Trend of Using Eye Tracking Technology in Business Research

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***Abstract*—Eye tracking refers to measure gaze positions and movement to reveal what individuals are looking at. Thanks to the advances of eye tracking technology, there are growing numbers of research focus in using eye tracking to study human behavior. The study aims to identify the research trend of eye tracking studies. By searching the databases of Social Sciences Citation Index (SSCI) and Science Citation Index (SCI) in a fourteen years period between January 1999 and October 2013, we found 2,354 articles mentioned eye tracking. Among them, 28 were articles of business discipline. By analyzing these articles, the study maps the intellectual structure of the eye tracking research in business area. The results provide fundamental insights on the recent research of using eye tracking technology.**

***Index Terms*—Bibliometric, literature review, eye tracking, SSCI/SCI.**

I. Introduction

The eye tracking research can be trace back to the study of Louis Émile Javal in 1879 in Paris, which observed readers' reading of text [1]. In 1908, Edmund Huey built the first eye tracker using a sort of contact lens with a hole for the pupil. The lens was connected to an aluminum pointer that moved in response to the movement of the eye. The first non-intrusive eye trackers was developed by Guy Thomas Buswell In 1922, which used beams of light that were reflected on the eye and then recording them on film [2].

Due to the advance of eye tracking technology, the cost of eye tracking equipment is within affordable arrange for some laboratories and researchers. Researcher now can use commercial eye tracking equipment to observe eye movement of audiences. It is a new and objective way to observe human behavior. The eye movement could be a cue for cognitive and perception of audience. Unlike questionnaire survey which depends on subjects' self-report, eye tracker can get subjects' real response to stimulate by observing their eyes movement.

Literatures have indicated the possibility of using eye tracking technology in business research and how great of the potential contribution of eye tracking data on business research. The eye tracking research is blooming for the past few years and attracts the focus from both academics and industry of various fields. This study aims to provide a comprehensive understanding of recent trends of eye tracking research of both business and non-business research field. To accomplish this goal, this study used bibliometric techniques and literature review to the articles which mentioned eye tracking and published in Science Citation Index (SCI) and Social Science Citation Index (SSCI) during the year period of 1999 to October 2013.

Bibliometric analysis is a research technique using quantitative data to describe distribution patterns of research articles with a given topic and a given time period [3]-[5]. The current study makes use of bibliometric approach to reveal research trend of eye tracking research and to serve as a roadmap for both academics and practitioners. The purposes of this study are to:

1) Analyze distribution of eye tracking articles of all research fields, such as publication years, countries of authors and research fields.
2) Analyze distribution of eye tracking articles of business, such as publication years, countries of authors, published journals, and citation times.

This paper is structured in four sections. The first section provides a brief introduction for this study. Then, the second section introduces bibliometric techniques that used in this study. Next, this study explains the analysis results. Finally, we conclude the article with a discussion of limitations and implications for future research.

II. Methodology

The study searched titles and abstracts of journal articles to identify research articles mentioned eye tracking. The sources of databases were Social Science Citation Index (SSCI) and Sciences Citation Index (SCI). The study chose SSCI/SCI database since it earned a reputation as the leader among electronic database of academic literature. This study restricted articles publication during the years 1999 to November, 2013.

The current study collected 2,354 articles. Among them, 28 articles were published in journals of business field. To confine the range of the articles to business research, the study selected only 28 articles of business research for bibliometric analysis.

This study aims to explore the recent development of using eye tracking technology in business related research by the identified the 28 eye tracking articles published in business relative journals. Although the search was not exhaustive, the study hoped that it serves as a comprehensive base for an understanding of recent trend of eye tracking in business field.

This study collected the bibliographic data of all the 2,354 eye tracking articles and the 28 eye tracking article of the business field to observe distribution of publication years,

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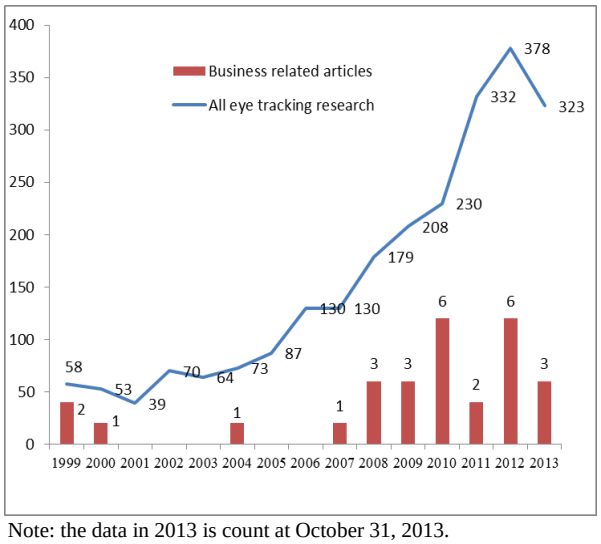
country of author, published journal, and cited times. These analyses aimed to describe recent trends of eye-tracking research. The current study used SAINT (Science Assessment Integrated Network Toolkit) toolkit to conduct bibliometric analysis [6]. SAINT toolkit provides some tools to for the purposes of bibliometric analysis. The study use ISI data import of SAINT toolkit to import data downloaded from SSCI/SCI database to Microsoft Office Access database in local computer. The current study aims to help follow-up researchers to understand the research trends of eye tracking research in the recent years.

III. Results

A. Distribution of the Year of Publication

Fig. 1 illustrates the historical development of the number of published eye tracking articles. The distribution of annual publication output is shown in Fig. 1 from 1999 to October 2013. The eye tracking equipment need to following subject gaze movement. The blossoming of computer and visualize technology enhance the development of eye tracking technology. As revealed in Fig. 1, only 50s to 70s articles were published per year before 2005. Nevertheless, the amount of published articles dramatically increased from 87 in 2005 to 130 articles in 2006 and to 378 in 2012. The increase in the number of articles on the topic of eye tracking has reflected the popular of eye tracking equipment. This demonstrates that academics and researchers gradually pay attention to eye tracking.

Fig. 1 also illustrates the number of published eye tracking articles in the journals of business field. As revealed in Fig. 1, only 5 articles published in the journal of business fields before 2007. The amount of published articles slightly increased after 2008. However, the number of published business research articles was still less than 10 articles per year. The results revealed that the use of eye track technology is not so popular in business field.



Note: the data in 2013 is count at October 31, 2013.

Fig. 1. Eye tracking publication from 1999 to October 2013.

B. Distribution by Authors' Countries

Table I reveals distribution of authors' countries of the 2,354 eye tracking articles of all fields. Based on author affiliations, the study identified countries producing the most publications on eye tracking research among the period between 1999 and 2013. The five most prolific countries in eye tracking research were USA (42.21%), England (12.06%), Germany (11.72%), Canada (7.18%), and Netherland (6.58%). Scholars of USA, England, Germany, Canada and Netherland played important roles and were interested in eye tracking research. Eye tracking research based on eye tracker equipment. Scholars in the countries with competences in eye tracking technology may be with advantages in conducting eye tracking research. This may be a reason why scholars in these countries contribute a significant proportion of eye tracking articles.

TABLE I: Distribution of Eye Tracking Articles by Authors' Countries

Countries	Articles	Percentage (% of 2,354)
USA	970	41.21%
England	284	12.06%
Germany	276	11.72%
Canada	169	7.18%
Netherlands	155	6.58%
France	101	4.29%
Scotland	93	3.95%
Japan	76	3.23%
Italy	75	3.19%
Switzerland	69	2.93%
Australia	67	2.85%
Sweden	66	2.80%
Spain	58	2.46%
China	57	2.42%
South Korea	54	2.29%
Taiwan	53	2.25%
Finland	38	1.61%
Austria	31	1.32%
Belgium	21	0.89%
Norway	21	0.89%
Denmark	20	0.85%
Israel	19	0.81%
Poland	15	0.64%
Ireland	14	0.59%
Brazil	13	0.55%
India	11	0.47%
Russia	10	0.42%

Notes: Countries with more than 10 articles are listed.

C. Distribution of Articles by Research Fields

Eye tracking research articles fell into fields of psychology (including experimental psychology, psychology developmental, multidisciplinary, psychology ophthalmology, and others), neurosciences, psychiatry, linguistics, clinical neurology, electrical electronic, and computer Science, as Table II reveals. Most research into electronic commerce was in the psychology relative fields.

More than half of the 2,354 articles were belong to the psychology relative fields.

TABLE II: DISTRIBUTION OF EYE TRACKING ARTICLES BY RESEARCH FIELDS

Research fields	Articles	Percentage
Psychology Experimental	566	24.04 %
Neurosciences	370	15.72 %
Psychology	284	12.07 %
Psychiatry	244	10.37 %
Linguistics	186	7.90 %
Psychology Developmental	163	6.92 %
Psychology Multidisciplinary	152	6.46 %
Ophthalmology	148	6.29 %
Clinical Neurology	99	4.21 %
Engineering Electrical Electronic	94	3.99 %
Computer Science Artificial Intelligence	92	3.91 %
Behavioral Sciences	81	3.44 %
Computer Science Software Engineering	77	3.27 %
Psychology Biological	75	3.19 %
Physiology	74	3.14 %
Psychology Clinical	74	3.14 %
Computer Science Information Systems	71	3.02 %
Multidisciplinary Sciences	63	2.68 %
Computer Science Cybernetics	61	2.59 %
Computer Science Theory Methods	58	2.46 %
Education Educational Research	58	2.46 %
Optics	57	2.42 %
Ergonomics	56	2.38 %
Psychology Applied	53	2.25 %
Rehabilitation	53	2.25 %
Surgery	50	2.12 %

Notes: Fields with more than 50 articles are listed.

TABLE III: DISTRIBUTION OF EYE TRACKING ARTICLES BY JOURNALS

Journals	Articles
Journal of Memory and Language	59
PLOS One	45
Cognition	39
Schizophrenia Research	36
Biological Psychiatry	34
Journal of Autism and Developmental Disorders	33
Journal of Experimental Psychology Learning Memory and Cognition	32
Journal of Vision	28
International Journal of Psychology	27
Quarterly Journal of Experimental Psychology	27
Psychophysiology	25
Lecture Notes in Computer Science	23
Neuropsychologia	23
Vision Research	21
Investigative Ophthalmology Visual Science	20

D. Distribution of Eye Tracking Articles by Journals

Table IV reveals the 20 journals that published more than 20 articles of eye tracking research. The original eye tracking research is design for research of language reading behavior. Thus, Journal of Memory and Language published 59 eye tracking articles and was in the top one position. The following journals were PLOS One (45 articles), Cognition (39 articles), Schizophrenia Research (36 articles), Biological Psychiatry (34 articles), Journal of Autism and Developmental Disorders (33 articles), Journal of Experimental Psychology Learning Memory and Cognition (32 articles), Journal of Vision (28 articles), International Journal of Psychology (27 articles), Quarterly Journal of Experimental Psychology (27 articles), Psychophysiology (25 articles), Lecture Notes in Computer Science (23 articles), Neuropsychologia (23 articles), Vision Research (21 articles), and Investigative Ophthalmology Visual Science (20 articles).

TABLE IV: DISTRIBUTION OF EYE TRACKING ARTICLES BY JOURNALS

Journals	Articles
Marketing Science	5
Journal of Marketing	4
Journal of Marketing Research	4
International Journal of Advertising	2
International Journal of Electronic Commerce	2
International Journal of Market Research	2
Journal of Consumer Research	2
Clothing and Textiles Research Journal	1
Electronic Commerce Research and Applications	1
International Journal of Research in Marketing	1
Internet Research	1
Journal of Business and Psychology	1
Journal of Interactive Marketing	1
Journal of Product Innovation Management	1

E. Distribution of Eye Tracking Articles of Business Field by Journals

Eye tracking articles of business field is significantly spread out among different journals (see Table IV). The 28 source articles were published in 14 journals, where represented that no single business academic journal played a majority role in publishing eye tracking article. Table III depicts the top 3 journals (Marketing Science, Journal of Marketing, Journal of Marketing Research) that published at least four articles. Marketing Science was ranked first, with 5 articles [7]-[11], followed by Journal of Marketing, with 4 articles [12]-[15], Journal of Marketing Research, with 4 articles [16]-[19]. Four journals published 2 articles each, including International Journal of Advertising [20], [21], International Journal of Electronic Commerce [22], [23], International Journal of Market Research [24], [25], and Journal of Consumer Research [26], [27]. Seven journals published 1 articles each, including Clothing and Textiles Research Journal [28], Electronic Commerce Research and Applications [29], International Journal of Research in Marketing [30], Internet Research [31], Journal of Business and Psychology [32], Journal of Interactive Marketing [33], and Journal of Product Innovation Management [34].

Among the 28 articles of eye tracking research in business field, most articles [7]-[21], [24]-[27], [30], [33] were published in marketing relative journal Five articles were published in journals focused on internet or electronic

commerce research [22], [23], [29], [31], [33]. Four articles were published in advertising or consumer research journals [20], [21], [26],]27]. Thus, marketing, consumer behavior, and electronic commerce are three major disciplines for eye tracking research.

Table V reveals the highly influence eye tracking business academic article were published. As Table V revealed, the article published by Wedel and Pieters [11] in 2000 receive 74 citations. Article published by Pieters and Wedel in 2004 receive 73 citation [14]. Pieters and Wedel are most highly influence authors. They published 9 of the 28 articles of eye tracking research in the field of business research. Their articles appeared in Journal of Marketing, Journal of Marketing Research, Marketing Science, and Journal of Consumer Research.

TABLE V: CITED TIMES OF EYE TRACKING ARTICLES OF BUSINESS FIELD

Paper Title (Authors, Journal, Year)	Cited Times
Eye fixations on advertisements and memory for brands: A model and findings (Wedel, M; Pieters, R, Marketing Science, 2000)	74
Attention capture and transfer in advertising: Brand, pictorial, and text-size effects (Pieters, R; Wedel, M, Journal of Marketing, 2004)	73
Visual attention during brand choice: The impact of time pressure and task motivation (Pieters, R; Warlop, L, International Journal of Research In Marketing, 1999)	60
Visual attention to repeated print advertising: A test of scanpath theory (Pieters, R; Rosbergen, E; Wedel, M, Journal of Marketing Research, 1999)	37
Does In-Store Marketing Work? Effects of the Number and Position of Shelf Facings on Brand Attention and Evaluation at the Point of Purchase (Chandon, Pierre; Hutchinson, J. Wesley; Bradlow, Eric T., Journal of Marketing , 2009)	34
Goal control of attention to advertising: The Yarbus implication (Pieters, Rik; Wedel, Michel, Journal of Consumer Research, 2007)	27
Path Data in Marketing: An Integrative Framework and Prospectus for Model Building (Hui, Sam K.; Fader, Peter S.; Bradlow, Eric T., Marketing Science, 2009)	23
Sales Effects of Attention to Feature Advertisements: A Bayesian Mediation Analysis (Zhang, Jie; Wedel, Michel; Pieters, Rik, Journal of Marketing Research, 2009)	20
The Stopping Power of Advertising: Measures and Effects of Visual Complexity (Pieters, Rik; Wedel, Michel; Batra, Rajeev, Journal of Marketing, 2010)	14
Analogies and mental simulations in learning for really new products: The role of visual attention (Feiereisen, Stephanie; Wong, Veronica; Broderick, Amanda J, Journal of Product Innovation Management, 2008)	12

Note: The above highly influence eye tracking business academic article were published in 1999-2013 and received at least 12 citation.

IV. CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

The study presented a bibliometric study of eye tracking research. After searching the SCI/SSCI database, the study found 2,354 eye tracking articles in the period of 1999 to October 2013. Among them, only 28 articles belong to business field. The current study found that more than half of articles were in the various fields of psychology.

For the articles of eye tracking research in business field, most of the articles belong to disciplines of marketing, consumer behavior, and electronic commerce. Journal of Marketing, Journal of Marketing Research, Marketing Science, Journal of Advertising, Journal of Consumer Research, Journal of Electronic Commerce and

The study found that Journal of Interactive Marketing, Journal of Business Research, Journal of Advertising Research, Journal of Marketing Research, and International Journal of Marketing Research are the major journals which published eye tracking articles. The results reveal that no single journal play a dominate role in eye tracking research.

The current research found that Pieters and Wedel are pioneers and most highly influence authors in using eye tracking technology in business research. They published 9 of the 28 articles of eye tracking research in the field of business research.

Even though the body of research has the undeniable value of offering informative insights into the knowledge structure of eye tracking research, it has some limitations. First, our search keyword may be incomplete, and many valuable papers may not have been included. Besides, the study collect only SSCI/SCI indexed articles, which might influence the generalization of the study. However, we still trust the study provides a valuable integration and different perspective on eye tracking research. Believe this paper will provide a useful briefing for newcomers of the field.

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