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Bibliography analysis: The influence of affective design on human cognition using Kansei engineering

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Abstract

There is a lot of research using affective and cognitive aspects as an approach to creating a product design or evaluating a product and service with consumers as the center of the design. Overall, human factors, product design, and affective design are important factors in creating products that are useful and enjoyable to use, by considering all factors, designers can create products that have a chance of success in the market. This research was conducted to look at studies based on variables, objects, and methods based on previous journals. This aims to identify previous research and see opportunities if research is carried out in the future. The method used uses affective and cognitive aspects and uses measurements using *eye-tracking* and EEG. Many statistical measurements are carried out using ANOVA. Based on the analysis, and interpretation of previous research journals, after identifying each aspect and component, conclusions can be drawn regarding aspects of each journal and future research opportunities, then research can be obtained or carried out using the research object of a product that will be made either commercially or commercially. does not use variables eye tracking and EEG measurement tools to determine the user's response. Then, a stimulus can be given to measure a person's level of cognitive response, using product design images, music, physical products, interfaces, music, etc. which will evoke a response from the person. Apart from that, methods that can be used for further research can use affective and cognitive aspects as methods.

Keywords: Bibliography analysis; Design; Cognitive; Affective; Stimulus; Eye tracking

1. Introduction

Cognitive Ergonomics (CE) is a branch of ergonomics that is related to human mental processes, including perception, memory, and reactions as a result of human interaction with the use of system elements. Cognitive ergonomics has one goal, one of which is improving cognitive performance by intervening in both human-machine interaction and human-computer interaction. The processes that occur in humans are caused by input in the form of stimuli that are captured by the human five senses after interaction with a machine or computer. One form of human-computer interaction triggers a stimulus in humans when they see and hear visualizations of images, videos, writing, or sound in an advertisement. Currently, there is a lot of relevant information and research related to vision allocation such as *eye tracking*, *visual occlusion*, *visual attention*, etc. Apart from that, there is also a lot of research that focuses on affective design or stimulates users' emotions in selecting or seeing responses to design stimuli and image illustrations. Kansei engineering proposed by Nagamachi is an effective way for designers to understand user requests and this can be applied to different design methods and objects in various fields [1] (see Table 1), such as *the interface of a game* [2], watch products [3], 3D chair designs [4], images in databases [5], sound or audio for advertisements [6] etc. However, according to Desmet [5] in some cases, participants may experience difficulty in verbally expressing the emotions evoked by the product. Some investigations have attempted to circumvent this problem by adopting cartoon patterns (non-verbal instruments) rather than adjectives for emotional responses. In such studies, participants are asked to read an image or look at an object while their eye movements are recorded by an eye-tracking system, which allows

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researchers to analyze where people focus their visual attention [4]. Therefore, the relationship between humans and machines refers to human cognitive and affective design in a product, both physical products and services. This research wants to know and identify bibliographically the relationship between human cognition and how humans respond with perspective and perception of the stimulus using affective design.

2. Methods

2.1. Bibliometric Analysis

This study was carried out by selecting research journals that were appropriate to the purpose of writing using keywords and derivatives from " *ergonomic* ", " *Kansei* ", " *advertisement* ", " *eye-tracking* ", and " *affective design* ". These keywords were chosen to look for trends in contextual relationships from research that has been conducted using similar discussions or topics. The focus of this study is to identify the relationship between human cognitive ergonomics and affective design with responses to stimuli in the form of product design, whether services, physical products, or *interfaces*, on human attention, response, and perspective.

To identify relevant literature, at this stage, a systematic bibliographic search was carried out for the period 2012 to 2023 using a search on Scopus and VOSviewer to see the correlation between keywords. This study began by searching for keywords derived from " *ergonomic* " using a research strategy by entering the initial keywords in Scopus, namely *ergonomic*, *ergonomics*, *ergonomic cognitive*, and *cognitive*, resulting in the following *command* : (TITLE-ABS-KEY ("ergonomic") OR TITLE-ABS-KEY ("ergonomics") OR TITLE-ABS-KEY ("cognitive ergonomics") OR TITLE-ABS-KEY ("cognitive")). The article search stage uses each keyword and its derivatives, then an article search is carried out by combining the intended keywords, then filtering is carried out according to the specified period. Search for combined keywords using the following *command* : (TITLE-ABS-KEY ("ergonomic cognitive") OR TITLE-ABS-KEY ("Kansei engineering") AND TITLE-ABS-KEY ("eye tracking")). The steps for collecting articles using keywords are carried out in stages as in Figure 1 below:

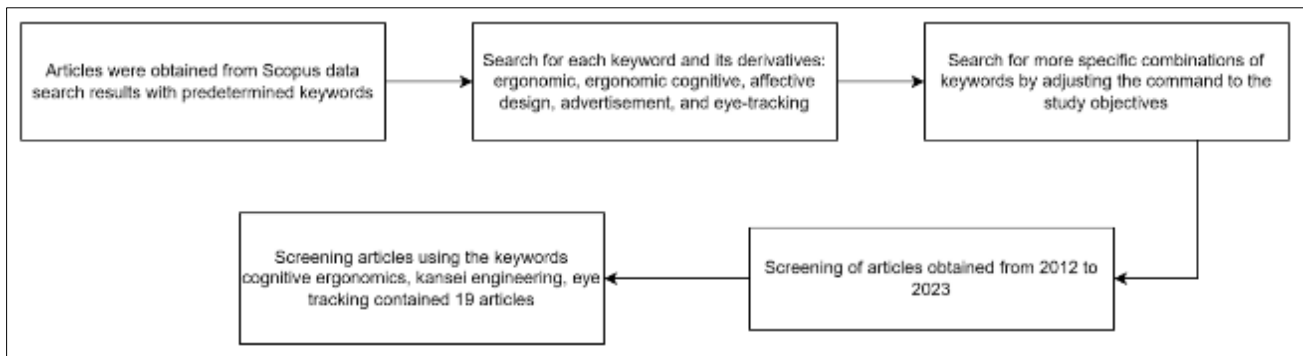


Figure 1Data Collection Stages

Based on searches using the selected keywords, there were 554 journals with the main keyword search, namely " *cognitive ergonomics* ". A graph of the number of documents published each year can be seen in Figure 1 as follows,

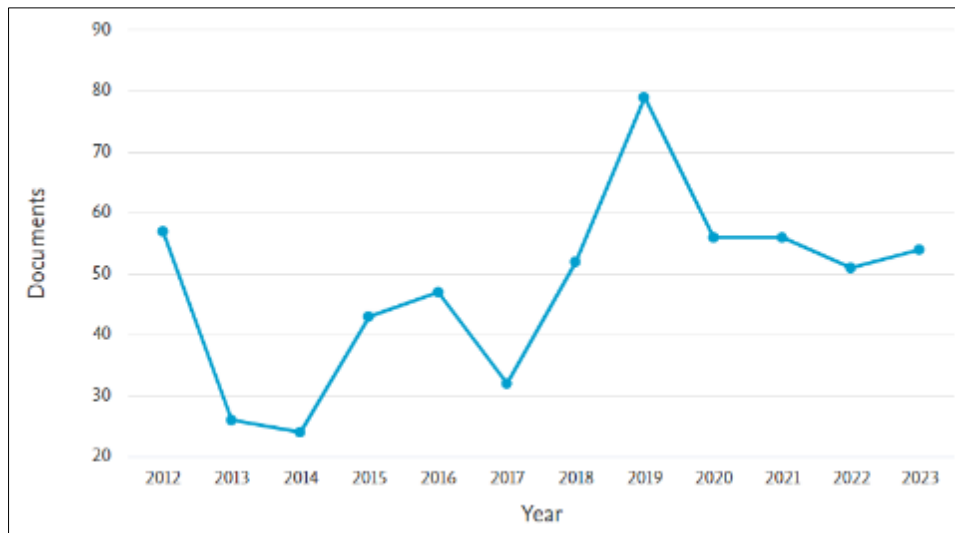


Figure 2 Number of documents each year with the keyword "cognitive ergonomics"

Previous research used these keywords, then analysis was carried out based on country of origin. Figure 2 is a graph produced based on a search for countries that influence research that matches existing keywords or countries that cite a lot of existing research. It was found that the United States was the country with the highest number of related journal publications with 61 articles, followed by Brazil, Germany, etc.

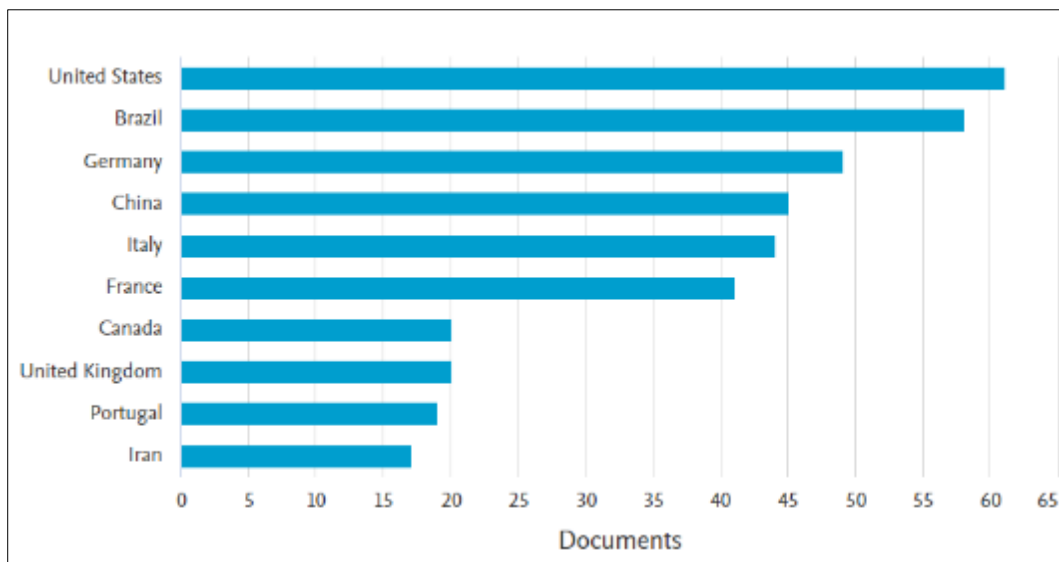


Figure 3 Number of documents by each country with the keyword "cognitive ergonomics"

Apart from that, searching for keywords is also a stage in carrying out this bibliographic study. A keyword search was carried out on articles representing this study using the keywords *eye tracking*, *cognitive*, and *affective*. Figure 3 is an illustration of the relationship between each keyword and articles that are widely available, while Figure 4 is an illustration of the relationship between keywords and articles that are obtained in the form of *eye tracking*, *cognitive*, and *affective*. In Figure 3, the keywords obtained are general and focus on relationships related to humans. The relationship is related to humans, then if we look closely there is a relationship with other keywords such as human gender, eye tracking, stimulus, and several other keywords.

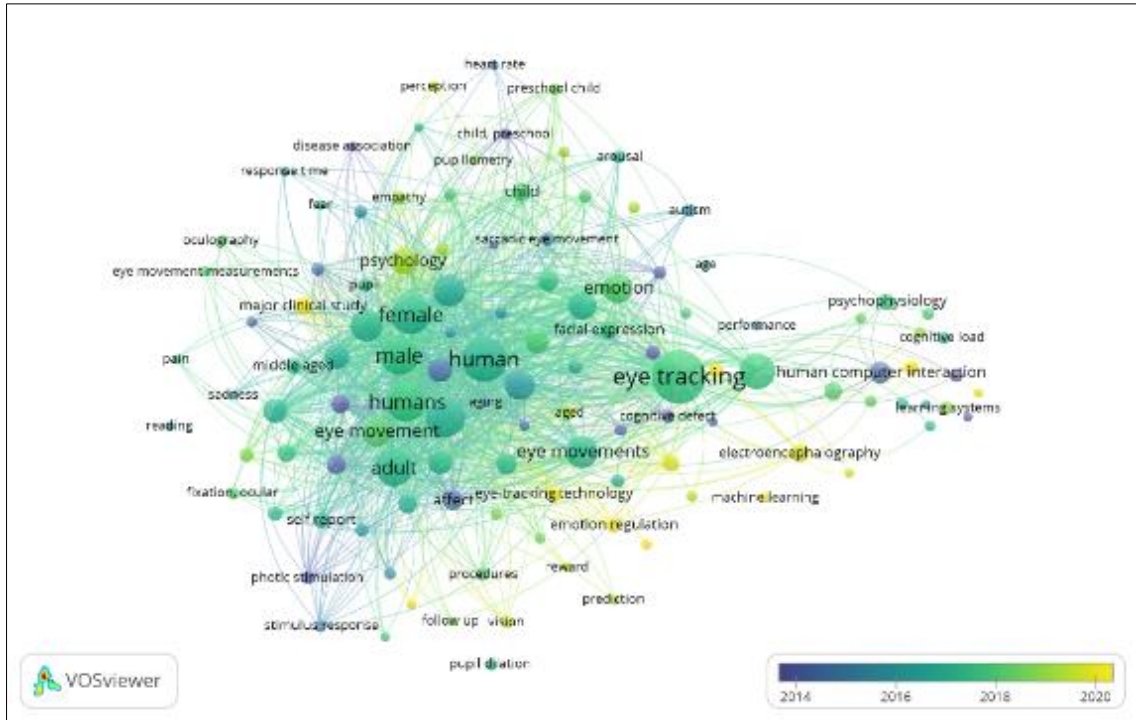


Figure 4 The relationship between keywords in the articles obtained

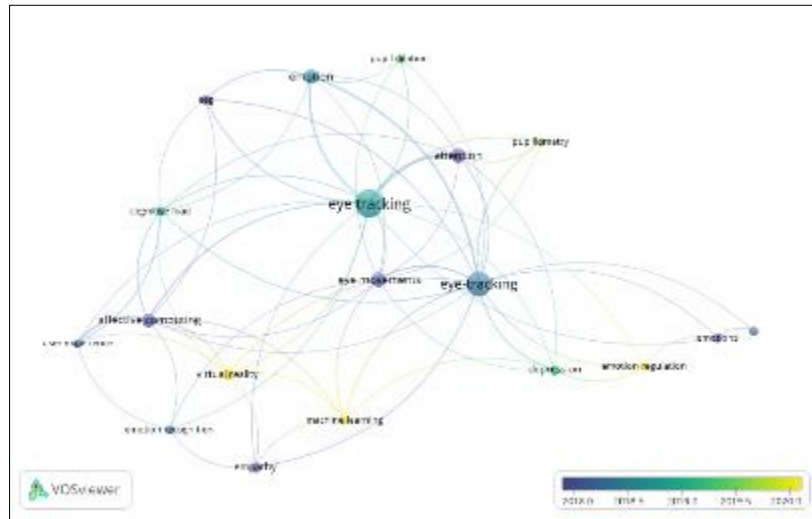


Figure 5 Relationship between eye-tracking, cognitive, and affective keywords between articles

3. Literature Analysis

Literature research is carried out by applying similar scientific fields and topics but with different titles and objects from previous research. Literature studies were obtained using sources from Scopus-integrated journals including ScienceDirect, PubMed, etc. in the 2012-2023 period which aims to make it easier to conduct research regarding the relationship or level of influence of attention, understanding, perception, response, and *memory* towards an advertisement. The research was carried out by sorting and reviewing research journals that were appropriate to the purpose of writing using the keywords *Kansei engineering*, *affective design*, *cognitive ergonomics*, *advertisement*, and *eye-tracking* to see contextual trends from *affective design advertisement* and *eye-tracking research*. After considering and examining the title, abstract, additional keywords, and research model of each article obtained to determine its relevance, in this bibliographic research study 11 articles were considered to be identified. Table 1 is the identification results

Table 1 Identification of Literature Study Journals

Writer	Topic	Object				Participants	Method	Tool		Approach	
		A	B	C	D			Eye tracking	EEG	Affective	Cognitive
[5]	Respond to user design assessments using images	v				Experience in design; woman man; age 20-35 years; do not consume cigarettes or caffeine for 2 hours before the experiment; not have a previous injury, illness, or eye surgery; have normal vision	Anova	v		v	v
[3]	Design evaluation for customer evaluation of the product	v				-	Anova	v		v	v
[4]	evoke in consumers through form in product design and development	v				man and woman; attended at least 4 years of design training; have good eyesight	Anova	v		v	v
[1]	User-centered product design by integrating design thinking and Kansei engineering into products	v				Designers and consumers; aged 19-31 years; designers aged between 24-36 years; all participants had attended college	Cluster			v	v
[7]	Objective measures of food/drink advertising are associated with preferences	v		v		Children and teenagers between 8-15 years; 43.1% are women	Regression	v			v
[6]	The influence of music in advertising on audience response	v	v		v	Woman; normal vision; normal hearing	T-test	v	v	v	v
[8]	<i>favorite</i> illustrations with Kawai <i>feeling</i>	v				men in their 20s, women in their 20s, and women aged 65 years or older	Anova	v		v	v
[9]	A neurophysiological data integration approach for product assessment evaluation	v				Industrial or mechanical engineering students; aged between 21 and 29; man / Woman; vision, sensitivity to color, and mental health are checked	Correlation, DEAP	v	v	v	v
[10]	<i>Selfie</i> content at exhibitions and the type of text appeal to the perceptions and decisions of potential visitors	v				Men and woman; ages 21-30; experienced Xiaohongshu and have been to exhibitions	Statistics	v		v	v

Writer	Topic	Object				Participants	Method	Tool		Approach	
		A	B	C	D			Eye tracking	EEG	Affective	Cognitive
[11]	<i>Neuroscience and marketing</i> measurements in advertising and consumer behavior	v				female and male students; aged 21-24 years; no history of neurological disease	Anova, SEM	v	v		v
[2]	<i>eye-tracking</i> indicators and affective states (confusion and frustration)	v				age between 19-58 years; 11 people wore glasses, 1 wore contact lenses, 27 people did not	Anova	v		v	v

Description: A= image/illustration/text ; B= audio/music; C= physical product; D= video

4. Results and discussion

This section, explains the relationship between the keywords for each article obtained and the identification obtained for articles that are considered relevant to the search obtained. One goal of cognitive ergonomics is to improve cognitive performance by intervening in both human-machine interaction and human-computer interaction. Cognitive ergonomics is also related to human mental processes, including perception, memory, and reactions as a result of human interaction with the use of system elements. Human cognitive processes depend on the stimuli perceived by each human sense. In cognitive psychology, feature recognition requires two requirements, among others, the feature stimulus is generated from the outside world and previous knowledge and experience regarding the feature stimulus must be obtained, and people can tolerate a certain level of physical variation in feature recognition [4]. Perception consists of three components: subjective experience, emotional response, and behavioral or expressive response based on a person's complex psychological condition [1]. According to Siu [5], more and more designers, engineers, and marketing researchers are noting that products must be designed to meet various requirements and extreme psychological needs of users. Crozier's research says that consumers' psychological responses to a product are influenced by the product's appearance (including size, shape, and color), and the emotional elements of its design. Responses to the latter are related to complex brain structures involved in emotional processing [5]. Eye movements or eye-tracking are thought to provide a physiological assessment of attention that is directly related to cognitive processes [7]. Many studies show that eye tracking allows researchers to understand how the characteristics of marketing materials and product information drive consumers, and thereby draw consumers' attention to advertising. It also helps to understand how consumers process information, and under what conditions the available information is used [11]. In addition, many studies have also tried to correlate affective states with various physical indicators using electroencephalography (EEG) and electrocardiography (ECG) [2]. There are many variables, indicators, and objects that can be used to measure cognitive aspects using stimuli which can be in the form of product design using affective aspects.

Many studies that discuss cognitive ergonomics relating to humans are concerned with human cognitive aspects and responses to the stimuli received. The stimulus given is a stimulus that can be received by the human senses such as hearing, sight, smell, touch, etc. To see a human response to a stimulus, you can use various objects such as physical products, interfaces, images, text, video, sound, etc. In the case of physical product use, product design evaluation is a complex and ambiguous decision-making process that is heavily involved in every design stage and iteration. Design evaluation at the initial design stage greatly determines the final result and is carried out by expert assessment. It depends on the expert's experience and use of domain knowledge and can be influenced by biasing factors such as the expert's personality and life experience [9]. According to research using human cognitive aspects, various research objects and variables are used, including; watches [3], chair shapes [4], bamboo pencil cases [1], various images from a database [5], food and drink products [7], television advertisements [6], image illustrations [12], design car interiors [9], and many more. These studies were conducted using different methods and measurement variables. Some studies carry out measurements using eye-tracking [5], [3], [4], [7], [6], [8], [9], [10], [11] and [2]. Eye-tracking has become popular as a user research tool for recording a user's gaze path. Eye-tracking research records the trajectory of eye movements during certain tasks, to analyze the cognitive behavioral processes and psychological activities of users [13]. Apart from that, [6], [9] and [11] also use neurophysiological measurements such as EEG, etc. The use of EEG has the power of data on brain regions that can be analyzed and utilized to predict customer decision-making, differentiate customer preferences, and help analyze advertising settings. They found that features extracted from EEG power were effective for the above applications [9]. According to Zhu, with the increasing knowledge about neurophysiology and its research methods, research using electroencephalogram (EEG) is increasingly being used to understand the actual thoughts of users.

Combining eye tracking and EEG research is a possible current and future trend in the research field. Based on the combination of these methods, it is possible to obtain user information that is more accurate, in-depth, and comprehensive than subjective reports, making it possible to do so objectively [13]. Apart from that, the measurements carried out in previous research also varied. Several studies use data processing analysis using ANOVA analysis [2] ; [3] ; [4] ; [5] ; [10] ; [12], regression analysis [7], cluster analysis [1], correlation analysis [9], SEM analysis [11] and T-test analysis [6]. Analysis using statistics is carried out to look for significance and correlation between variables that can be obtained after measurements using either eye-tracking or EEG.

5. Conclusion

This study concludes that ergonomics has many aspects that can be used as a study or research. Cognitive ergonomics provides improved cognitive performance by intervening in both human-machine interaction and human-computer interaction. Cognitive ergonomics is also related to human mental processes, including perception, memory, and

reactions as a result of human interaction with the use of system elements. There are many variables, indicators, and objects that can be used to measure cognitive aspects using stimuli which can be in the form of product design using affective aspects. This study can be used as a means of exploring cognitive ergonomics and affective aspects. Based on the existing articles and the articles that have been identified, this study can provide suggestions regarding future research that might be carried out and developed by adapting existing objectives and conditions. Future research can carry out research studies, both observational and experimental, by combining several variables such as cognitive aspects in the form of attention, understanding, perception, and response and affective aspects of using Kansei Engineering. Apart from that, research objects can be used to design or illustrate images of a product, or combine all research objects that have been carried out. The methods that can be used in future research are also varied, using cognitive and affective aspects, and the research objects above, the approaches or methods that can be used are ANOVA or correlation analysis.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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