields and challenges for adoption.

Acknowledgements

My sincerest gratitude goes out to my co-supervisor, Dr. Marco Mandolfo, who guided me throughout this long process and offered me a valuable opportunity to collaborate with KIT Karlsruhe for the delivery of this thesis.

I dedicate this work to my grandmother, Zagorka, whose support and love I feel every day.

Without two Milicas by my side, the past two years of studying in Milan would not have been the same. Thank you for being my family, far away from family.

From the first day of school, there was Mia, who I now like to call my soul sister. Thank you for sharing this journey with me.

Finally, I want to thank my father, Aleksandar, and my mother, Snežana, without whom all of this would not be possible. You are my strength every day.

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List of Abbreviations

3MS- Make Measurement Make Sense

4A's- American Association of Advertising Agencies

AI- Affinity Index

AI- Artifical Intelligence

ANA – Association of National Advertisers

APA- American Psychology Association

BOLD – Blood oxygen level dependent response

BPM- Breaths Per Minute

EEG – Electroencephalogram

FEF- Frontal Eye Field

fMRI- Functional Magnetic Resonance

GRP – Gross Rating Point

IAB- International Advertising Bureau

LIP – Lateral Intraparietal Area

LIP- Low Involvment Processing

ML- Machine Learning

MRC- Media Rating Council

SCR-Skin conductance response

Introduction

Advertising industry is massive part of today's economy. Each year, billions of dollars are being poured into advertisements of different products and services. However, a significant problem arises: a large portion of this money is wasted. Average person is exposed to roughly 6 to 10 000 advertisements each day, nevertheless, major part of them fails at attracting attention. As Herbet Simon, Nobel laureate that introduced the concept of *attention economy*, stated: 'A wealth of information creates a poverty of attention'. Consumers are growing increasingly resistant to advertising, not only that they are not paying attention to it, but they are even consciously trying to evade them. This overabundance of advertising has also become an environmental issue, contributing to visual pollution and emissions of CO2. When an advertisement passes unnoticed, there is a wastage of all of the resources involved in its production.

Advertising is losing on its efficiency and the industry has faced a turning point, where a change needs to happen in order for industry to survive. Moreover, current advertising metrics are only pushing the problem further, not being standardized nor based on scientific evidence, and prone to different sorts of ad frauds. Metrics, that were suitable once upon a time, are still being used in todays' highly altered environment. In the early 1950s, with the widespread adoption of television into households globally, metric of 'impression' became a pertinent and meaningful concept, since when a TV was turned on it was actually watched by the whole family, without skipping the advertisements, partly due to the absence of remote controlor at that time. Thus, airing an ad on TV actually meant that someone viewed it, and a higher reach of a TV channel would certainly imply higher effect of an ad. Today, airing an ad on TV does not imply someone actually seeing it (The Attention Council,

2021). Due to highly distractive world we live in and proliferation of media channels, attracting and sustaining attention of consumers became a complex task. And without attention, there can be no impact made by an advertisement. Considering aforementioned, there is a need for advertisements to be optimized and evaluated by the attention they attract and hold, and not by the vague metric of impressions.

Attention metrics stand for a set of different measurements based on attention that are being exploited for evaluation of the ads, instead of, or for complementing traditional metrics. However, there is still no standardization on what attention is, nor how it can be measured. Present thesis endeavors to provide contributions to this pertinent issue, by expanding comprehension of the concept of attention within the advertising industry. Exploring both academic and grey literature, thesis aims to deliver overview on current industry efforts for making a switch towards attention metrics, as well as study differences between how the academia is approaching issue of measuring attention, versus the industry. Ultimately, it aims to propose a comprehensive set of metrics for quantifying attention. In the achievement of this objective consumer neuroscience tools are playing a pivotal role.

Consumer neuroscience is a relatively new field, found in the intersection of marketing and neuroscience. It allows for observing underlying brain processes in order to obtain better understanding of consumer behavior. Techniques that are used for this purpose are biometrics, eye-tracking, brain imaging techniques such as fMRI, eye-tracking, and physiological measurements. Its applications are many, from designing the product to best suit the needs of customers, enhancing the design of retail stores, to improving overall customer experience. Opportunity for advertising industry lies in the possibility to study and quantify human attention, while present thesis aims to explore measuring techniques and tools for this purpose.

Thesis outline

The thesis starts with explanation on methodology adopted for conducting this work. Second chapter is dedicated to exploration of the concept of attention: its definition and history overview. Followingly, thesis delves into importance and role of attention in advertising, through examination of major advertising processing models. Subsequent section was dedicated to presentation of major attention typologies and processes, where the attention starts to appear as multi-faceted rather than unitary concept. Section was concluded with considerations on overlaps between different types of attention and how they relate to each other. Final part of second chapter is dedicated to exploration of ways in which attention can be measured, exploiting consumer neuroscience. Thus, the question 'What is consumer neuroscience?' was answered and its tools were presented. The chapter ends with table that summarizes scientific papers where attention to advertising was measured, with the use of some of the consumer neuroscience tools. In addition, table tried to categorize this papers by the specific type of attention they are tapping, considering process and metrics they adopted, and relying on definitions and findings put forth previously. After having dealt with concept of attention and ways of its quantification, thesis shifts towards metrics in advertising. Firstly, metrics that are currently used in advertising industry were explained, with division into traditional and online advertising metrics, concluding with all the shortcomings they possess. Last part is dedicated to attention metrics. Industry switch towards attention metrics, that is currently taking place, was presented, as well as the ways of their delivery. Important notion was about the ways in which industry, at this point in time, measures attention and how they use consumer neuroscience tools. Last chapter of the thesis is discussion. It consists of critical comparison between what has been discovered throughout delivery of this thesis about attention to advertising and modes of its quantification in academia

versus industry. This chapter uncovers opportunities for improvement for the industry, thus important point is the proposal of a set of metrics that could potentially be utilized for the more elaborated approach to measuring attention. Furthermore, chapter discusses implementation of proposed metrics, as well as the different application fields. In addition, biases of the measures are exposed and challenges for adoption are put forth.

1. Methodology

The thesis is developed adopting literature review approach, where both academic, and so called, grey literature were analyzed and presented. Grey literature stands for papers found in between academic research and everyday discourse. Generally, they include industry reports, case studies, technical specifications, standards and policy documents (Cluley, 2018). The reason for choosing to include as well grey literature in this work, lays in the fact that *Attention Metrics* are highly innovative concept that is just gaining momentum in advertising practices. Academic research on this topic has its limits and is rather scarce. Furthermore, academic papers require considerable amount of time to be published. On contrary, advertising environment is fast paced one, where changes happen on a daily basis, thus for the comprehensive outlook, it requires to be monitored 'in real time'. In addition, the aim of the thesis is to bring value to both academia and industry, therefore logical course of action was to examine literature concerning both of these spheres, and moreover, draw connections between them.

Papers were searched primarly through academic platform Scopus, or alternatively, through Google Scholar. Considering Scopus, in the first phase of research, there was a need to define research words and research limits. Fields of resarch in each of the queries were limited to *Business, Management & Accounting*, *Computer Science* and *Neuroscience*. The results were sorted by highest citations, and followingly by newest date of publication, in order not to loose notion of new papers that could appear valuable but still did not have a chance to obtain high number of citations. First retrieval of papers was conducted by following query, looking for matches in *article title, abstract or key words*: 'attention' AND 'advert*' AND ('metric*' OR 'measur*').

This query was the main one for retrieving academic papers and it resulted in 561 results. From these, 40 papers were selected, examining the abstract, and not considering papers below 7 citations, in case they are not recently published. Moreover, specific field studies were not considered, for instance, tourism and sports specific studies. This query was later supplemented by others, as well considering *article title, abstract and key words*, for instance: 'attention' AND 'eye-tracking' & ('CPC' OR 'CPM') AND 'advert*' & 'advert*' AND 'attention' AND ('artificial' OR AI*). Additional papers were obtained by examining references in selected papers. These papers covered four major topics of this thesis and those are: consumer neuroscience, attention in advertising, viewability standard and advertising compensation metrics. Finally, for understanding the concept of attention, more general queries were used, for instance, 'attention' AND 'literature review', with focus on psychology and neuroscience field. Google Scholar was exploited arbitrary searching for key words and concepts of interest at the moment.

Grey literature was mainly retrieved from websites of crucial advertising stakeholders, International Advertising Bureau (IAB), Media Rating Council (MRC), Association of National Advertisers (ANA), Attention Council, etc. Moreover, by extensive google search main players in the field were identified, namely Adelaide, Lumen, Dentsu, Amplified Intelligence and rest. They have conducted, sometimes in a form of collaboration, extensive studies on attention to advertising that offered more practical information, compared to academic studies. During two months period their websites were constantly monitored in order to keep informed about new advancements regarding attention metrics, measuring attention, and standardization. These sources were important for understanding industry dynamics and how the advertising ecosystem works in practice.

2. The concept of Attention

This chapter is aimed at grasping the complex concept of attention, from giving considerations on its definiton to understanding underlying processes involved in the concept of attention. In addition, it will convey the opportunities consumer neuroscience offers for quantifying attention. After giving brief history overview and discussing the main theoretical underpinnings, the focus will shift towards attention in advertising specifically and understanding all the facets of attention that may appear, which will provide the groundwork upon which the thesis is developed. Consumer neuroscience tools for measuring attention are presented, as well as how they are currently being exploited in the field of advertising. Finally, the chapter ends with a table summarizing academic papers aimed at measuring attention to advertising, by identifying which type of attention or underlying process is tapped by a specific measurement procedure given in the paper.

2.1. Definition and brief history

Various disciplines, including philosophy, psychology, neuroscience, neurophysiology, and more recently organizational theory and marketing, have been exploring attention. However, cumulative body of work concerning this phenomenon is still non existant, and there is no consensus on definition nor construct of attention (Ocasio, 2011). The concept of it remains unclear and rather fractioned (Lindsay, 2020). Nevertheless, understanding attention reasearch across different fields can provide insights regarding its role in the marketing and advertising industry (Buhić, 2022). American Psychology Association (APA) defines attention in the following way:

a state in which cognitive resources are focused on certain aspects of the environment rather than on others and the central nervous system is in a state of readiness to respond to stimuli

Nonetheless, in the corpus of literature, widely cited is the definition given by William James, published in the book under the title 'The Principles of Psychology', in 1890, and that is: *taking possession by the mind, in clear and vivid form, of one of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others* (pp. 917-918)'

Paradox of defining attention is illustrated in two statements, one given by William James and that is *Everyone knows what attention is ,* to *No one knows what attention is* stated in the paper under the same title by Hommel et al. in 2019. Moreover, the paper states 'the concept of "attention" is one of the most misleading and misused terms in the cognitive sciences'.

Interest in this topic predates the formal establishment of psychology as a discipline in 1879. It originated in philosophy, where fundamental questions were raised, such as whether attention is automatic or intentional. While the philosophers themselves did not conduct experiments, their conceptual analyses laid the foundation for later scientific studies of attention. Scientific explorations of attention originates in psychology through behavioural experiments which helped uncover its dynamics (Lindsay, 2020).

Early developments in psychology field were taking place at the end of 19th and in the beginning of 20th century, with notable figures like Wilhelm Wundt, Edward Titchener, William James and Helmholtz. James' defintion of attention is the one mentioned above, and it is considered that, with the work published in a book *The Principles of Psychology*, James inspired the scientific approach to attention research

that followed. According to James, clarity is central attribute of attention, however he is known for emphasizing its selective aspect. Wundt has the merits of introducing study of attention to the field of psychological research. He noted the volountary control of attention when performing a simulation that included switching attention from auditory, to visual stimulus. Helmholtz provided evidence for relationship between attention and perception, highlighting the essential role of attention in visual perception. In addition, he was the one that observed attention that is not followed by eye movement, namely covert attention, as well as the fact that attention is limited in its nature. Titchener published a book named *Lectures on the Elementary Psychology of Feeling and Attention*, which helped establish a solid foundation for studying attention in the field of psychology (Proctor & Vu, 2023).

In the mid 20th century, cognitive psychologist like Donald Broadbent and Anne Treisman developed theories that helped explain attentional processes, and those are Filter Theory by Broadbent and Feature Integration Theory by Treisman. Filter Theory was inspired by issues encountered by radar operators in the Second World War as they were attempting to communicate with more pilots at once over a single loudspeaker. The theory given by Broadbent suggests that all incoming stimuli would undergo extraction of physical properties, for example location of sound, and then face a selective filter, after which more complex psychological properties would be extracted only for stimuli that had specific physical property and therefore passed the filter. This theory is playing an important role even today, since it introduced distinction between preattentative and attenatative stage, where attentative stage starts once the selective filter is passsed. Function of selective filter, therefore, is in preventing overload of the second stage, the one more complex in its nature. In the following years, however, it was demonstrated that higher level of processing, that presumably only happened in the second stage, could in some cases happen even in

the first stage. What was problematic about assesing the level of processing for unattended stimuli is the fact that measures were not immediate, since method adopted was retrospective questioning. Instead, assesing this processing by a more recent development, neural response to a stimuli, appears to be more appropriate. Treisman revised Filter theory given by Broadbent, making it less drastic, by proposing that unattended stimuli was not entirely filtered out but rather 'attenuated'. In exceptional cases, this weak signal coming from unattended stimuli may arrive to the second stage, and be sufficient for identification. This usually happens when the signal is characterized by personal significance, for example name of a person, or it has a particular significance in current context (Driver, 2001).

Another contribution of Anne Treisnam is Feature Integration Theory that remains grately influenced by Broadbent's theory. Namely, in preattentative stage, features of visual stimuli such as its color, shape, and similar are extracted, but it is only in the attentative, second stage, that they are integrated in order to produce multidimensional perception of an object. This theory was supported by visual search task where participants had to look for a target, firstly defined either by specific color (red/green) or orientation (vertical/horizontal), and later by a specific combination of this features (for instance, red and horizontal). What emerged from this is that the first task performance was not affected by increase in non-targets, while the second resulted in less efficiency when increasing the number of non-targets. The first task apparently could be performed in parallel, in preattentative stage, while the second one required serial attentative processing (Driver, 2001).

In addition, in the mid 20th century, Cherry delivered his revolutionary work concerning the auditory selective attention, called *cocktail party phenomenon*. The work was touching upon issues of how subject chooses the voice to attend to, when several are present, as well as what is extracted from the unattended ones (Proctor & Vu,

2023). Deutsch and Deutsch (1963) as cited in Kahneman (1973) build upon Filter Theory proposed by Broadbent, proposing that the bottleneck is located just before the stage of response, preventing more than one response and selecting the one that

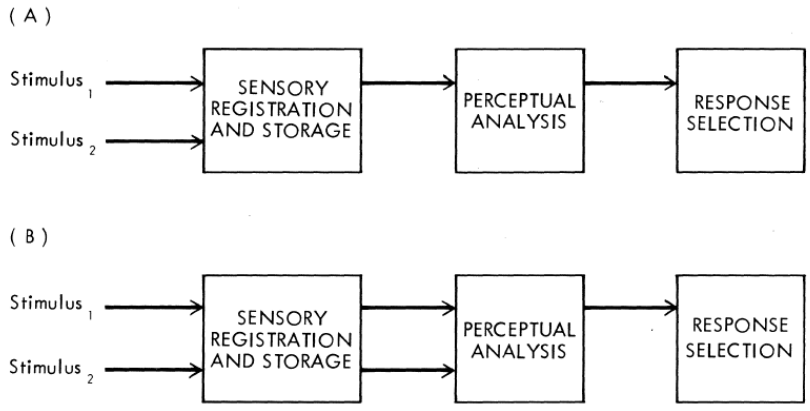

Figure 1 Two models of selective attention (Kahneman, 1973)

is the most appropriate given the situation. Both theories represent the models of selective attention and their comparison is given in the Figure 1 (Kahneman, 1973). Kahneman reflects on this models saying that 'man's cognitive operations are far more flexibile than either of these bottleneck theories would suggest'.

At the end of 20th century, notable figure in the field of attention research is Daniel Kahneman. In 1973, he published the book *Attention and Effort*, where he revised existing research on attention thus far, and presented his idea of attention being correlated with effort, the special case of arousal that is corresponding to what the subject is doing and not what is happening to him (Kahneman, Attention and Effort, 1973). Kahneman proposed capacity model, namely he regards attention as resource that can be divided between separate tasks in different amounts, given that at any moment total amount of attention resource capacity is limited (Proctor & Vu, 2023). Kahneman's book has been cited over 10 000 times and influenced greatly the attention research that followed (Bruya & Tang, 2018) Moreover, Michael Posner is another prominent figure, proposing three separate functions of attention, and those

are alerting, orienting and executive control (Posner & Petersen, The Attention System of the Human Brain, 1990).

At the beginning of 21st century, work on attention research has flourished. From 2000 to 2020, number of articles published containing attention in their title equals the number of articles before that time (Proctor & Vu, 2023). More recent work on attention includes neuroimaging techniques, as electroencephalogram (EEG) and functional magnetic resonance (fMRI) that allow for observing brain activity and thus revealing neural correlates of attentional processes.

2.2. Attention in advertising

The first stage in the mental stream of thought leading to a purchase is attention.

Thus, the first function of an advertisement is to attract attention.

C.H. Sandage, 1945.

Milosavljevic and Cerf (2008) state that attention is essential construct for each individual involved in marketing. The research integration of findings from cognitive psychology, cognitive neuroscience, and marketing is still in its early stages. However, a handful of marketing researchers have ventured into this emerging field, which seems to offer significant potential for advertising research (Vakrastas & Ambler, 1999) he importance of attention in advertising is reflected in advertising processing models where it holds the prominent position.

2.2.1. Advertising processing models

The widely acclaimed and highly favored advertising processing model is **AIDA**. AIDA is the acronym standing for Attention → Interest → Desire → Action, as the first formal advertising model. In this model, attention appears as the first step people

go through upon being exposed to an advertisement (Milosavljević & Cerf, 2008). It suggests that each advertising process commences with capturing attention, succeeded by information integration and comprehension, which then can lead to desirability and action (Strong, 1925). It was created by St. Elmo Lewis in 1898, for the purpose of offering guidance to salesman, and it still remains the best known model (Heath & Nairn, 2005). In advertising, the ability to capture consumers' focus is an important parameter, inherently measuring the effectiveness of an advertisement. Attention is refered to exactly this phenomenon (Hamelin, Al-Shihabi, Quach, & Thaichon, 2022). More recent research has shifted the emphasis from the concept of hierarchy towards four core constructs, and those are: attention, affect, memory and desirability. They possess the ability to impact advertising performance either individually or in combination (Venkatraman, et al., 2015)

Elaboration Likelihood Model (**ELM**) is developed by Petty and Cacioppo in 1980s. It gives explanation on how people process and respond to persuasive messages derived from their motivations and ability of cognitive elaboration, thus how the attitudes are being formed. Two routes to persuasion proposed by the model are central and peripheral route. Central route is the one involving considerable effort and active thinking, whereas peripheral route involves little amount of cognitive effort. In case of lacking motivation or ability to engage in thourough cognitive ellaboration, peripheral route will take place.

Extending the ELM discourse, Heath (2000, 2001a, 2001b) puts forth Low Attention Processing (**LAP**) theory. According to this theory consumers adopt passive learning, which is low-attention cognitive process, and implicit learning, process that is independent of attention, when exposed to advertising or when adopting information about brands. Thus, he states that the content of advertising is learned passively and implicitly, and that the number of times an ad is seen in high attention state will be

negligble compared to the ocassions when it is processed in low attention state. He explains this phenomenon by the 'time-poor' environment we find ourselves in, therefore many decisions that need to be made on a daily basis are made intuitively rather than thought through.

MacInnis and Jaworski (1989) proposed integrative framework for information processing of an advertisement, expanding on theories presented thus far. Overview of the model is given in Figure 2. Fundamental elements of the model are needs, classified as either utilitarian or expressive. Utilitarian needs represent desire for a product that can remove the problem, or help in avoiding it, whereas expressive needs reflect the desire for a product that deliver social or aesthetic utility. The model draws relationship between the needs and motivation to process brand information, where the motivation is affected by the needs. Authors defined motivation as desire to process brand information within the advertisement. Two dimensions of processing, namely attention and intensity of processing, are influenced by motivation. With regards to attention, they state that it can be dedicated to an ad in varying degrees, highlighting the fact that it is a limited cognitive resource. Therefore attention to advertising can vary from low to high. Higher attention will be dedicated to an ad if the relevance of the ad information is superior to secondary task that is often taking

place, such as conversation, 'daydreaming' or presence of other environmental stimuli.

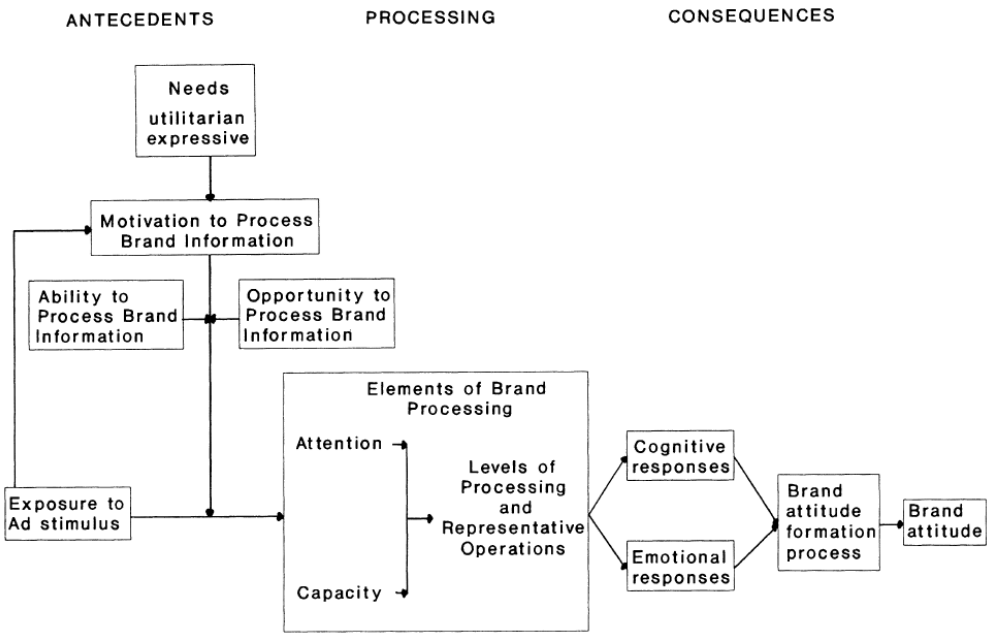

Figure 2 Integrative attitude formation model (MacInnis, Jaworski, 1989)

Another advertising processing model is proposed by Rodgers and Thorson (2013), and that is Interactive Advertising Model (**IAM**) (Figure 3). It is concerned with internet advertising specifically, and aims to answer the question how people perceive and process internet advertisements. They have highlighted the need to adapt traditional advertising processing models to a more complex environment of internet advertising. The model includes three paradigms, namely functional, structural and information processing. The assumption of the model is that the information processing is dependent both on function and structure. Before delving into exploration of how consumers process online advertisements, it should be understood why are they visiting this online space in the first place. Functional part of the model explains this, indicating that consumers tend to switch between serious and playful mode, conditioned by their motives for visiting internet. Thus, the motive

of individuals will influence the way in which an advertisement will be processed. This is consumer-controlled part of the model, while advertiser-controlled part of the model is concerned with structural elements. Structural part is explaining features of an advertisement, and what kind of effect they produce on consumer's memory, attitude and behaviour. However, structuralist approach alone can not explain why and how consumers react in a certain way to an advertisement, and that is the reason for supplementing it by functionalist approach. The information processing that includes cognitive effects of attention, memory and attitude will be explained by physical features of an ad, such as ad type, ad format and ad features (size and color, that are considered objective, and subjective features indicating if an ad is exciting/interesting/boring and similar), as well as the motives for visiting the website or being on the internet. It should be noted as well, that the important difference compared to traditional advertising lays in the possible outcomes. Namely, digital

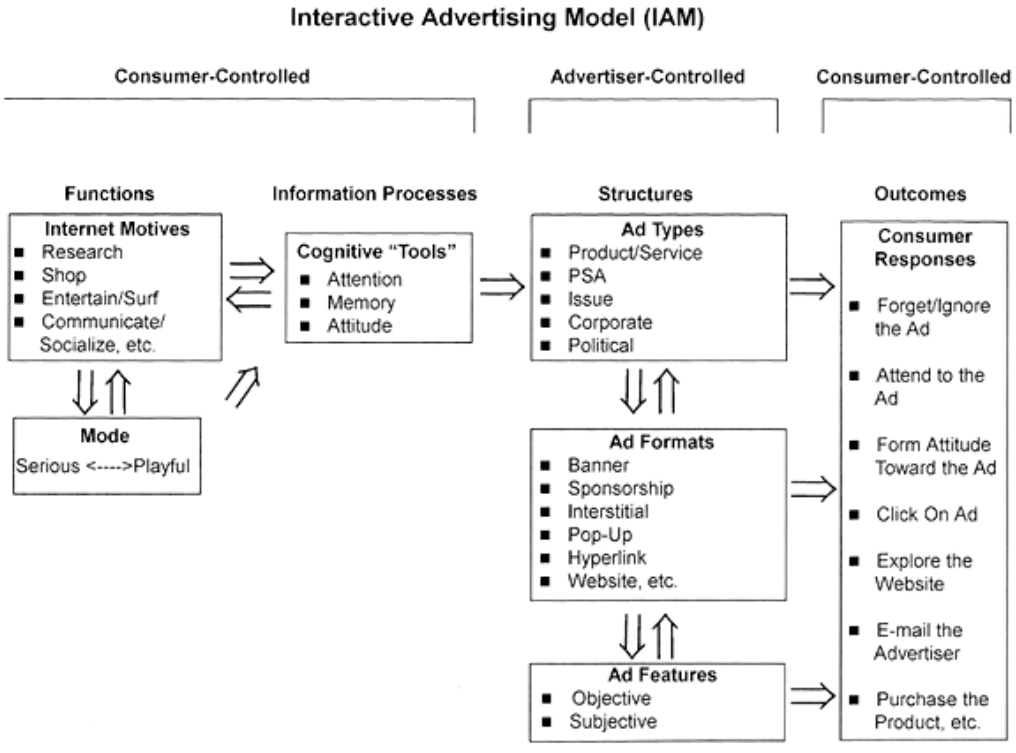

Figure 3 Interactive Advertising Model (Rodgers, Thorson, 2013)

environment allows for more interactivity between consumer and advertisement, translated into clicks, click-through rate, purchase, time spent on website or leaving of the website, and existance of cookies that allow for tracking of consumers and identifying repeated visits.

2.2. Attention as multi-faceted concept

It is important to note that attention is not a unitary concept. Over the past 20 years, attention research in cognitive sciences has emphasized the variety of mechanisms and processes that portray attention at the individual level (Norman & Shallice 1986, Posner 2004, Posner and Rothbart 2007). Limited information processing capacity of individuals is, up until now, primarily explained by the concept of attention. However, cognitive neuroscientists have proved that attention is not a unitary process

		Mode of allocation	
		Exogenous	Endogenous
Domain of allocation	Space		
	Time		
	Sense		
	Task		

Figure 4 Framework for Attention (Posner, 2012)

and should rather be considered as a variety of interconnected processes that operate in the brain's neural networks (Posner, Rothbart, 2007). Nevertheless, neuroscience literature is still not consistent with its categorization concerning attentional mechansism (Ocasio, 2011). In neuroscience and psychology, studies of attention are predominantely concerned with visual attention (Kanwisher & Wojciulik, 2000). As attention in advertising is mainly related to visual one, this thesis will delve into that one specifically, with some considerations of auditory and tactile one.

Michael Posner, in his book *Cognitive Neuroscience of Attention* gives operationalized view of attention, as *differential allocation of information processing resources*. In this regards, he notes that allocation can be attained by different modes and within different domains, where modes and domains are independent from each other (Figure 4). In terms of modes, Posner defines exogenous and endogenous one. Endogenous attention refers to top-down attention, while exogenous is bottom-up, and their detailed explanation will follow. Domains of allocation can be space, time, sense or task. For the purposes of this thesis, focus will be on domain of space, which has subdivision to overt spatial attention and covert spatial attention.

The difficulty of defining the concept of attention is aggravated by existance of several types of attention. Bearing that, more attempts were made to categorize attention into taxonomies. For instance, in terms of modalities there is visual, auditory, spatial and temporal attention. Allocation of attention can be overt, followed by eye movements, or covert, through the 'mind's eye'. Moreover, the enduring division on top-down and bottom-up in terms of attention control, is important. Hommel et al. (2019) delineated more than 10 diverse forms of attention in an endeavor to highlight the futility of term attention (Narhi-Martinez, Dube, & Golomb, 2022). In the following sections, major models of attention will be discussed, along with an exploration of the interconnections that exist between them.

2.2.1. Top-down and bottom-up attention

Top-down, also known as goal-directed and bottom-up, or stimulus driven, are concepts refering to attentional processes regulation. Top-down process is knowledge based, helping the individual to differentiate between distractors and actual signals. Bottom-up, on the other hand, is driven by characteristics of the signal (Sarter, Givens, & Bruno, 2001). Bottom-up processes are involountary, rapidly shifting attention to

salient visual features, while top-down are concerned with individuals' longer-term cognitive strategies.

Temporal dynamics of these two types of attention show differences. Connor et al. (2004) argues that bottom-up attention acts early, whether considering neural or psychophysical levels, while top-down attention will prevail within 100 milliseconds. Bottom-up attention, therefore, has earlier time course, due to saliency effects coming from visual features. Top-down is later, since it requires operations by higher-level cortex and it is standing for cognitive control (Connor, Egeth, & Yantis, 2004). If attention is observed as a two-step process, consisting of pre-attentative state and focal attention, bottom-up processes are regarded to as pre-attention states, while top-down are the ones of focal attention. However, it does not imply their sequentiality, as top-down attention can sometimes act as moderator for bottom-up attention (Milosavljević & Cerf, 2008). Moreover, Anton-Erxleben and Carrasco (2013) define time course of bottom up attention as 'quicker', rather than 'earlier', stating that bottom up attention will impact top down one for 80-130 milliseconds upon appearance of distractor. Moreover, bottom up attention, also refered to as exogenous, or transient, rises quickly and reaches its peak at 100-120 milliseconds, what explains the name 'transient'. Top down attention or endogenous, also known as sustained, takes about 300 milliseconds to be deployed (Cheal, Lyon, & Hubbard, 1991; Hein, Rolke, & Ulrich, 2006; Ling & Carrasco, 2006a; Liu, Stevens, & Carrasco, 2007; Muller & Rabbitt, 1989a; Nakayama & Mackeben, 1989; Remington, Johnston, & Yantis, 1992 as cited in Carrasco (2011)). The two are working together in order to optimize attentional performance (Egeth & Yantis, 1997). Neisser (1967) states that allocation of attention is flexible and responsive to the intentions of given moment, yet pre-attentative mechanisms are rather operating autonomously and outside of volountary control.

In this regards, top down and bottom up attention can alternatively be regarded as:

- Volountary - refers to task intentions at the moment,
- Non-volountary / Automatic - phenomenon of allocating capacity, or paying attention to any novel signal, object in sudden motion, or, for instance, conversation where subject's name appears (Kahneman, 1973).

In conclusion, top-down processes are volitional, controlled and endogenous, while bottom-up are automatic, non-volitional, and exogenous.

From marketing perspective, and more precisely, advertising one, distinction between the two is relevant. Attention that is directed towards an ad resulting from goals of an individual, is called top-down attention or directed attention. Factors such as consumers' goals, motivation and familiarity of the brand play an important role in determining attention (Casado-Aranda, Sanchez-Fernandez, & Ibanez-Zapata, 2023). In this regards, top down attention is individual based, as individuals' 'mental set' represents top-down factor (Awh, Belopolsky, & Theeuwes, 2012; Corbetta & Shulman, 2002; Itti, Koch, &Niebur, 1998; Theeuwes, 2010). Moreover, in advertising research it has been proven that top-down factors influence both path of eye movements and its temporal pattern (Wedel, Pieters, Liechty, 2008; Pieters, Wedel,

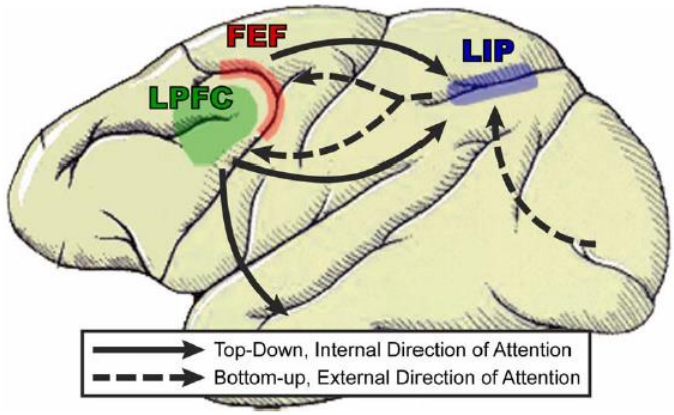

Figure 5 Schematic control of attention (Buschman, Miller, 2007)

2007; Rotello, Stewart, Keir, Duffy, 2001). On contrary, attentional capture, or bottom-up attention is the one captured by the properties of an ad. Therefore, advertisement that is salient in its properties will lead to attentional capture. Salient visual feature is the one 'popping out', for instance red fruit in the field of green. Moreover, saliency can be caused by color, shape, orientation or similar (Connor, Egeth, & Yantis, 2004). More specifically, search advertisements are expected to evoke top-down attention, while the advertisements that appear on non-search Web sites tend to evoke attentional capture, if characterized by distinctive features (Greenberg, 2013).

Numerous studies have demonstrated that specific areas of the occipital, parietal, and frontal cortex show heightened activity in response to both endogenous (top down) and exogenous (bottom up) shifts of attention. Overall, the vast majority of studies argues that although there is an overlap in networks underlying, these two types of attention are rather independent (Carrasco, 2011). The source of top down attention appears to be in frontal eye field (FEF) located in prefrontal area and it is less reactive to distractors. Bottom up processing, on the other hand, is considered to finalize in lateral intraparietal area (LIP), where cells are prone to respond to salient stimuli (Lindsay, 2020). Supporting figure presented above (Figure 5) indicates that top down control, as internal direction of attention, originates in the frontal cortex, while bottom up flow happens from parietal to frontal cortex (Buschman & Miller, 2007).

2.2.2. Overt and covert attention

Visual attention is effectively controlled by eye movements, although it is not the only way (Lindsay, 2020). Namely, there is a distinction between, so called, overt and covert attention, subdomains of spatial attention allocation. Overt attention is the one indicating attention followed by eye movements for extracting visual information,

while covert attention, on the other hand, occurs in the absence of eye movements (Carrasco, 2011).

Interaction between the two does not have clear interpretation in attention research and theory. There are theories claiming that covert attention has the purpose of guiding overt attention. Moreover, according to one theory, covert attention involves preparation of eye movemets, even if in the end they are not executed (Rizzolatti, Riggio, Dascola, & Umilta, 1987). It is known that control of eye movements includes frontal eye field (FEF), region located in the frontal cortex. When stimulating neurons in this region at levels that are too low to cause eye movements, effect obtained is the one closely resembling covert attention. Therefore, covert attention could be defined as mechanism to help decide where to look overtly (Lindsay, 2020). However, there are opposing theories and interaction between the two remains unsettled (Posner, 2012). Neuroimaging studies demonstrated an important overlap in the brain structures that are activated by overt attention, and those activated by covert one. However, (Klein, 2004) finds the issue in regards to this, stating that even if neural structures are the same, overt and covert attention can still be mediated by diverse neural circuits, which can hardly be captured with neuroimaging.

2.2.3. Levels of attention

In the realm of advertising research, a considerable body of literature discusses levels of attention (Heath & Nairn, 2005; Grimes, 2008; Courbet, Fourquet-Courbet, Kazan, & Intartaglia, 2014; Liu, Lo, Hsieh, & Hwang, 2018; Nelson-Field, 2020). Namely, attention can be either high or low, passive or active. Greenwald and Leavitt (1984) proposed four following levels of attention, examining differences in consumer involvement with advertising: preattention, focal attention, comprehension and elaboration. They are stated in a sequence of increasing involvement and increasing

processing capacity dedicated. High levels of attention imply high viewer involvement, thoughts about advertisements and outwardly expression of their emotions (Petty, Cacioppo, & Schumann, 1983). This type of attention can be measured by self-reports (Laczniak, Muehling, & Grossbart, 1989). Current advertising environment suggests that it is likely that advertisements will not receive any active processing, or active attention from consumers (Bauer & Greyser, 1968). In relation to this, Heath (1999) as stated in Grimes et al (2006), posits the low involvement processing (LIP) theory. This theory suggests that advertising, in general, is processed at lower levels of involvement, but with high efficiency. Processing is rather passive and automatic, while advertising stimuli will constitute a part of implicit memory. Nevertheless, according to Heath, it will still result in influence in regards to brand choice even with no active thought about it, or rather, active attention. Measuring attention to advertising, when it is at low levels, requires different measures, and is more complex compared to high attention (Bellman, Nenycz-Thiel, Kennedy, Hartnett, & Varan, 2019). High arousal is related to high levels of attention, on contrary, low arousal implies low attention as well. K. Nelson-Field (2020) in her book *The Attention Economy* and *How Media Works* suggests three levels of attention, namely non-attention, low attention or passive viewing, and high attention or active viewing. When exposed to advertisement, viewers tend to switch between these three states, as suggested by results of experiment conducted. Furthermore, she gives evidence for low attention driving results in advertising. The following model (Figure 6) of advertising attention processing was proposed, aiming to depict levels and grades of both consciousness and attention, referring to statement of Demasio (2000) as cited in Nelson-Field (2020) …*both consciousness and attention occur in levels and grades, they are not monoliths, and they influence each other in a sort of upward spiral*.

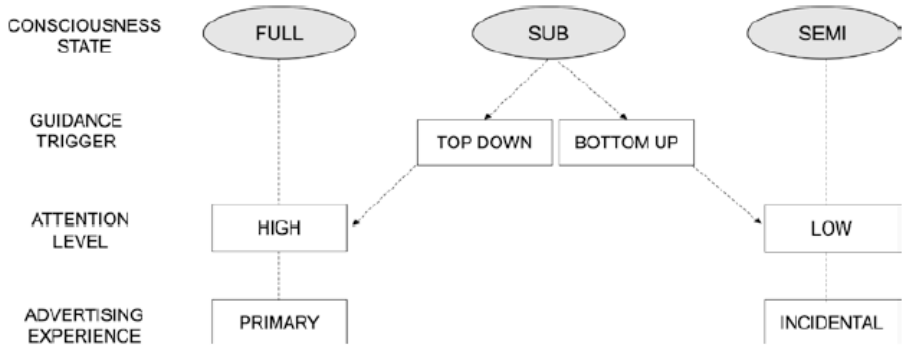

Figure 6 Levels of attention (Nelson-Field, 2020)

2.2.4. Components of attention

Attention is a term overarching multiple underlying processes (Hommel & Colzato, 2015; Di Lollo, 2018). According to Ballard (1996), attention includes range of processes:

- Basic arousal,
- Alertness,
- Selection,
- Concentration,
- and Sustaining attention.

Arousal indicates the state of wakefulness, excitement, that promotes performance of well learned responses. Although arousal enables information processing, at high levels it will interfere with complex cognitive tasks (Greenwald & Leavitt, 1984). Therefore, more arousal does not mean more attention. Yerkes-Dodson curve, as cited in Lindsay (2020) shows inverted U shape in terms of arousal and performance. Performance is poor at low levels of alertness, but so is at high, while medium levels represent the optimal point. However, Kahneman (1973) reflecting on his capacity model, states that more attention capacity will be available at moderately high levels of arousal. Attending to one stimulus over the others is a process of selective attention.

Attention can also be divided, by allocating attentional resources to more than one stimuli at the same time. Sustained attention, or vigilance, is preservation of alertness over time, as well as receptivity for stimuli (Davies, Jones, & Taylor, 1984; Davies & Parasuraman, 1982).

Posner and Boies (1971) propose three compononets of human attention, and those are:

- Alertness,
- Selectivity,
- and Processing capacity.

Alertness and selectivity are already addresed, while processing capacity is indicating limited central capacity system, upon which several tasks are placed, and consequently they tend to interfere. The results of experiment suggests that central processing capacity is pertaining only to conscious mental operations. Higher capacity allocation is paired with higher levels of attention, as suggested by Greenwald and Leavitt.

Posner and Petersen (1990) conceptualized attention suggesting three following functional components or attentional networks:

- **Alerting** – the attentional component of alerting encompasses the ability to enhance vigilance towards an upcoming stimulus. Intrinsic alertness is related to cognitive control of wakefulness and arousal, while phasic alertness occurs when an external warning stimulus precedes the target, increasing the response readiness. This function is mediated by neural networks in thalamic, frontal and parietal regions of the brain.
- **Orienting** – this component helps the selection of information when more sensory inputs are present. It can be either voluntary, when subject is

specifically searching for a target, or reflexive, when attention is directed to location by sudden event. Distinction can be made between overt and covert orienting, depending on presence or absence of head/eye movement. In terms of neural networks, the ones associated with this function are located in areas of superior parietal lobe, temporal parietal junction and the frontal eye fields.

- **Executive control** – employed in situation that require more complex mental processing, such as planning, decision making, error detection, etc. Its neural networks are found in anterior cingulate cortex and lateral prefrontal cortical regions (Fan & Posner, 2004).

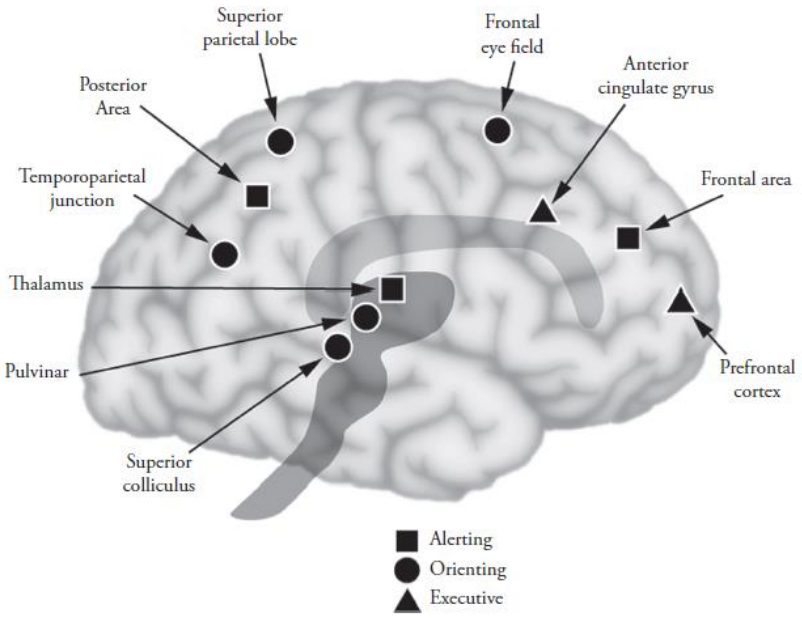

Figure 7 Anatomy of three attentional networks (Posner & Rothbart, 2007)

2.2.5. Selective, sustained and divided attention

Selective attention refers to the cognitive process through which individuals concentrate their information processing on a particular set of sensory stimuli at a moment in time (Ocasio, 2011). Human brain has limited processing capacity, thus

processing of all external stimuli is not feasible (Lavie, 1995). In presence of competing and distracting external stimuli, selection mechanism is responsible for coherent responding (Ocasio, 2011). The idea of selective attention arising from limited capacity of human brain has its neurophysiological grounds (Lennie, 2003). Limits on the human brain are presumably imposed by the fixed quantity of total energy available and additionaly by neuronal activity that is high in energy costs when involved in cortical computation (Carrasco, 2011). Selective attention is impacted by both top-down and bottom-up attentional processes. Initially, much of the research placed importance on bottom-up factors, such as features and characteristics of the stimuli, while more recently the importance of top-down attentional processes has been emphasized, such as prior cognitive orientations, goals and task demands, or motivational aspects (Corbetta & Shulman, 2002).

Attentional vigilance is a process of sustaining concentration on a specific stimuli. This kind of attention is limited in its duration, thus while individual's attention towards stimuli is high, the period of sustained attention is taking place, once this kind of attention can no longer be preserved, the switch towards low attention processing will happen (Ocasio, 2011). Focal attention is effectively preventing irrelevant stimuli to interfere with the main task, nonetheless some evidence demonstrate that at times irrelevant stimuli is still processed reaching the level of recognition (Kahneman, 1973). Neurophysiological studies demonstrated that sustained attention to stimuli leads to increased neuronal sensitivity, resulting in the same effect of neurons to attended stimuli as if it were luminazed (Carrasco, 2011). Ballard (1996) argues that vigilance performance is affected by factors falling into three categories, namely task parameters, situational parameters and subject characteristics. Situational factors such as noise, temperature, vibration and situational variables can impact the ability to sustain attention. Subject characteristics

include demographics, personality traits, physiological state, arousal level and similar. In addition to this, there is also the effect of interaction among factors that can further influence the performance.

Divided attention is related to the question often addressed in attention research, *can two simultaneous but unrelated inputs be processed at the same time?* Kahneman (1973) in his book *Attention and Effort* reviews existing theories related to this issue. Deutsch and Deutsch (1963) and Norman (1968) assumed that although parallel processing may occur at all levels of perceptual analysis, there is a bottleneck for information entry to awareness, response selection and permanent memory. Neisser (1967) argued that focal attention is unitary, whereas parallel processing occurs at the pre-attentative stage. Treisman (1960), on the other hand, suggested that even during focal attention some parallel processing may occur. Kahneman concludes that parallel processing of simultaneous inputs is possible, however demands of those processes will interfere with each other considering the limited information processing capacity. He associates this problematic with effort theory, suggesting that response performance to simultaneous inputs depends mainly on how demanding are the activities among which attention is being divided are.

2.2.6. Interconnections of Attention Typologies

Consensus on different typologies and models of attention is, up to this point, not achieved. In chapters above, typologies that tend to repeat across attention research, both in the field of neuroscience and marketing, were pointed out and defined. However, since different research papers consider different types of attention, certain amount of overlap exists between them.

To begin with, the analysis will consider the categorization of attention into top-down and bottom-up. This categorization has gained widespread acceptance in

neuroscience research on attention. Accordingly, the terms "endogenous" and "volitional" can be regarded as synonymous with top-down attention. Building on the previous discussions, the exercise of top-down attention is closely linked to selective attention, as individuals willingly direct their focus towards specific stimuli guided by their own objectives and motivations. The ability to sustain attention or vigilance for extended periods of time indicates the capacity to remain focused on these selected stimuli, which is influenced not only by individual goals, but also by personal attributes and situational factors. Conversely, bottom-up attention often results in divided attention. Even when attention is initially concentrated on a single stimulus, bottom-up factors, such as the appearance of distractors during sustained attention, can lead to the division of attention between the stimuli. Moreover, division of attention between high and low is present mainly in the marketing or advertising research, while in the neuroscience this kind of division is rather rare. High attention is indicating sustained attention, while low attention is rather related to divided one, even if it does not necessarily imply low attention. Divided attention can in some cases appear as high, however, it is less probable, since the division of attentional capacities across multiple stimuli is probable to result in decreased performance and difficulties in maintaining concentration.

2.3 Measuring attention

For an extended period of time, marketing research has been relying on established concepts, techniques and methods where pen and paper for collecting data were common practice (Jordao, Souza, Oliveira, & Giraldi, 2017; Isa, Mansor, & Razali, 2019). Traditional methods of self-reported measures, such as focus groups, surveys and similar were widely used for assessing advertisement success. These methods have advantages of being inexpensive, accessible, simple and quick (Venkatraman, et al., 2015), however they are biased and unable to assess unconscious processes. When

it comes to measuring attention, most of them were suited for assessing high attention processing only, even if this kind of processing is rare to encounter in advertising landscape. Such is, for instance, metric of recall that was widely adopted for evaluating performance of an advertisement, and assessing if it managed to capture attention. With regards to this, psychophysiological measures offer more objective and reliable implications concerning consumer thought process (Shaw & Bagozzi, 2017).

2.3.1. Consumer neuroscience

Neuroscience employs novel technologies that enable the measurement of neurophysiological activity, facilitating the investigation of complex human behaviors (Milosavljević & Cerf, 2008). It has unveiled a significant knowledge regarding the human brain and its intricate processes of stimulus processing and decision-making (Kennedy, Northover, 2016). In recent years, applications of neurophysiological methods, for the sake of studying advertising effects on consumer, have witnessed surging growth (Pozharliev, Verbeke, & Bagozzi, 2017). Consumer neuroscience offers safe and noninvasive methods for accessing brain responses to stimuli, and they incorporate electroencephalograhy (EEG), functional magnetic resonance (fMRI), biometrics that are eye tracking, skin conductance, heart rate, respiration, facial expressions, as well as psychometrics, namely reaction times (Falk, et al., 2015; Pozharliev, Verbeke, Strien, & Bagozzi, 2015). More direct measures of attention can be obtained exploiting the use of neurophysiological methods such as eye-tracking or EEG.

Eye tracking

Eye tracking is the process of observing movements and fixations, as well as pupil size of an eye through eye tracking system. The system is composed of hardware and

software. Hardware stands for device, eye tracker, that can be remote and exploit cameras for tracking eye movement. Otherwise, it can be head-mounted and track movements with the help of sensor. The most commonly applied are optical methods. In optical methods, hardware usually includes one or more cameras and infrared light. Software consists of algorithms that use the help of machine learning and advanced image processing to transform what camera captured, into data points. Eye-tracking tools measure two switching states of the eyes, fixations and saccades. Saccades are quick movements of the eye from one location to another, whilst fixations are moments during which eye is mostly immobile, and it lasts for 200-300 milliseconds. Output of the eye tracking data can be visually presented in various ways. The most common visual representation are heat maps, where the hotter colors (i.e. red) stand for areas where frequency of eye fixations is highest or duration of eye gaze is longest. Moreover, data can be visualized as gaze plots where the sequence of eye fixations over time is depicted, usually as series of connected dots. While the gaze plots show the location, order and time of eye fixations, scanpaths are rather focused on order of fixations and are suitable for reaviling patterns.

Electroencephalograph (EEG)

Electroencephalography (EEG) is a medical device that is used for measuring electric activity of the brain. It is delivering insights into brain working mechanisms, identifies active brain areas as well as interactions among them. It does so with the help of electrodes that are placed on the scalp. Brain is communicating through electrical impulses generated by neuron activity, what can be detected by the electrodes. Electrodes are placed in elastic caps, meshes or rigid grids, in order to ensure data collection from identical scalp positions along many iterations. EEG records this data and displays it as a series of waveforms that are called electroencephalograms. Considering that electrical signals are very small, recorded data is first digitized and

amplified. After this process, it becomes possible to present it as a electroencephalogram, in other words, as sequence of voltage values over time.

Human brain contains billions of neurons with highly complex firing patterns. Neural oscilations, that can be measured through EEG, conisist of a combination of various underlying base frequencies, believed to reflect specific cognitive, emotional or attentional states. Researchers classify these frequencies into distinct frequency ranges or bands: Delta band (1-4 Hz), theta band (4-8 Hz), alpha band (8-12Hz), beta band (13-25Hz), and gamma band (>25Hz). With regards to studying attention, alpha, beta and gamma waves appear as frequencies of interest.

Alpha waves demonstrate increased levels during mental and physical relaxation with eyes closed. On contrary, they are reduced once eyes open and subject engages into mental or bodily activity. Alpha suppresion is a reliable indicator of mental activity and engagement, such as focused attention to some kind of stimulus (Pfurtscheller & Aranibar, 1977). Another frequency used for assesing levels of alertness and attentional processing is beta frequency, where increased levels of beta indicate focused attention. Gamma frequencies are the one less known in EEG research, however some researchers argue that they are by-product of eye-movements and micro-saccades.

Functional Magnetic Resonance Imaging (fMRI)

Functional magnetic resonance imaging is non-invasive neuroimaging technique that measures the small changes in the blood flow and oxygenation levels occuring when a certain part of the brain is working. Namely, when a specific brain region is active it requires more oxygenated blood, consequently leading to an increase in blood flow towards that area, known as neurovascular coupling response. fMRI is indirectly measuring electrical activity of the brain by detecting alterations in the blood's oxygen

level. This phenomenon is known as the blood-oxygen-level-dependent responde (BOLD). BOLD signal is based on the fact that oxyganated and deoxygenated blood have different magnetic properties. When the BOLD response significantly deviates from the baseline it indicates the regions associated with neural activity. The BOLD response has a delay of 1-2 seconds compared to neuronal activity. Spatial resolution, on the other hand, is relatively high, ranging from 1 to 3 millimeters. Another limitation of fMRI, apart from temporal resolution, is the fact that BOLD signal can be impacted by head motion or physiological noise.

Other biometrics

Biometrics are physiological or automatic response to an external stimuli. Typical physiological reactions comprise parameters such as heart rate, respiration, and skin conductance (Venkatraman, et al., 2015). Heart rate is indicating the speed of heartbeat. Most commonly it is measured by electrocardiogram that employs external skin electrodes. In measuring attention, increased heart rate is indicative of increase in arousal and thus indicates increased ability to focus on an ad (Lang, Bolls, Potter, & Kawahara, 1999). Respiration rate is the number of breaths taken in a certain amount of time, most commonly one minute in order to obtain measure breaths per minute (BPM). This is another biometric that is used to infer arousal. Skin conductance response (SCR), or galvanic skin response (GSR), or electrodermal activity, reflects the variations in sweat gland activity. Namely, upon experiencing emotional or psychological arousal, sympathetic nervous system reacts with increased activity, leading to changes in skin conductance. This kind of changes are measured with the help of electrodes that are placed on the skin. It is considered direct measure of arousal, but is characterized by a small delay because of the nature of physiological responses (Venkatraman, et al., 2015).

Each of these methods are characterized by specific strenghts and weaknesses, offering different advantages when evaluating advertising messages. EEG, for instance, has high temporal resolution, and much higher compared to fMRI, thus it suggests higher effectiveness if the aim is investigation of second-by-second, ongoing, consumer response. Temporal resolutin for EEG is on millisecond time scale, while for fMRI it is measured in seconds. However, when it comes to spatial resolution, fMRI offers considerable better performance in comparison to EEG. Spatial resolution of fMRI would be 2-3 mm, while EEG is measured in cm, specifically 1-2. Therefore, if there is an aim of exactly locating the brain response, fMRI appears as more suitable (Pozharliev, Verbeke, & Bagozzi, 2017).

2.3.2. Applications of consumer neuroscience in advertising

Thus far, in marketing research, and more specifically advertising one, predominantly used instrument is eye tracker. Particularly, it found applications in commercial marketing research, owing to fast decline in its costs. Global companies, such as Microsoft, Google, IBM, etc. exploit this instrument for the sake of evaluating their advertising efforts and supporting decision making regarding design of not only advertisements, but also websites, packaging and shelf layout. Notably, eye tracking delivered through webcams is gaining ground. The recording of eye movement has become part of desktop, laptop and tablet computers, but also billboards, kiosks, TVs and smartphones. This has allowed for remote eye tracking to take place, for the sake of conducting experiments in the most natural environment (Wedel, 2013).

In advertising research, eye tracking data most commonly answers four questions, *what consumers look at, when, how often and for how long.* Common eye-tracking measures are time to first fixation, number of fixations, blink rate, accumulated fixation duration and average fixation duration, pupil size and smooth pursuit eye

movements. Eye tracking in the field of advertising research enables the comprehension of predominantly bottom-up mechanisms of attention capture (Casado-Aranda, Sanchez-Fernandez, & Ibanez-Zapata, 2023), which may account for three times greater influence on visual attention compared to other factors (Pieters & Wedel, 2004). From this experiments, the suggestions on how to create effective advertising by manipulating its visual characteristics can be infered. However, it should be noted that the visual characteristics of an advertisement represent just a fragment of the overall narative, and thus cannot be fully relied upon to predict attention (Casado-Aranda, Sanchez-Fernandez, & Ibanez-Zapata, 2023). In advertising particularly factors such as consumer goals, motivation and familiarity of the brand play an important role as top down mechanisms of controlling attention (Huddleston, Behe, Minahan, & Fernandez, 2015; Vu, Tu, & Duerrschmid, 2016).

Bellman et al. (2019) argues that one measure of attention is not sufficient for identifying all of the aspects of intricate concept of attention. The authors state that measuring attention to advertising is rather complex undertaking. Indeed, different types of attention are tapped by different measures. In the table below, a subset of the research papers aimed at measuring attention to advertising were analyzed. They are categorized based on the potential attention type and process they measure, utilizing selected consumer neuroscience tools. It can be noted that major part of papers are adopting eye-tracking tools. Although it is the more convenient tool, this approach to measuring attention is placing the equality sign between attention and visual fixation of an eye. Taking into consideration previous discussion on types of attention, mentioned approach can easily foresee some of the aspects of complex concept of attention. Moreover, Bellman et al. (2019) states that problematic of relying exclusively on eye-tracking may arise in case of 'daydreaming', when one is looking but not attending nor responding to specific stimuli.

More recently, experiments with tools such as EEG, fMRI and different types of biometrics have been set in motion. These tools are able to assess brain processes that are indicative of attention but can not be implied by utlizing eye-tracking tools only. It appears that the combination of consumer neuroscience tools is needed in order to comprehensively evaluate and measure attention.

Table 1 Summary of consumer neuroscience attention metrics across advertising research

Measuring attention to advertising through consumer neuroscience tools																
Tool typology	Metric used	Type of attention									Attention process (Bellman, 1996)					Authors
		Top-down	Selective	Sustained	High	Bottom-up	Divided	Low	Overt	Covert	Basic arousal	Alertness	Selection	Concentration	Sustaining attention	
EEG	Occipital alpha activity					x			x	x						Venkatraman et al (2015)
	Frontal Alpha Asymmetry (FAA)			x	x					x						
EEG	Frontal Alpha Asymmetry (FAA)		x	x	x					x						Clark et al. (2018)
EEG	Occipital alpha blocking and parietal beta activity at 50 ms					x				x						Geske, Bellur (2008)
	Occipital alpha blocking and parietal beta activity at 250ms	x								x				x	x	
Biometrics/ Electrocardiogram	Heart rate deceleration										x	x				Venkatraman et al (2015)
Biometrics	Heart rate variability (HRV)														x	Clark et al. (2018)
	Skin conductance rate (SCR)										x					
Biometrics	High skin conductance level				x						x	x				Bellman et al. (2019)
	Decrease in skin conductance level							x			x	x				
	Heart rate variability (HRV) or HR deceleration											x				
fMRI	dlPFC	x														Venkatraman et al (2015)
	vmPFC		x													
	Primary visual cortex (V1)					x										
	Amygdala										x					
Eye-tracking	Dwell time			x	x				x					x	x	Clark et al. (2018)
Eye-tracking	Long dwell time & few fixations			x	x				x					x	x	Venkatraman et al (2015)
Eye-tracking	Average eye gaze duration (brand, pictorial, text and adv as whole)		x						x				x	x		Pieters et al (2010)
Eye-tracking	Shorter amplitude saccades and short fixations						x	x	x			x				Wedel, Pieters, Liechty

	Longer amplitude saccades and long fixations	x	x	x					x				x	x	x	(2008)
Eye-tracking	Fixation frequency/Fixation per pixel, dwell time	x			x				x				x	x		Wang, Day (2005)
Eye-tracking	Ad dwell time and ad-element dwell time					x	x		x				x	x		Pieters, Wedel (2004)
Eye-tracking	Fixation frequency								x				x			Pieters et al. (2002)
Eye-tracking	Fixation frequency to brand, pictorial and text								x				x			Wedel, Pieters (2000)
Eye-tracking	Gaze duration, fixation frequency, inter and intra-element (headline, pictorial, body text, packshot) saccades								x				x	x		Pieters et al. (1999)
Eye-tracking	Long fixation, low blink rate			x	x				x					x	x	Bellman et al. (2019)
	Short fixations, high blink rate							x	x				x			
Eye-tracking	Fixation frequency, gaze duration								x							Yu-Ping, Shao-Kang, Ai-Yun (2016)
Eye-tracking	Fixation location and frequency, gaze duration								x					x	x	Hamelin, Al-Shihabi, Quach & Thaichon (2022)
Eye-tracking	Fixation count								x							Egner, Reimann, Hoeger, & Zangemeister (2018)
Eye-tracking	Gaze duration, fixation frequency								x					x	x	Ning, Luo, Whang, Zhang (2023)
Eye-tracking	Fixation frequency and gaze duration								x							Liu et al (2018)
Eye-tracking	Fixation frequency (if longer than 100 ms), rate of advertising fixation (total fixation / fixations on adv)	x							x				x	x		Gho, Jang-Han (2011)
Eye-tracking	Location of first fixation, gaze duration and fixation sequence	x				x			x				x	x		Cao et al (2018)

3. Advertising Metrics

Advertising metrics play a crucial role in optimizing and enhancing the effectiveness of ad campaigns. The chapter that follows aims at introducing the reader to measurement problematic of the advertising industry, and it is predominantely based on the analysis of the grey literature. Measurements in advertising are not standardized, however International Advertising Bureau (IAB) delivers guidelines that are recommended to be followed by both advertisers and publishers. It should be noted, as well, that they are not based on scientific evidence, but on industry standards (Adelaide, ANA, 2021). This chapter will firstly present current metrics adopted in advertising both in online and traditional advertising environment, main trade models, and followingly limitations they impose. Attention metrics, based on quantifying attention to advertising, represent a way to tackle this issues and make a shift towards more meaningful way of assesing advertising effectiveness. Thus, the final part of the chapter is dedicated to overview of industry efforts towards switching to attention metrics, as well as their methods for quantifying attention.

3.1. Traditional advertising

Traditional advertising includes forms of offline advertising, such as OOH (Out-Of-Home), TV, Print and similar. Most of them fall under the term of Mass media, indicating communication towards highly broad audiences. It predates the appearance of online advertising, has different operating mechanisms, and thus diverse evaluation metrics, as well.

3.1.1. Reach and Frequency

Audience represents total number of individuals reached by a certain media channel. Target audience, on the other hand, is usually a subset of total audience, representing specific part of market that is aimed to be reached by an advertisement. In traditional media, target audiences are mainly based upon demographics, thus may be specific age class, education level or similar. Reach and frequency are exposure based metrics, widely adopted for evaluation of offline media performance. Reach represents part of the total target audience that is reached by given media channel. Frequency stands for number of times each individual, on average, was exposed to an advertisement. It is considered that, in the process of media selection, reach and frequency are taken into account as two highly important factors (King & Reid, 1997; Kreshel, Lancaster, & Toomey, 1985; Leckenby & Kim, 1994; Nowak, T, & M, 1993). The concept of reach and frequency were expanded by the adoption of *effective reach and frequency* both by practitioners and academia (Kreshel, Lancaster, & Toomey, 1985; Turk & Katz, 1992). Because of the dynamic and inherently not standardized environment, definiton of effective reach tends to vary (Cheong, Gregorio, & Kim, 2010). Effective frequency stands for the number of times an individual should be exposed to an advertisement in order for it to become effective (Cannon & Riordan, 1994) or, in other words, to result in a measurable effect such as recall or recognition (Ipsos Encyclopedia, 2023). Level of effectiveness may be defined as minimum level, for instance > 3 times, discrete level, that would be 3 times precisely, or as range, for instance, from 2 to 4 times (Ipsos Encyclopedia, 2023). Effective reach is most commonly indicating number of people that were exposed to an ad at effective frequency level. Effective frequency planning (EFP) is putting effective reach and frequency into practice, however throughout the time its shortcomings have been pointed out, such as arbitary

choice of level of effectiveness as well as the theory it is based upon, that sees advertising as a subject to threshold effect (Stankey, 1989).

$$Reach = \frac{Net\ contacts\ (Number\ of\ unique\ individuals\ reached)}{Total\ target\ audience}$$

$$Frequency = \frac{Gross\ Contacts\ (Impressions)}{Net\ contacts}$$

3.1.1. Gross Rating Point

Gross Rating Point (GRP) is composed of Reach and Frequency. It offers more comprehensive measure of advertising impact, since it takes into account both the percentage of target audience that is reached as well as the number of times they were exposed to an advertisement. GRP is the metric most commonly used to evaluate performance of TV channels.

$$GRP = Reach * Frequency * 100 = \frac{Gross\ Contacts}{Target} * 100$$

3.1.2. Affinity index

Different media channels are characterized by different audiences, thus some media channels may be more efficient at reaching target audience of company compared to the others. For the purpose of assessing this issue, Affinity Index (AI) can be exploited. It represents proportion between percentage of targeted audience and percentage of targeted population, thus higher index indicates higher efficiency of media channel for reaching target market of company.

$$AI = \frac{Percentage\ of\ targeted\ audience\ (\%TA)}{Percentage\ of\ targeted\ population(\%TP)}$$

$$\%TA = \frac{Number\ of\ people\ on\ target\ in\ audience}{Total\ audience}$$

$$\%TP = \frac{Number\ of\ people\ on\ target\ in\ population}{Total\ population}$$

3.1.3. Modes of compensation

In traditional advertising, widely spread pricing models are Cost Per Mille (CPM) and Cost Per Rating Point (CPRP). They are used for the sake of evaluating cost efficiency, or effectiveness of an advertisement compared to costs involved. CPRP is mostly adopted by TV and Radio providers. It is calculated by dividing gross media costs with gross rating points. CPM is indicating the amount of money spent to obtain 1000 impressions, where one impression equals one appearance of an ad.

3.2. Online advertising

In an increasingly digitalized world, online advertising has emerged as a cornerstone of marketing strategies for diverse businesses. It is the broad term encompassing wide range of formats, such as display advertising, search engine advertising, social media advertising, video advertising, native advertising, etc. Online environment enabled accessing more precise audience data that resulted in much broader set of metrics for its evaluation compared to traditional advertising. The metrics are not standardized, and they are alternating across providers and advertisers. In this chapter, the most important metrics for evaluation of online advertisements will be presented, however the list is not exhaustive.

3.2.1. Impression measurement

Impression is exposure based measure, and it is indicative of the opportunity to serve an ad. In digital environment, impression can be related to either web page, or specifically to an advertisement. Page impressions are telling about traffic obtained by a web page during certain period of time. They occur once a user's browser makes a request for a page from a web site server (Bhat, Bevans, & Sengupta, 2002). Page impressions are not directly linked to performance or effectiveness of an ad, therefore considering the topic of the thesis, the focus will be placed upon ad impression. According to IAB (2004) ad impression is 'measurement of response from an ad delivery system to an ad request from the user's browser'. It should be noted that this is *served* impression. In their *Interactive Audience Measurement and Advertising Campaign Reporting and Audit Guidelines* dating from 2004, IAB delivers common practices that should be employed when measuring impressions. They have laid emphasis on filtering data from robotic, fraudulent activity, using the client-initiated approach in counting instead of server-initiated one, as well as recording the activity as late as possible, so that the probability of actual opportunity for an ad to be seen by the user resulted highest. In server-initiated approach to counting ad impressions, count is happening concurrently when underlying page content is being served. Thus, it makes this approach furthest away from recording actual opportunity for user to see an ad.

Reach and frequency

The product of reach and frequency represents the number of impressions. Reach stands for a number of unique people that were exposed to an ad in a given period of time (Batra, Myers, & Aaker, 1996). On the other hand, frequency stands for a number of times a unique individual will be exposed to an ad, in a given time frame (Novak

& Hoffman, 1997). The metrics of reach and frequency originated in traditional media, but they were adapted for online environment as well. The difference between traditional and online advertising is the fact that online environment has the advantage of real-time data and analytics, whereas in traditional advertising it may be challenging to precisely measure reach and frequency. Moreover, online advertising allows for more control on ad delivery, thus number of times an ad is shown to a user, i.e. frequency, can be managed, enabling advertiser to define limit. Even if reach and impressions are highly similar metrics, according to survey published in 2010, which was conducted by Cheong, de Gregorio and Kim in United States, reach had much greater importance in evaluation of offline media, namely 74% of survey participants stated that reach is factor used in evaluation of offline media, whereas for online media it is only 31%. On contrary, for online media, the measurement of impression is of much greater importance, stated to be used by 72% of survey participants.

Path to viewability standard

The crucial aspect of comprehending overall advertising effectiveness is understanding the interplay among viewability and impact of an ad. For this sake, path to viewability standard should be taken into account (Nelson-Field, 2020). Served impressions had two major underlying problems that made them unreliable in conveying information about ad performance. Namely, ad frauds, standing for impressions generated by bots and not by human activity, as well as the fact that served impressions did not imply advertisement in fact being seen, nor even that there was an actual opportunity for ad to be seen. Served impressions, as noted, are counted every time an ad is loaded, however it can happen, for instance, that it is loaded in the part of the web page invisible to the user. The phenomenon of 'invisible banners' is widely known, and it explains advertisements that are loading in windows that are

not seen by the user (Edelman, 2014). The term of 'banner farm' indicates websites with primary objective of driving traffic and hosting large amounts of advertisements. They often adopt unethical practices and execute ad frauds, such as invisible banners, in order to exploit online advertising payment system that is based on impressions, as well as the one based on clicks. Additional reasons for served ad not even offering the opportunity to be seen by the user can be due to ad blocking software, slow loading, screen ratio issues, device incompatibility and similar. Moreover, there were estimations, for example one given by comScore that even 54% of served ads were not seen by users. Google later confirmed these estimations (Cluley, 2018). This means that 54% of advertisements that are paid for are not seen by the users. Karen-Nelson Field (2020) illustrated this problem, giving the metaphor of going to the store every day and buying a pack of biscuits but not knowing if they will be half empty. The same was happening when trading with traditional impressions.

In February of 2011, important stakeholders joined forces in order to improve digital advertising measurements and make them more accountable. Making Measurement Make Sense (3MS) initiative was born, gathering International Advertising Bureau (IAB), Association of National Advertisers (ANA) and American Association of Advertising Agencies (4A's), and joined by Media Rating Council (MRC), as well, in 2012. Five guiding principles of 3MS were defined, and they are:

1. Move to a "viewable impressions" standard and count real exposures online.
2. Online advertising must migrate to a currency based on audience impressions, not gross ad impressions.
3. Because all ad units are not created equal, we must create a transparent classification system.
4. Determine interactivity "metrics that matter" for brand marketers, so that marketers can better evaluate online's contribution to brand building.

5. Digital media measurement must become increasingly comparable and integrated with other media.

The first principle addresses over-counting of impressions, due to ads failing to load on the screen of the user. The second principle supports marketers in understanding better target audience, thus advocates for introducing the reach and frequency of exposures. In this way, the cross media comparison would become more feasible. Traditional media, compared to digital one, is rather limited in types of inventory (30 seconds spot, full page back cover). On the other hand, digital media is characterized by ample quantity of different inventory that, according to 3MS, should undergo transparent classification. In the digital environment that is over saturated with metrics, fourth principle highlights the importance of having set of standardized and relevant ones, enabling the comparison across the websites (ANA, 2011). The initiative, among else, was advocating for introducing online GRP (Gross Rating Point) that would provide reach and frequency information for viewable impressions only. GRP is widely spread metric in traditional media, specifically TV advertising. It provides insights into impact made by an ad. It is calculated as multiplication of reach and frequency, where reach is percentage of target group reached by an ad, while frequency is a measure of number of times target group has seen an ad.

After long discussions, the agreement on what constitutes *viewable impression* has been reached. Viewable impression, as defined in *MRC Viewable Ad Impression Measurement Guidelines (Desktop)* is *served impression that was contained in the viewable space of the browser window, on an in-focus browser tab, based on pre-established criteria such as the percent of ad pixels within the viewable space and the length of time the ad is in the viewable space of the browser.* For display, advertising requirement for pixels was set at 50%. The time requirement is at least one continuous second post ad render, given that the pixel requirement holds. In terms of video, the requirement for pixels remains the same,

while time requirement is set to two seconds. Additionally, the ad can be considered viewable in case of a strong user interaction, such as click, even when the viewabilty requirements are not met. In given case, the click should be in line with guidelines provided by IAB in their *Click Measurement Guidelines.* There were. In 2019 MRC begun the review of the standard, motivated by the objections that both time and pixel requirement should be increased. More specifically, they considered pixel increase to 100%. Karen Nelson-Field (2020) reflects on introduction of viewability standard, saying that it is solely the improvement of served ad, thus the better measure of whether the ad had the potential to be seen, but it is, however, still not indicative of an ad actually being seen. Ultimately, viewable does not mean viewed and does not imply viewed. She states as well, that terms of attention and viewability are not to be mixed, since they are two distinct constructs. Viewability should be regarded as media owner output while attention is a consumer output. Viewability simply means media owner delivering opportunity to the user to see an ad within the standards predefined by MRC. Attention, as stated previously, is consumer related and it is impacted by various factors, among which, one is viewablity. Different guidelines were conveyed for the mobile web and mobile in-application advertising environment. The requirements on pixel and time level remained the same, 50% of pixels for at least one continuous second. However, the idea of 'Sub-Second Ad Impression' was introduced. Namely, the mobile environment has different consumption dynamics compared to desktop one, which can, in specific cases, lead to the creation of Opportunity To See (OTS) at a sub-second level. Thus, time requirement of more than 0.5 seconds but less than one second post render, while pixel requirement remains unchanged, constitutes sub-second ad impression. It is up to buyers and sellers to evaluate if this impression is bringing value or not.

3.2.2. Click measurement

IAB Media Measurement Task Force (1997) defined click as *an interaction with an advertisement*. Clicks are indicative of consumers' interest regarding the advertisement, or can serve the purpose of transfering users to another browser window. Clicks happen subsequent to ad impression or search transaction. It is stated that clicks should be derived from ad impressions that fulfilled quality requirements only, thus ad impressions that were excluded for the reason of possible fraudulent activity, such as robots and HTTP invalid user agents, should not undergo the process of counting clicks. Significant part of guidelines was dedicated to identifying fraudulent and invalid clicks. Ad impressions are suitable measure if the goal is more exposure related, for instance increasing brand awareness, while clicks deliver better information about audience interest and response to an ad (Bhat, Bevans, & Sengupta, 2002). International Advertising Bureau has provided guidelines on click measurement, releasing the final version in 2009. The aim of provided guidelines is to establish the procedure on counting clicks which would fulfill the minimum requirements. These guidelines covered browser based internet activity, or any technology that is exploiting standard HTTP protocols. Three types of clicks were defined, and those are 'click-through','in-unit click', and 'mouse-over'. Click-through is defined as user-initiated action on an ad element leading to redirection to another ad location. The transfer is ususally happening from publisher to advertiser site. In-unit click, on contrary, does not cause redirection, but may result in server log event. This metric is considered behavioural, it is rather easy to measure and is considered more accountable compared to impressions (Rosenkrans, Online Advertising Metrics, 2007). Moreover, they demonstrate an immediate interest towards the advertised brand (Singh & Dalal, 1999).

3.2.3. Modes of compensation

Cost Per Mille

Cost Per Mille (CPM) is the payment model based on metric of impressions. Thus, the advertisers make payment to publisher once a visitor got the opportunity to see an ad. This model is the one closest to traditional advertising, where, for instance, price for magazine ad is based on estimated audience of the magazine (Kursad, Nanda, Varghese, 2012). This is one of the earliest advertising compensation models and it is exposure based (Hoffman & Novak, 2000). In this case, advertiser is charged a flat-fee for each exposure, i.e. impression (Rosenkrans, 2006). According to IAB (2008), CPM mode resulted in a large portion of total online advertising revenue.

Cost Per Click

Cost Per Click (CPC) is based on click measurement, therefore publisher pays once the visitor has made a click on an advertisement (Kursad, Nanda, Varghese, 2012). It is considered one of the most important mode of compensation on the internet (Chatterjee, Hoffman, & Novak, 2003). This kind of approach to compensating for advertisement placement was considered revolutionary at the time, giving significant advantage to digital media compared to traditional one. Number of clicks became the measure of accountability. Nevertheless, soon enough, clicks have witnessed fast decrease, from level of 5% to only 0,2%. This problematic introduced the question of effectiveness of online advertising, as well as made advertisers step away from clicks as a measure of performance (Kursad, Nanda, & Varghese, 2012). However, when it comes to search engine advertising, CPC mode holds the prominent position.

Cost Per Engagement

Cost Per Engagement (CPE) is social media related mode of compensation. In this case, the advertiser will pay for an ad only when some kind of interaction between user and advertisement occurs. Engagement, as defined per IAB, is *spectrum of consumer activities and experiences,* furthermore it can be broken down into following categories: *interaction, content redistribution* and *advocacy and influence*. Interactions are quantifiable measures of physical or mechanical action with the content/advertisement. They can be either internal or external, where internal include: clicks, completion, conversion, direct messages, downloads, installs, saves, swipes, time spent metrics and similar. Public interactions enveil comments, follows, hearts, likes, hash tags, posts, mentions, ratings, subscribes, and similar. Content redistribution stands for promotion of advertising content by individual users of given social media platform to subset of users that could be friends, followers and so on. Advocacy concerns positive content about brand that is passed from one user to the others, and it represents a form of recommendation. CPE is broader term than CPC, thus it includes it but is not limited to it.

Cost Per Acquisition

Cost Per Acquisition (CPA) means the advertiser pays only when the given advertisement led to an action by the user, which can be acquisition of a product, download of an app or similar. CPA approach often includes partnerships with affiliate marketers who receive payment based on their ability to drive conversions for the advertiser. It is known as affiliate marketing, and it is performance-based. The advantage of this mode is in the fact that expenses for an ad will directly match the purchase from the consumer (Edelman, 2014). Compared to other modes of compensation, CPA is a more direct and measurable way of evaluating effficiency of an advertisement.

3.3. Measurement limitations

Web represents one of the most measurable mediums, however web analytics are still in the stage of development (Rosenkrans, 2006). Metrics standards do not exist, and this allowed for flourishing of cheating, falsified click-through rates and web site traffic (Menn, 2000, as cited in Rosenkrans, 2006). All of the current payment schemes are prone to ad frauds. Invisible banners as common ad fraud were mentioned, and they were partly tackled by viewability standard. However, Cluley (2018) states that it is not possible to make distinction between activities that are initiated by humans versus ones initiated by computers. Despite advertising platforms' efforts to differentiate between clicks generated by humans and those generated by bots, the outcomes have been underwhelming. Benefits of paying per click are many, however that payment model has witnessed frauds as well. Click frauds are common practice, either falsified by stuff for smaller syndicator sites or, more probable, through botnets (Edelman, 2014). Hackers are able to execute programs that will send false clicks through online ads (Rosenkrans, 2006). Another major issue is that click rates have witnessed significant decrease. In addition, they are not considering lagged effect, which indicates taking action after certain amount of time upon being exposed to advertisement. It is only considerate of immediate effects. In cost per acquisition, the frauds are happening when the cheater makes a claim that certain user is referred by them, when in reality, that user would make a purchase anyhow. This is made possible by monitoring software placed on users' computers or similar. Since cost per acquisition is normally very high, even small number of frauds can lead to high damages. Such fraud happened in 2012-2013, when eBay was damaged by 21 million of dollars caused by fake referrals. Moreover, there are a lot of customers that would buy from specific website anyway, even without advertisement. This is especially true for big platforms such as eBay. For example, the user that is searching for 'eBay laptop'

subsequently will click on advertisement for eBay, but the truth is they would probably buy from this website even in the absence of the ad (Edelman, 2014). In addition, payment models like CPM and CPC encourage publishers to have as high number of impressions, or as high number of clicks as possible. This can lead to mismatch between aim of advertiser and aim of publisher. Publisher is reaching for as high as possible profit, while advertiser's aim is to attract attention, send the message or inform users. Thus, publisher will work on quantity of impressions instead of their quality. The same applies for clicks. In addition, with respect to payments based on impressions, even if they are classified as viewable, it does not imply that they are actually viewed. Therefore, it can still happen that the ad passes unnoticed by the users.

Another big problematic surrounding payment scheme based on impressions is the fact that all impressions are considered equal, when in reality this is not the case. Impressions differ in amount of attention they attract, implying that they differ as well in amount of value they are generating. Nelson-Field and Amplified Intelligence (2022) made distinction of impressions, proposing four categories, and giving percentage of presence among all impressions generated:

- Viewable with 2 seconds attention (17%)
- Viewable with no attention (9%)
- Viewable with >0 seconds attention (44%)
- Not MRC Compliant (30%).

Payment models as CPC, CPA and CPE are placing value on high attention processing that will result into action. Such interaction-based metrics are capturing narrow group of people and high-attention processing, leaving out low-attention one as invaluable. The problem surrounding this is that advertisements are normally processed in a low attentive state (Nelson-Field, 2020). Moreover, the research has proven that they can

bring value even when processed at low levels. Amplified Intelligence, together with Dentsu Aegis Network Global performed study that allowed for obtaining insights into relationship of low attention processing and sales. The results showed that high attention in fact is leading to best results, nevertheless low attention processing demonstrated impact and that incidental ad exposure can impact decisions of consumers (Nelson-Field, 2020).

Existing currencies in advertising are based on industry consensus, and not on scientific evidence (Adelaide, ANA, 2021). The mode in which traditional impressions are bought and sold only pushes further already existing problem of inattention to advertising (Nelson-Field, 2020).

Table 2 Limitations of current advertising modes of compensation

CPM	CPC	CPA	CPE
Ad Frauds	Ad Frauds	Ad Frauds	Ad Frauds
Quantity over quality	Quantity over quality	High attention processing only	High attention processing only
Viewable ≠ viewed	High attention processing only	Targeting those who would buy anyway	
Impressions are not equitable	Low click rates		
	Neglects time lag		

3.3.1. Cookie apocalypse

Yet another limitation of metrics adopted for online advertising is the fact that they rely greatly on third- party cookies for tracking users' activity. Cookie apocalypse is standing for elimination of third-party cookies that is taking place due to various privacy concerns. Google postponed this practice for the end of 2024. IAB (2022) stated that changes taking place right now are set to create disruption throughout the entire media and advertising industry (IAB, Ipsos, 2022). This disruption will encompass various aspects, such as the way the industry conducts business, identifies and reaches out to audiences, and approaches media planning and buying processes in general. In addition, they noted that current measurements are on the brink of disappearance. Considering industry, 60% of leaders consider that ad campaign measurements will be affected by this loss of third-party cookies. In the era following cookie apocalypse, basic online tracking will be impacted and result in blocking of third-party cookies, limited use of first-party cookies, limited access to browser history and less ad frequency controls. In addition, user identification and user location will become highly limited (IAB, Ipsos, 2022).

3.4. Industry based metrics for attention measurement

By conducting grey literature analysis, it became possible to identify key companies that are advocating for the integration of attention metrics into the advertising industry. The subsequent sections will provide an overview of the primary initiatives undertaken by these companies, along with an exploration of the current methods employed by the industry to measure attention in advertising. Prominent, identified companies in the field are: Adelaide, Lumen, Amplified Intelligence, Real Eyes, TVisions and Neurons. Moreover, Dentsu appeared as an important catalyst for

attention movement to take the leap in advertising ecosystem, with its Attention Economy initiative.

Adelaide is a company born in 2019, with a mission to offer more precise measures of media quality. Adelaide has partnered with Association of National Advertisers (ANA) in creating guides to attention metrics. Up to this point, they have published more than ten guides concerning different topics on attention metrics, such as creative optimization and marketing mix modelling with attention metrics, how the media and creative are capturing attention, calculating media value, programmatic advertising with attention metrics, etc. In order to quantify attention they are exploiting eye-tracking tools. They have created the attention based metric for evaluating advertisements, namely:

- **Attention Unit (AU)** – It indicates the probability of an advertisement to capture attention and subsequently drive impact. AU can take values from 0-100, where the higher value implies higher probability of an Ad to hold the attention. Important advantage of this metric is the fact that it is omnichannel metric, thus it allows for comparison of performance across the channels, may it be display, TV or even podcasts, as well as across the formats and devices. They call this 'apples-to-apples' media quality comparison, whereas the comparison is usually 'apples-to-oranges' since with different channels come different measures of performance as well. Attention Unit is considerate of factors that represent attention proxies, thus indirectly assessing attention, such as size of an advertisement, its position and relative position compared to other elements of the website, viewability, duration, clutter of the page and type of device it appears on. In addition, consumer neuroscience tool of eye-tracking is exploited for directly assessing attention. Delivery of AU is supported by machine learning.

Dentsu has partnered with leading advertisers and media owners in order to develop the initiative called Attention Economy. The aim of the initiative is to disrupt trading practices within advertising industry and to establish a new value system. **Amplified Intelligence**, guided by Karen Nelson-Field, is one of the crucial partners of the initiative. Eye-tracking was the main technology used during the research that took place in UK, US and Australia in early 2019. During the research, exposure to advertisements on three platforms has been analyzed, namely TV, in-feed social media and pre-roll on video platforms. For measuring attention, two types of data were collected along the experiment:

- Attention proxies, specifically viewability, percentage of pixels on-screen, time on-screen and the portion of display that was covered by an ad.
- Eye-tracking data, more specifically if the eyes were on-ad, on-screen but not on-ad, and off screen completely. In this way they identified three types of attention, namely passive attention, active attention and non-attention. They proved that passive attention can boost the sales, and that it is not only full gaze and active attention that delivers value.

Amplified Intelligence, that was important collaborator of Attention Economy Initiative, is overall one of the leaders in attention movement of advertising industry. Book published by its representative, professor Karen-Nelson Field, 'The Attention Economy and How Media Works' uncovered many issues of advertising ecosystem and proposed alternative metrics that are based on the attention. This company stands out as the sole differentiator among various forms of attention, namely, distinguishing between passive, active, and non-attention. The advantage of Amplified Intelligence is the exhaustive database of human attention, which they have been collecting throughout the years partly in collaboration with Dentsu. This database is constantly being updated and represents critical element of predictive model.

Lumen introduced the concept of attentive seconds, which is calculated as percentage of actually viewed advertisements out of 1000 impressions, multiplied by average eyes-on dwell time. This attention currency is used across different media, such as TV, digital, OOH, print, etc., enabling their direct comparison. The technology is based on a funnel presented below (Figure 8).

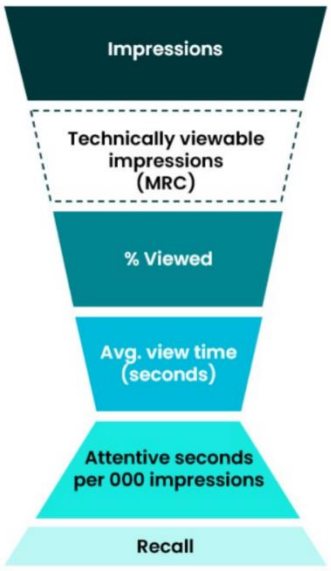

Figure 8 Lumen attention based funnel of impressions (lumen-research.com)

Table 3 Quantifying attention to advertising: Current industry efforts

Company	Founded	Neuroscience tool	Metric	Contextual factors as attention proxies	Implementation
Adelaide	2019	Eye-tracking	Eye gaze duration	Page clutter Size of placement Relative position Viewability Device Duration	Predictive model on probability of placement to capture attention / Attention Unit (AU) scored from 1 to 100
Lumen	2013	Eye-tracking	Eyes-on dwell time	Ad format Domain	Predictive model powered by AI and machine learning forecasting attention per ad
Amplified Intelligence	2017	Eye-tracking, facial recognition	Eye fixation or eyes nearby	Platform Ad format Context on page Demographic Creative	Predictive attention model powered by machine learning and AI
Real Eyes	2007	Eye-tracking, facial coding	Eyes on screen, facial reaction, head pose	Creative Audience Context	Proprietary software based on machine learning
TVision	2014	Eye-tracking	Eyes on screen	/	/
Neurons	2013	Eye-tracking, EEG	/	/	Predictive AI

4. Discussion

Given chapter is aimed at proposing a set of metrics for quantifying attention to advertising, which will allow for more reliable assesment of advertising effectiveness. It will critically discuss disparities currently existing between industry and academy based ways of quantifying attention, successively leading to opportunities for improvement in the industry. Additionaly, chapter will explore possible application domains of these metrics, as well as some considerations for implementation of proposed metrics. The measurement of attention in advertising poses significant challenges, partly due to limited knowledge and the inherently unregulated nature of the industry, which may allow for manipulations and malpractices. Thus, this part will undergo thorough discussion. Finally, the chapter will conclude by presenting future prospects and acknowledging the limitations of the proposed work. Special consideration in the future developments will be given to metaverse applications, as well as the assessment of auditory and tactile attention.

4.1. Critical comparison: Academia vs Industry

In the previous chapters, a comprehensive overview of the methods employed to measure and quantify attention has been presented. Both academic and industry approaches were examined in order to enable a comprehensive understanding. Building upon the groundwork laid earlier, this section will delve into critical analysis of the divergences that exist between academia and industry concerning attention measurement. By highlighting the points of misalignment, valuable opportunities for potential advancements in this domain will be uncovered.

In the academic realm, attention has been the subject of exploration across diverse disciplines, including neuroscience, philosophy, and medicine. In contrast, the investigation of attention within the domain of marketing appeared later. It resulted from the realization of attention's paramount importance in comprehending consumer behavior. Attention apeared as a crucial concept in the science of marketing, representing the first stage of processing in major advertising processing models. As a result, the field of marketing now endeavors to gain understanding of attention's dynamics and aims to leverage its influence to effectively communicate and engage audiences in an increasingly competitive business environment, and ever decreasing attention to advertising efforts. Having said that, analysis of academia efforts was executed, taking into consideration scientific papers related to measuring attention to advertising solely, whereas papers oriented towards measuring attention for medical purposes or similar, were excluded. Academia has pioneered this field of exploiting consumer neuroscience for measuring attention to advertising, with first papers dating back to 1999. Before consumer neuroscience, attention was mainly measured through self-reports, which gave rather vague and unprecise measure of the concept of attention. Currently, academia is exploiting various set of tools in order to quantify attention. Namely, eye-tracking, EEG, fMRI, as well as biometrics such as heart rate variability and skin conductance. Diverse metrics are used, each of them allowing for tapping into different attention process and inherently different type of atttention. Attention processes, as defined per Bellman (1996) encompass five different stages, that are arranged in increasing order of dedicated attention capacities. Namely, as mentioned, they are basic arousal, alertness, selection, concentration and sustaining attention. Basic arousal indicates only the state of readiness to notice the stimuli, while sustaing attention is the most profound form of attention that can be achieved. Academia acknowledges existance of different types of attention and places emphasis upon the fact that attention is multi-faceted concept.

However, when measuring attention they are rarely clearly indicating which type of attention is being measured. Thus, this thesis attempted to deliver summarization in a form of table (Table 1) of papers, indicating which type or process of attention is being measured. Conclusion obtained from aforementioned table, is that academia is considerate of different ways to capture different aspects of complex attention construct. Common measures for the eye-tracking tool are dwell time to advertisement as whole, ad-element specific dwell times, fixation location and frequency, blink rate, etc. Interpretation of results obtained in this way allows for identification of mainly higher levels of attention, such as concentration and sustaining attention. One study made distinction between long dwell times and few fixations that would indicate higher and sustained attention, and short dwell times with high fixation frequencies, that would on contrary imply divided and lower attention. Eye-tracking is suitable for identifying overt attention, the one that is followed by eye-movement, but will hardly identify covert one. It appears as well that it is not suitable for identifying lower stages attention processes, that are basic arousal and alertness. For this, biometrics are tool that seem more suitable. Metrics used for interpretation of EEG results are FAA (Frontal Alpha Asymmetry) and occipital alpha activity. FAA manages to identify sustained and higher levels of attention. Occipital alpha activity suggests that some kind of visual processing is occuring, and since it is not dependent on eye movement can identify both overt and covert attention.

Industry has only recently entered this field, with few prominent companies. In contracts to academia, industry is rather scarce in different consumer neuroscience tools it adopts. Eye-tracking is the predominantely used one, with the exception of Neurons, company that implemented use of EEG in their practices, as well. Amplified Intelligence made distinction between active, passive and non-attention, where active attention is indicated by eye fixation, passive attention implies eyes being near-by but

not on ad, and non-attention, that indicates absence of any kind of eye fixation. However, they are still using one tool for measuring attention, that is eye-tracking. It seems that industry recognizes attention as a unitary concept, considering that most of them state using eye tracking and dwell times for identification of attention. In comparison to academia, their approach is more superficial and simplified. Having acknowledged that most of the advertisements nowadays are being processed at low attention processing mode, this way of measuring attention can easily overlook some of the attention processes taking place upon exposure to an advertisement.

Critical differences between academia approach, and industry one, can be summarized by following:

- Industry is mainly exploiting eye-tracking tools, whereas Academia is more thourough, using eye-tracking, fMRI, EEG and Biometrics;
- Industry indirectly states that attention equals to eye fixation and neglects different types of attention. For industry attention is a unitary concept;

4.2. Conceptualization of a set of metrics

In this chapter, I am going to propose set of attention metrics, intended to be exploited for quantifying attention to advertising. They are based on the main findings delivered by present thesis, and those are:

- Attention is not a unitary concept;
- Attention is the umbrella term encompassing five attention processes, according to Bellman (1996) : basic arousal, alertness, selection, concentration and sustaining attention;
- In order to identify many facets of attention, various consumer neuroscience tools should be exploited, each measuring different signal;

- Levels of attention to advertising may differ from one individual to another, however even low attention processing is delivering results;
- The higher the attention dedicated to an advertisements, the more effective the advertisement becomes.

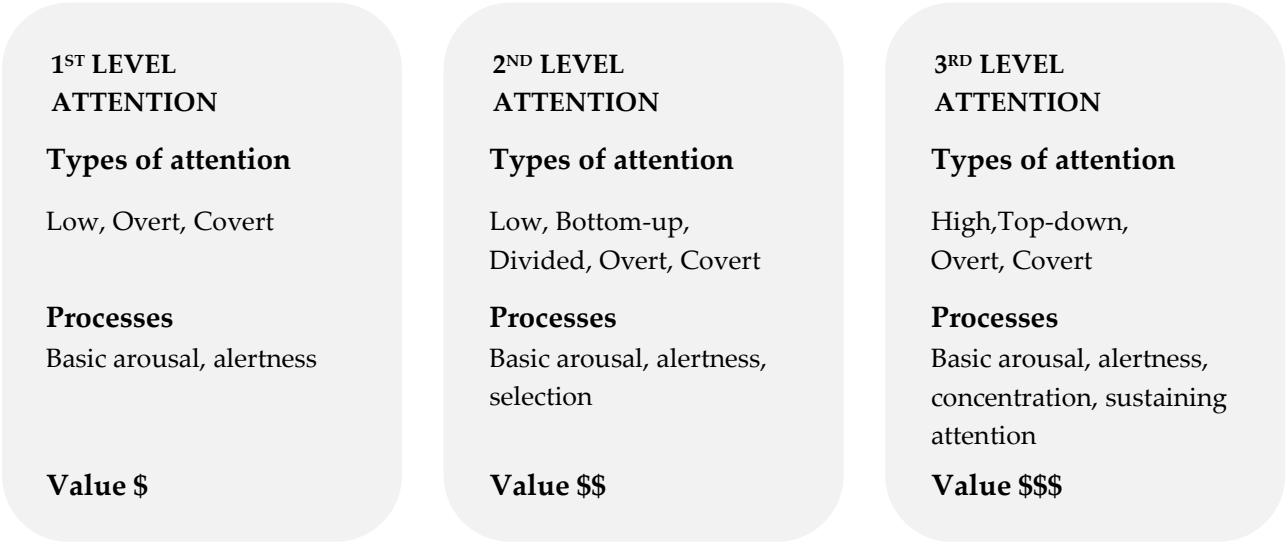

Figure 9 Quantifying attention on three different levels

	Biometrics		Eye-tracking			EEG	
	SCR	HRV	Dwell time	Fixation frequency	Blink rate	FAA	OAA
1ST LEVEL ATTENTION	Increase	Increase					
2ND LEVEL ATTENTION	Moderate	Moderate	Low	High	High		
3RD LEVEL ATTENTION	Moderate	Moderate	High	Low	Low	High	Blocking

Table 4 Set of Metrics for Quantifying Attention

Quantification of attention should be executed adopting the combination of consumer neuroscience tools and making distinction between different types of attention. Figure 9, and Table 4 are illustrating the proposed metrics. Figure 9 is presenting three levels of attention, explaining which type of attention, and which process of attention is each level comprehensive of. Each level has been assigned either one, or more tools,

suitable to measure given modality of attention. These set of metrics will allow for quantifying of attention at different levels and in different forms. Of great importance was to introduce metrics that could identify low attention processing as well, since, as discussed throughout the present thesis, major part of advertisements are processed in that modality. Thus, three set of metrics are proposed (Table 4), grouped by the level of attention (Figure 9), in its increasing order.

For the more effective measurement of attention, combination of consumer neuroscience tools should be adopted. Eye-tracking is the basic tool, already highly exploited across the industry. This tool is undoubtedly valuable for inferences about attention, additionaly it is low in costs and complexity, thus highly convenient. However, it should be complemented with other tools, as eye-tracking alone can be misleading. To illustrate this, it happens that consumers fixate their eyes on an ad when in a state of 'daydreaming'. Thus, they are not actually paying attention to an advertisement, or not sustained attention at least. In case of using solely the tool of eye-tracking, state of 'daydreaming' would be fallaciously identified as sustained attention. This applies to other consumer neuroscience tools, as well. For instance, using only EEG to measure attention towards an advertisement can be misleading in a way that attention signals may be arriving from some other stimuli, and not the advertisement, such as placing focus on a thought instead of an environment. The combination of tools could help avoid such confusions. Even tho this introduces additional complexity into attention metrics, currently it seems as the right path not to overlook different aspects of attention, and a way to mitigate the potential biases.

Attention studies have expanded and the interest in the field of advertising has grown immensily in the previous period. However, attention remains vague concept. Due to this, quantification of attention should be performed with great caution, aiming to minimize any incorrect inferences.

The number of consumer neuroscience tools proposed is varying with the level of attention that is seeked to be quantified. Overall, tools included are EEG, biometrics, and eye-tracking. Eye-tracking is the basic, already established tool for measuring attention, thus it remained present at both second and third level of attention. Second level of attention was complemented by biometrics, while third, and highest, level of attention, is complemented by both biometrics and EEG. Solely first level of attention remains with one tool, and that is biometrics. The reason behind this is that first level is simply indicating subject being in a state to pay attention, namely presence of arousal and alertness, which biometrics can successfully measure. In addition, this level is delivering lowest value, thus also costs of measuring should tend to stay low. On contrast, third level of attention is delivering highest value. Thus, EEG, that is the most expensive tool, as well as the most complex for interpretation, was assigned to third level solely. EEG is highly suitable for measuring sustained and high levels of attention (Clark, Leslie, Garcia-Garcia, & Tullman, 2018), with its FAA (Frontal Alpha Asymmetry) and OAA (Occipital Alpha Activity). Considering eye-tracking, dwell times and fixation frequency offer an assessment of the extent to which information within an advertisement is comprehensively analyzed (Venkatraman, et al., 2015). Thus high dwell times and low fixation frequency, supplemented by low blink rates would indicate detailed information processing. The idea is that biometrics measures of HRV (Heart Rate Variability) and SCR (Skin Conductance Rate) should be present at all levels, since they are intended to measure basic arousal and alertness. Increased heart rate variability suggests an enhanced capacity to focus on the ad (Lang, Bolls, Potter, & Kawahara, 1999). Without these attention processes, higher ones can not be sustained. However, as previously stated in the thesis (Chapter 2.2.4.), very high arousal will interfere with cognitive processes and thus attention will decline. Attention is optimal at moderately high levels of arousal, after which arousal becomes detrimental to attention. Advertisements consumed at third level of attention will

bring the highest value, as the value is increasing with the levels of attention. This should be taken into account for the applications of attention metrics, particularly if they are ought to be used as a mode of compensation.

Another crucial factor to take into account is the advertising context. Diverse contexts will seek diverse measures. The rise of digitalization has resulted in the proliferation of various advertising formats and channels. Consequently, certain advertising formats and channels will inherently garner more attention than others. This should be accounted for in the phase of application of aforementioned metrics. Media channels can roughly be divided into traditional and online channels, where traditional channels include TV, Print, OOH, etc., as previously discussed in Chapter 3.1. These channels have more standardized formats compared to online channels, such as social media, websites, streaming platforms, YouTube, etc. This thesis is focused on digital formats and TV, whereas OOH and print are not included in the consideration. Possible distinction of media is between single-stimulus and multi-stimulus environments, where TV and full-screen YT would be a part of single-stimulus environment, while social media and web placements are rather indicating multi-stimulus environment. Due to their distractive nature, multi-stimulus environments will hardly result in third level attention proposed in the aformentioned set of metrics. Thus, suitable measures of attention for these environments are the ones of first and second level attention. On the other hand, channels such as TV and YT imply full-screen advertisement, thus single-stimuli environment. Considering YT, politely interuptive advertising such as skippable pre-roll and full screen in-line ads are performing better in attracting higher levels of attention. In this kinds of environments it is possible to identify third level of attention. This will be important in the application of attention metrics for creative optimization, since optimization will evolve in different manner for high-attention

and low-attention placements. As stated by Adelaide and ANA in their guide *Using Attention Metrics for Creative Optimization,* low-attention placements, such as those in multi-stimulus environment, will ask for creative that is delivering more immediate messaging. On contrary, high-attention placements, such as full-screen ones, are suitable for high-engagement rich-media units. Drawing relation with proposed set of metrics, high-attention placements should be optimized by exploiting third-level attention metrics, whereas for low-attention placements, first and second level metrics are to be used.

4.2.1. Implementation

Implementation of attention metrics is a topic that needs further investigation and collaboration of experts. Most generally, companies face two choices for obtaining aforementioned measures: delivery in-house, or by the means of outsourcing. Improbability of implementation unfolding by each brand acquiring consumer neuroscience tools and developing the teams, should be denoted, taking into consideration costs and complexity this approach implies, thus high inefficiencies. It seems that ideal approach would be having expert companies in the market that would sell their services to publishers and advertisers, and that would be certified and monitored by the main advertising stakeholders, such as IAB and MRC, as well as government, in order to ensure respect of human rights and ethical codex.

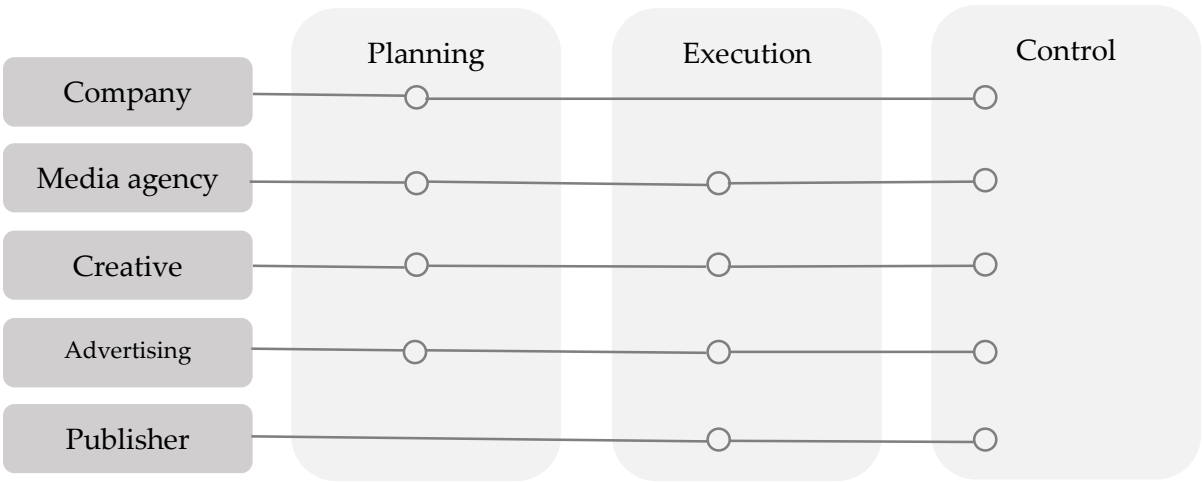

Figure 10 Traditional Advertising Ecosystem

In order to gain a deeper understanding into how the implementation should unfold, it is important to comprehend the advertising ecosystem (Figure 10) and its operational dynamics. Namely, traditional advertising ecosystem has three main functions: planning, execution and control. The ecosystem is consisted of Company, Media agency, Creative Agency, Advertising agency and Publisher/ Broadcaster, each having specific task in the aforementioned functions.

Firstly, the company, that is delivering a product or service, should define objectives of advertising, as well as the budgets. Thus, it will be involved in the planning and final control stage, while it is generally not involved in the function of execution. Media agency is the one in charge of media planning, more specifically suggesting the channels on which to invest, as well as interacting with advertising agency, for buying advertising space. Advertising agency usually acts as a mediator between media agency and publisher, selling the advertising space on behalf of publisher, for instance specific TV channel, when discussing realm of traditional advertising. Explained above is the traditional marketing ecosystem, while, with ever-changing environment it went through certain evolutions. However, it is useful for understanding the big picture and main dynamics in the industry. Specifically, concerning attention metrics, it is clear that the adoption must be initiated by all the players included. What is

lacking in the model, are the main stakeholders of the industry, such as IAB and MRC, which can play crucial role in implementation of attention metrics. Moreover, important forces in the industry can act as catalysts of change. Following companies are considered the big four of advertising industry: WPP, Interpublic Group (IPG), Publicis Group and Omnicom, with Dentsu and Kantar by their side.

Finally, for the implementation of attention metrics it is crucial that main forces in the industry initiate changes and start creating the conditions where attention metrics implementation can start evolving. First step would represent agreement on the problem and alignment of interest of all the parties involved. Stakeholders must demonstrate consensus on switching towards attention metrics. At this point in time, the first step is already taking place. Dentsu initiated *The Attention Economy* movement in 2019, aiming to drive the whole industry towards adopting attention as media currency, influencing both buy and sell side. They performed series of research, partnering with important players, Lumen, TVision and Amplified Intelligence. The Attention Council published report *From Attention to Action* in 2021 where they presenred a framework for navigating different phases of integrating attention into media strategy. Their idea consisted of bringing together ad industry professionals, academics, technology vendors and marketers so to create a well-rounded movement of attention economy. Moreover, ANA and Adelaide published more guidelines on Attention Metrics, explaining its importance and offering advices for its implementation. IAB hosted the first measurement leadership summit with the aim of standardizing attention metrics in advertising industry in February of 2023. In succession, in May of 2023, IAB has published *IAB Europe's Guide to Attention in Digital Marketing* with the aim to ignite wider industry interest about the future evolution of the attention measurement. The guide was written in collaboration with 19 industry

stakeholder, indicating that interest in the topic and general agreement on the importance is already present.

Second step represents standardization of methods for measuring attention, thus reaching the agreement on how the attention should be measured. This step is yet to be conducted. Present thesis gave contributions for this stage, proposing the set of metrics for quantifying attention, as well as summarizing ways in which attention was measured so far, by both academia and industry. The main issue that appears is lack of consensus on what attention is, and its definition. IAB states that the more probable outcome will be setting a range of standards among which advertisers can choose from, based on their needs and specific context.

For the buy side to see the value of switching from current metrics to attention ones, there is a need of evidence demonstrating practical value of attention metrics. Already now there are studies demonstrating that attention metrics have higher correlation to business outcomes compared to traditional metrics. Dentsu, within its attention initiative reported that ads actually viewed by consumers demonstrate important positive impact on brand lift. Moreover, Attention Council delivered aggregated research, linking attention metrics to various types of outcomes. Adelaide, in its *Using Attention Metrics* guide, published that attention has better correlation to brand impact than other KPIs, such as viewability or VCR (Video Completion Rate).

Artificial intelligence (AI) and machine learning (ML) algorithms seem to play a crucial role in current and future development of attention metrics and its implementation. Once database has been built, predictive AI is allowing for assessment of attention for specific ad within seconds, instead of weeks and months of laboratory testing and focus groups. Predictive AI can largely support wide implementation of attention metrics across industry. Thus, this concepts ought to be explained. Artificial Intelligence is encompassing the term of predictive AI, but not all

AI is predictive. In case of predictive AI, historical data is being used for making predictions about future outcomes. This approach is exploited in cases of massive datasets, impossible to be analyzed by humans. Predictive AI employs algorithms, such as machine learning, for delivering forecasts regarding future events and outcomes. Machine learning is considered sub-category of artificial intelligence. The main subject area of machine learning is computer modelling of diverse learning processes. Learning is phenomenon of acquiring new knowledge, developing motor and cognitive skills by means of instruction and practice, the ability to organize new knowledge into more general representations, and finally the ability to discover new facts by observing and experimenting. Since the beginning of computer era, researchers are aiming to implement those capabilities in computers, and that represents the field of machine learning (Michalski, Carbonell, & Mitchel, 1984). The process of machine learning is commonly unfolding in sequential stages consisting of: data collection, data preprocessing, data splitting, model selection, model training, model evaluation and finally, model deployment. The most time consuming part is data collection, when the databases consisting of various variables are being created. Data can be extracted from different sources. In specific case of attention metrics, data can be obtained from controlled laboratory settings, and that would be, for instance, EEG and eye-tracking data, which are direct measures of attention. On the other hand, proxy measures of attention should not be neglected, and they encompass data such as viewability, click-through rate, cursor hover time, active time in-view, scroll depth, contextual alignment, cursor position and similar. They are usually extracted through web analytics tools and tracking scripts embedded in websites and apps. Data collection time frames depend on a specific case, where the ones for attention metrics last from few years to a decade. Moreover, it is an ongoing processes, where databases are constantly being updated and supplemented. After reaching substantial amount of data points, the next steps would be data preprocessing and data splitting. Data

preprocessing is referring to elimination of outliers, incomplete data, and missing values, as well as normalization or scaling of data points. Data splitting follows, which implies splitting the dataset into two parts, one that will serve training of the model, while the other will be exploited for testing of the model. Training part of dataset is usually much larger, including 70-80% of all data points. After having completed aforementioned steps, selection of appropriate model follows. Model selection will depend, among else, on the type of the problem we choose to deal with. For instance, in the case of attention metrics, we could try to classify each ad by the level of attention it will attract, such as high attention, low attention or no attention, and that would represent classification problem. Otherwise, we could face regression problem, such as predicting seconds of active attention an advertisement will capture. This is a step where specific machine learning algorithm will be selected. It will depend on characteristics of the data and defined problem, thus there is no one correct solution for the given problematic. Possible solution can be found in deep neural networks, which is suitable for both classification and regression problems. It is created for highly complex problems, such as predicting attention is, and it is inspired by the structure and functions of human brain.

Majority of current attention metrics providers exploit predictive AI and machine learning for delivery of attention metrics (Table 3). In order to gain deeper understanding of ways in which this tool is being exploited, of great importance is construction of databases upon which training is happening. This can be studied through analysis of Amplified Intelligence system of attention metrics delivery, one of the leading forces in the industry. Figure 11 depicts that their database is divided into :

- Person level data,
- and impression level data,

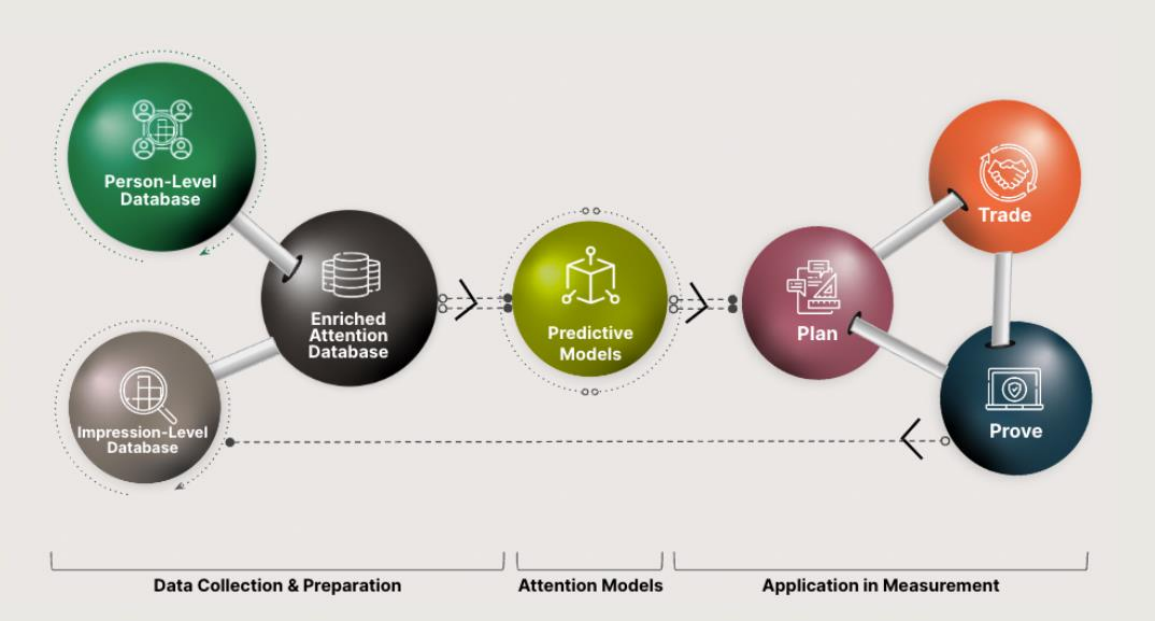

Figure 11 Amplified Intelligence implementation of Attention Metrics through Predictive AI, and Application fields (amplifiedintelligence.com.au)

together creating enriched attention database. Person level data includes data points obtained from eye-tracking studies, performed over years. More specifically, Amplified Intelligence database encompasses 454 million points of human attention data, representing one of the critical success factors of this company. Their human attention database is constructed exploiting eye-tracking tool and classifying attention into three possible categories: non-attention, passive attention and active attention. Non-attention is identified when eyes are off screen, passive attention when eyes are near-by, while active attention represents eyes on screen. Non-attention is considered not to bring any value, while passive and active attention can both bring value to advertiser. On the other hand, the person level data is accompanied by impression level data. It is important not to overlook aspects od advertisements such as context of placement, platform, ad-format, who you advertise to or demographics of customers, and creative or what is being said in the advertisement. These are all factors that will influence attention and performance of an ad. Thus they represent vital variables to be included in training

dataset. Lumen states the importance of including following three categories of data into attention prediction datasets:

- Biometric data,
- Psychographic data,
- Proxy data.

ShowHeros is one of the providers of attention metrics, that is transparent regarding data points it includes in its prediction model (IAB, 2023). In the Figure 12, presented below, crucial data points for attention prediction are listed. They are not inclusive of consumer neuroscience data, however they represent the part of database commonly referred to as 'proxy' data.

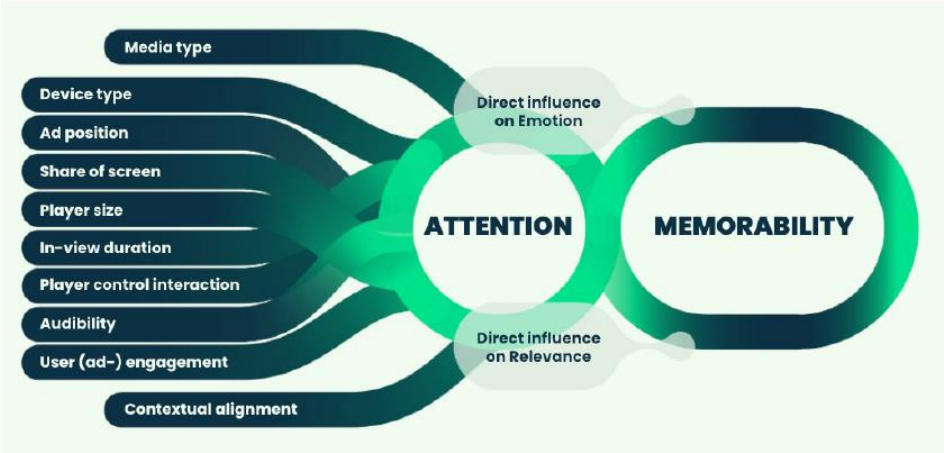

Figure 12 Data points for Attention prediction model (IAB, 2023)

In conclusion, aside from consumer neuroscience tools, predictive AI is crucial technology for implementation of attention metrics. This can help more efficient adoption of attention metrics. Measuring attention for each advertisement that is to be published seems unfeasible. The optimal solution appears to be building large databases on advertisements and attention they attract, which should be performed over the years in controlled environment, such as laboratory. After having built the database, predictive AI can learn from it, and give predictions on attention for future

advertisements within seconds. In that case, the database should include extensive information on advertisements, having variables on channel, format, ad size, position, creative aspects, duration, etc.

4.2.2. Application fields

Application of attention metrics can take place in all of the aforementioned functions, namely planning, execution and control. In the domain of planning, attention metrics can guide media agencies towards choosing channels based on attention they attract. Some channels are more efficient than others in attracting attention, and some formats are better than the others. This can facilitate informed decision-making and enable the strategic combination of channels and formats, resulting in the creation of a highly effective campaigns.

In the phase of execution, attention metrics are suitable for guiding creative optimization. Creative is the crucial component of advertising, largely impacting its success. Nielsen has conducted research (The Nielsen Company, 2017) where almost 500 ad campaigns were examined across diverse media, where they concluded that creative aspect of advertising is responsible for 47% of sales, making it the most important element of an ad. In order to find best performing creative solution, A/B tests can serve as guidance. The example of the test is given below (Figure 13), where TOS (time-on-screen) represents the proxy for active attention.

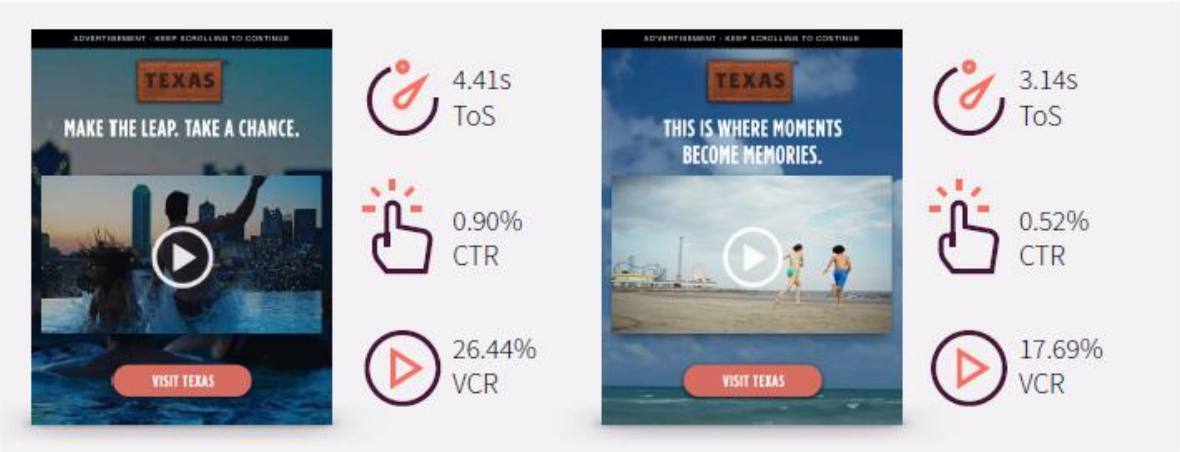

Figure 13 Example of attention based creative optimization (Adelaide, ANA, 2021)

For the more effective assessment of attention, time-on-screen can be substituted by attention metrics proposed in Chapter 4.2. It is important to note that when testing creative, other variables that are influencing attention should be held constant, as control variables. Thus, channel and format should remain constant in A/B testing.

Finally, attention metrics potentially may substitute current compensation modes of the industry, creating transition towards *pay-per-attention*. The industry has already proposed a few solutions for switching towards paying for attention, and moving away from traditional pay-per-impression. Adelaide suggested CPAU (Cost Per Attention Unit). Attention Unit is a metric whose delivery is supported by AI, and it is explained more in detail in Chapter 3.4. Lumen proposed aCPM (attentative Cost Per Mille), that is based on APM (Attention Per Mille) indicating attention in seconds that 1000 impressions obtained. In the previously proposed set of metrics, the idea is that value of attention increases with the level of attention. Thus, if they would be adopted as a basis for compensation, third level of attention should have higher price compared to the second level. To disseminate these metrics within existing methods of compensation, we can implement interaction with the CPM payment scheme. Thus,

instead of paying the same price for each impression, the distinction would be made between impressions generated within first, second or third level of attention. Furthermore, this could incentivize publishers for optimizing environments so that they are able to attract and hold attention. This would mean reducing clutter, optimizing positioning and size of advertisements and delivering non-intrusive ads, thus the ones in line with the environment where they are being placed in. Optimizing for attention can lead to great benefits not only for advertisers, but also for consumers. Consumers would benefit from higher quality experience, less distractions and more meaningful advertising. Switching modes of compensation towards attention based ones would create strong incentive for the whole industry.

ARF reported, in its *Attention Report*, typical cases of use from buy side, and those are creative and copy testing and examining effectiveness of various media channels. Moreover, 37% of buy side stated that they would use or consider using attention metrics in planning, 56% in media optimization and 75% in measuring ad effectiveness. With important changes taking place in digital advertising industry, such as cookie apocalypse, previously discussed in the chapter of Advertising Metrics, attention metrics will only gain on importance. In the new reality without third-party cookies, and thus with no possibility to track and attribute conversions, attention metrics offer alternative way for assessing effectiveness of an ad. Instead of exploiting third-party data for deciding on placement of the ad, contextual factors would be taken into account and placement of the ad would be optimized based on the assessment of which environment can capture the most attention, given the specific ad.

To summarize, attention metrics can find their application in various stages of advertising process, mainly:

- Media planning

- Creative optimization
- Transactions with media vendors
- Reporting and control.

4.2.3. Biases of measures

Exploiting EEG for quantifying attention has certain limitations, which may potentially lead to biases in the interpretation of the results. EEG is known to have low spatial accuracy resulting in difficulty to obtain precise location of signal, as well as results that are affected by experimental settings and artifacts (Alsharif, et al., 2021). Thus, sometimes signal obtained by EEG may not be reliable. Furthermore, we can discuss measurement accuracy and reliability of biometrics such as HRV (Heart Rate Variability). This measure can be impacted by factors such as sensor placement and signal noise, especially when obtained from wrist-worn devices. This problematic may lead to inaccurate HRV data, consequently leading to erroneous conclusions about state of attention, in the case of attention metrics. Another issue surrounding HRV, is the significant individual variability. Namely, establishing baseline HRV appears utterly challenging, considering the fact that HRV is impacted by many factors, among which age, fitness level and medical conditions, as well as belonging to diverse populations. Moreover, relationship between HRV and attention is still being understood. HRV may indicate shifts in autonomic nervous system activity, which are not necessarily aligned with attention states.

4.3. Challenges for adoption

The Attention Council and The Advertising Reasearch Foundation have conducted a survey 'The ARF Attention Report' (2022), on attention metrics, evaluating opinions of important participants in the industry. Among else, barriers to use attention metrics were examined. Distinction was made between answers given by research side, and

those given by buy side. For buy side, following barriers appeared as the most significant, in given order of significance:

- Difficult to deploy
- Need for more evidence of value
- Being able to buy with guarantees
- Incorporating into planning tools

For the research side, on contrary, only following two appeared as barrier:

- Incorporating into planning tools
- Difficult to deploy

Consumer neuroscience has been criticized for providing rather correlation evidence and not causal one. Even if they offer important information for understanding human brain, it does not imply that consumer behaviour can be deducted from it (Plassmann, Venkatraman, Huettel, & Yoon, 2015). This relates to stated barrier of 'Need more evidence of value'. In attention metrics specifically, there is a need for more evidence of value brought by deploying these metrics. Not only, but current experiments are usually characterized by small sample size, ranging from 20 to 30 participants according to prestigious journals such as Journal of Cognitive Neuroscience and Journal of Marketing Research. Thus, the generalizability of results can be argued (Plassmann, Venkatraman, Huettel, & Yoon, 2015).

Costs and complexity

The main issue surrounding adoption of attention metrics are the costs and complexity they imply. Acquiring or even renting consumer neuroscience tools may not be feasible for small companies. In addition, there are the costs and complexity introduced by the need of expertise. Namely, interpreting signals and metrics

obtained by consumer neuroscience should be done by experts, and not left to subjects having superficial knowledge about the topic. Consumer neuroscience, as a discipline still in its infancy, faces the common issue of misinterpretation or over-interpretation for practical use (Madriga, 2010 as cited in (Ulman, Cakar, & Yildiz, 2015). Interpretation is critical issue since it demands high level of knowledge integration (Illes, 2002). Additionaly, costs may be related to research process, for instance participant recruitement, data analysis and similar. This issue may be partially solved by outsourcing, hiring the company that would conduct the experiments, and in this way obtain economies of scale. In this case, important issue would remain evaluation of quality of company hired. Having both professionals well-versed in marketing and neuroscience is of significant importance. This is related to barrier identified by ARF as well, namely finding companies with guarantee. In addition, having discussed the possibility of implementation of attention metrics through predictive AI, the substantial costs of this solution refer to building of datasets. Namely, building attention metrics datasets would require years or even decades, which does not only implies costs, but also barriers to for entry for other companies. This could lead to a problem of concentration of power in the market.

Ethical concerns

There are ethical concerns surrounding consumer neuroscience and, consequently, attention metrics. The main issues are related to data privacy and potential manipulation of consumer behaviour.

Issues related to biometrics data and identified by Keyser et al. (2021), can be expanded to the whole consumer neuroscience data, and they encompasses the issues of (1) data collection and usage, (2) privacy and personal security and (3) data storage and safety. It is of key importance to have permission for data collection. Thus, all the

participants of the experiments must be introduced to what kind of information will be collected and give their consent. Adelaide and ANA in their *Using Attention Metrics* report, state the importance of only collecting data in laboratory or panel settings, with informed subjects, and not measure real-world attention responses through consumer devices. Any kind of consumer neuroscience data should never be captured without permission. The potential for unauthorized data collection, especially through widespread eye tracking technology, integrated into everyday devices, demands proper regulation to prevent any violations of human rights. To ensure ethical practices, providers of attention metrics should be subject to oversight by relevant legal authorities, with well-defined regulations governing data collection, storage, and processing. Without these measures in place, the risk of infringing upon fundamental human rights through irresponsible practices remains a significant concern.

Research domains of neuromarketing can be separated into two main strings, the one of consumer neuroscience related to academic research, while the second one is sector specific, including the direct application of the techniques (Hubert & Kenning, 2008). Having said that, ethical concerns are mainly related to sector specific research (Ulman, Cakar, & Yildiz, 2015). Carr (2008) emphasized the issue of mind-reading capability of neuromarketing techniques, stating that the seller side may gain considerable advantage, distorting the power balance in the market place, by acquiring the knowledge on how and what consumers think. Moreover, France banned the use of brain-imaging techniques, outside of medical or scientific research. This implies prohibition for commercial use of brain-imaging techniques, such as EEG or fMRI, while eye-tracking and biometrics would remain allowed.

When it comes to attention metrics, significant emphasis should be placed upon recognizing the human right to disengage from paying attention. This aspect is closely

linked to the previously mentioned issue of manipulation. Attention metrics enable the delivery of advertisements that are tailored to capture attention by leveraging human intricate brain processes. On the other hand, attention metrics can bring the benefit of higher quality advertisements. This remains open question for further debates. On the one side, attention metrics have the potential of reducing waste, making advertising industry more sustainable, and increasing overall advertising quality. However, some may argue that attention metrics represent the instrument of manipulation, allowing advertisers advantage over consumers, as more informed subjects in the market. Moreover, important concern remains legal part and if states would allow this kind of practices, or would follow approach of France, that banned the use of brain-imaging techniques for business purposes.

Lack of standardization

The chapter of Advertising metrics introduced the issue of the lack of regularization and standardization of advertising metrics overall. This will be reflected in attention based advertising metrics as well. Even tho guidelines exist, such as the ones provided by IAB and MRC, they are not obliging nor publishers nor advertisers. In implementation of attention metrics, the lack of standardization can influence the quality of metrics and create a 'lemon' market. The assumption is that buyers of attention metrics do not have deep knowledge about attention and consumer neuroscience instruments for its measuring. Thus, their information about the true quality of providers of attention metrics is limited. Without proper regulation and standardization, market could easily become overflowed with providers lacking expertise, and thus decreasing the quality of overall market. As indicated in the present thesis, there is no consensus on definition of attention, nor on different types and processes of attention. Thus, the question that arises is, in the current state, how could it be possible to reach consensus on ways in which attention should be

quantified? In addition, it was demonstrated that ways of quantifying attention are many, and the results of consumer neuroscience tools can be easily misinterpreted. Adoption of attention metrics by the industry should be preceded by regulations, that ought to be brought by the main stakeholders. On the other hand, exploitation of consumer neuroscience tools should not be permited to companies lacking expertise in neuroscience.

Limited scope

Attention metrics offer more successful explanation of effectiveness of an advertisement compared to traditional metrics. However, they are not grasping the whole picture, but a part of it. There is the limited knowledge about attention later translating to effects. We may argue that some advertisements are good at attracting attention, but result in negative feelings about the brand. For instance, for a long time advertising industry was using sexual conotation and erotica as an element of advertisements, as a proven road to attracting attention. However, it can easily spark controversy and provoke a backlash. Furthermore, this raises moral, as well as ethical questions. Will attention metrics push advertising industry towards having ultimate goal of attracting attention? In this evolving landscape, attention metrics stand as a transformative tool, poised to reshape how we evaluate ads. Nevertheless, they ought not to stand as the sole instrument for planning and executing advertising strategies; instead, they should be augmented by the knowledge of industry experts.

4.4. Future developments and limitations

The present thesis has certain limitations that should be denoted. In its exploration of attention, the focus was placed on visual attention, while auditory and tactile attention were put aside. For the advertising world, as it currently is, visual attention is crucial one. However, with recent developments, such as rise of podcast advertising

and introduction of metaverse, auditory and tactile attention remain important concepts to be explored. Podcast advertising became widely spread, where the visual attention does not play a role, but auditory one. In order to create a comprehensive set of attention metrics that will be utilized by the advertising industry, they should be able to measure attention to every mode of advertising that exists. Thus, future streams of research could explore ways in which auditory attention manifests in brain and which are the suitable consumer neuroscience tools for measuring this type of attention. Metaverse remains highly interesting environment for implementation and application of attention metrics. It allows for eye-tracking in real time, since majority of glassess are equiped with eye tracking technology. Besides that, metaverse is an immersive surrounding, offering very different advertising experience compared to traditional and digital ones. Thus, possible advancements of attention metrics could envolve in direction of measuring tactile attention. Measuring these kind of attentions would presumably require certain alternations to proposed metrics. However, without detailed examination of literature on auditory and tactile attention, it is not possible to give any suggestions. Scope of this thesis remained in the field of visual attention. As suggested by its title, main aim of the thesis was to define ways in which attention can be quantified. Thus, little consideration was placed upon factors that influence attention in advertising, that are creative aspect of advertisements, contents, format, etc. Another limitation of the work is in the fact that this is solely theoretical discussion of attention metrics. Set of metrics that are conceptualized in Chapter 4 of present thesis are ought to be tested in controlled laboratory environment, in order to confirm their suitability for identifying different types and levels of attention. Thus, future research, that may build upon present work, could consist of testing proposed metrics in a laboratory setting.

Conclusion

Attracting attention of consumers became crucial issue in advertising. It represents the first task of an advertisement, without which an ad cannot succeed in fulfilling its objective. In order to optimize and evaluate performance of advertisements based on the attention, there is a need of defining what attention is and how it can be measured.

What emerged from thourough exploration of academic literature is that attention is not precisely defined concept, even so, it appeared as multi-faceted, rather than unitary concept. What it implies is, term attention includes more underlying processes, such as: arousal, alertness, selection, concentration and sustaining of attention. In addition, there are multiple divisions of attention, among which, the ones more relevant for advertising industry are division into top-down and bottom-up attention, overt and covert, selective, sustained and divided, as well as the division in levels of attention which can either be high or low. When measuring attention, it is important to acknowledge that different types of attention will be identified in different manners. Thus, there is no one tool, or one metric, for quantifying attention. After extensive exploration of techniques for measuring attention, which consisted in analysis of 18 scientific papers where attention to advertising was quantified, primary findings surfaced. EEG appeared as tool highly suitable for identifying higher levels of attention, such as sustained attention is. For this purpose, metric of Frontal Alpha Asymmetry (FAA) and Occipital Alpha Activity (OAA) are predominantly used. Higher FAA values indicate more effective ads, while the OAA measures the extent of visual processing. Biometrics seem to be adequate for measuring lower attention processes and levels, such as arousal and alertness, which existance is necessary as well for higher levels of attention. Eye-tracking is the fundamental tool adopted for measuring attention, where attention is evaluated based on dwell-time, blink rate,

sequence and number of eye fixations and similar. It should be noted that this tool may neglect covert type of attention and lower levels of attention. A similar outcome would occur in case of adopting solely EEG or solely Biometrics. Thus, the present thesis places importance on using more than one tool and suggests supplementing tool of eye-tracking with other, aforementioned tools of consumer neuroscience, for obtaining comprehensive outlook on the attention. This approach would help avoid possible biases of tools and misinterpretation of results.

After analysis of grey literature and industry efforts currently employed in switching to attention metrics, following conlusions emerged. Industry's approach to measuring attention appeared as rather superficial. Whereas Academia exploits EEG, fMRI, Biometrics and eye-tracking for quantifying attention, industry is predominantly focused on eye-tracking, placing the equation sign between eye fixation and attention. By exploiting only one tool for measuring attention, industry is overlooking existance of different types of attention. Thus, there is a space for improvement by introduction of additional tools and measures.

Subsequent to proposal of the set of metrics for quantifying attention, present thesis discussed how the implementation in the industry should unfold. The first step is general agreement and industry consensus on necessity for introducing this type of metrics to current advertising system. Through grey literature analysis, it seems that this step is reaching its completion point. The second step would be standardization of attention metrics, where this work attempted to deliver contributions. As IAB (2023) stated, it seems more probable that there will be more than one consensus on what attention represents and how it can be measured, thus companies would be able to choose based on their needs and specific context. Lastly, wide implementation of attention metrics will likely happen by means of predictive AI, as highly efficient and powerful tool.

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