

The impact of emotional involvement on online service buying decisions: an event-related potentials perspective

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When examining a buying process, changes in human brain signals and their event-related potential (ERP) components can be considered a reflection of the consumers' emotions. In this experiment, participants were shown 12 products and related services that were available for purchase. After recording ERP components, we used a questionnaire to measure the individuals' emotional involvement toward the services (i.e. the same services shown in the stimuli) of the 12 products to measure the emotional valence of the services. The emotional ERP components and the late positive potential (LPP) were elicited under the service conditions and distributed over the left frontal regions. We determined that the services may evoke an LPP and that services with a high emotional value may evoke a larger LPP, which suggests that positive emotion may be measured using the LPP amplitude in the left frontal regions. This result helps elucidate whether positive emotions are stimulated during the product-service system

decision-making process and helps understand the emotional valences of different services. Our analysis of the emotional motivation of the consumer suggests that the LPP may be useful as an emotional indicator for measuring consumers' evaluation of services that provides a neural view of product-service system buying decisions. *NeuroReport* 26:995–1002 Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.

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Introduction

Consumer emotion plays a significant role in the decision-making process to buy a product [1]. Many scholars have paid close attention to the impact of emotions on consumer behavior. In pursuit of some type of emotional volatility that is associated with the purchase of consumer goods, the purchase of a product is no longer a simple function of the product's utility. The consumer experiences the buying process as an improvement of a rational emotional perception, which is more important than product consumption [2]. To extend the material production of a product, an increasingly important marketing tool is the association of a particular product that exerts a positive emotion in the consumer. Such an approach to marketing requires an understanding of the factors that induce consumer emotions. Many marketing stimuli, including products and brands, may evoke emotions during the buying decision [3,4]. Edell and Burke [5] presented the different emotional responses to advertising. However, many factors, such as the services related to a product, can influence the consumers' sentiment. It is helpful to understand the relationship between consumer sentiment and consumer behavior, particularly with regard to the emotions evoked by services. Bitner [6] suggested that the service environment

affects the consumers' emotional, cognitive, and physiological reactions and thus affects their consumption behavior. Chaudhuri [7] described the emotions induced by different types of products during the buying process. Tractinsky *et al.* [8] found that the product type, as well as the design dimensions of the online store, may affect consumer sentiment.

In accordance with technological advances, researchers have used electroencephalograms (EEGs) and neuroimaging to study the physiological characteristics of emotion. Thus, research using techniques to measure in-vivo brain activity is growing. Some studies have shown that early posterior negativity and late positive potential (LPP) in brain activity are induced by pleasant and unpleasant stimuli [9–11]. It has been demonstrated that happy and unhappy stimuli can evoke greater early posterior negativity and LPP amplitudes compared with neutral stimuli. Positive or negative emotions induce a greater LPP 400–800 ms after stimulus presentation than neutral stimuli [9]. It has been proposed that the physiological characteristics of emotions may appear in the brain [12] instead of being manifested in the surrounding physical reaction. Dietrich *et al.* [13] demonstrated the effects of a word' emotional connotation on event-related potentials (ERPs) and noted that further investigations are needed for the application of emotion. However, the study of functional aspects of the brain during emotional processing is associated with brain asymmetry, particularly

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the relationship between the left prefrontal regions and positive emotion. Erk *et al.* [14] found that pictures of attractive cars activate the left hemisphere more than the right hemisphere. Change in human brain signals observed on an EEG and the brain's main ERP components are considered a reflection of the consumers' cognition [15]. When consumers observe different elements related to the product, such as the product's attributes, brand, and advertisements, different signals can be evaluated by monitoring brain activity [16].

Identifying the cause of emotions has clear practical importance for understanding consumer behavior. Because each emotion can exert unique influences on the behavioral response, consumer behavior depends on the relative efficacy of emotional states [5]. Studies on emotion and decision-making have largely demonstrated that emotions [1] play a significant role in the purchasing decision. The complexity of customer demands may make the design of services difficult within the product-service system (PSS) model. It is difficult for a company to identify the most attractive service in a PSS. Moreover, focusing on consumer emotion may be a useful strategy [17] in service design. Frequently, companies design a PSS as they develop a product [18], but they ignore the particularity of the service and its function. The development of attractive services in Chinese manufacturing firms is far from systematic and immediate. Measurement of the emotional valence of a service will aid the development of novel methods that can be used to design services.

No study has directly examined ERPs that are correlated with service cognition as consumers make buying decisions. Although many recent studies have investigated service as an integral design element, these studies lament that there is no good neural theory that can be applied to service cognition and emotion evocation. Much remains unknown with regard to emotion and decision-making, particularly the neural mechanism underlying service judgment in a PSS. In this experiment, participants were shown products and related services that were available for purchase. During the presentation of the words associated with a service, the brain responses to recognized items are characterized by an emotional ERP component. As a result, first, the meanings of service advantages and the emotion evocation of a service will be investigated. Second, a method for ERP service evaluation will be investigated by analyzing the amplitude of the LPP in the buying decision. Third, by clarifying the LPP in the left frontal region, the relationship between positive emotion and emotional function of the left prefrontal cortex will be investigated. On the basis of the emotional motivation of the consumer, we hypothesize that there is a significant difference in the LPP amplitude when consumers view services with different emotional values. We speculate that the LPP can be elicited through the evaluation

process for sequentially displayed service stimuli. In addition, a service with high emotional value may elicit higher LPP amplitudes than a service with low emotional value.

Methods

Participants

Twenty-one healthy, right-handed college graduates (13 female; ages 21–29 years, average age 25.4 ± 2.56 years) participated in this study. All of the participants had normal or corrected-to-normal visual acuity and did not have any history of neurological or mental disease. One participant was excluded because of excessive signal artifacts. Therefore, 20 participants (13 female; ages 21–29 years, average age 25.4 ± 2.47 years) were included in the data analysis. Before the experiment, the participants were notified of the task procedures and the procedure for recording EEGs. Written informed consent was obtained from all of the participants. The Academic Board of the University reviewed and approved this research protocol.

Materials

Online shopping has gradually increased consumer consumption by providing services related to physical products, which has changed the competitive landscape. Jingdong Mall is China's largest sales platform for electronic products, which has attracted consumers through the use of more services. Although Jingdong Mall has offered many services related to electronic products since 2015, online sales may lead to a new service marketing paradigm. According to Tukker and Tischner [18], two forms of service exist in the product-oriented services system: product-related service and advice, training, and consulting services. The main difference between the two forms of service is their extension. Product-related services focus on products, whereas advice, training, and consulting services focus on both products and processes. Product-related services are provided by the supplier to help the customer manage a product during its useful lifetime, specifically through maintenance contracts, the supply of spare parts and consumables, product inspection, diagnosis or repair, transportation, on-site installation, refurbishing, cleaning, updates, and upgrades. The PSS provider may also provide advice, training, and consulting services associated with the product, with regard to its most efficient use (including the most energy-efficient configuration) and the life activities, processes, and business of the customer. For example, these activities can include knowledge-based services, such as training on product use, advice on product choice, and training and consulting to improve the skills and competencies of consumer cognition.

After investigating and analyzing Jingdong Mall with regard to service provision in China, we suggest categorizing service into the following four types: provision of

core product-oriented value-added service, provision of core product-oriented financial service to customers, provision of support and maintenance services for the core product, and provision of operational services associated with the core product. With the steady growth of the Chinese market, the network consumption of goods and services presents new bright spots in China's retail market. Because of manufacturing servitization, the mix of products and services that is ultimately purchased by the consumer belongs to the product-oriented services system. Therefore, on the basis of data on China's total retail sales of social consumer goods from 2014, experimental materials were selected for three types of goods undergoing manufacturing servitization in China: household appliances, clothing, and electronics. We chose the 12 highest sales categories among these goods, which included refrigerators, washing machines, air conditioners, shirts, suits, mobile phones, laptops, and other goods.

Twelve product names (in Chinese characters) were chosen and divided into the following three categories: electronics (e.g. laptops and phones), household appliances (e.g. washing machines and refrigerators), and clothing (e.g. shirts and suits). Each mix of products and services had one product attribute (e.g. CPU and memory for laptops; style and material for suits) and service design (e.g. maintenance and delivery for washing machines and refrigerators; training and consulting services). We selected the product attributes and services based on corporate websites and a survey. The experimental materials included mobile phones, laptops, refrigerators, washing machines, suits, shirts, and other products suitable for PSSs. For each product and service description, the expected product attribute was determined by the eye movements of each participant. During the eye movement experiment, the participants were asked to buy the 12 products on the Jingdong Mall website to simulate a real online shopping environment. We then recorded their individual preferences for the 12 products. The participants would see the product that they expected based on the eye movement experiment. There was one expected product attribute (e.g. laptops with Intel 7 CPUs and 16 GB of memory) for each product and six configurations for service designs (e.g. for laptops, participants could select from the following six types of services: accidental damage warranty, 1 year of hardware warranty, free lecture, convenient return in 14 days, personal technical assistance, and door-to-door delivery). Therefore, each product and service mix had six service configuration combinations that could be selected for each participant; thus, 21 independent experiments were designed for our 21 participants.

After recording, we used a questionnaire to measure the individual emotional involvement associated with the services (the services shown in the stimuli) for the 12 products. In this study, we selected happiness, surprise,

and interest as positive emotions induced by the services. There are three problems associated with a service with detailed descriptions of the positive emotions in a test scale. We adopted a seven-point Likert scale, with 1 being very low and 7 being very strong. On the basis of the questionnaire results, the emotional value induced by each service was averaged and ranked. The choices provide an indicator measure of each participant's degree of emotional involvement, which can be used to classify the most attractive sets for each service. On the basis of the questionnaire results, we subdivided 72 trials into two conditions, which are shown in Fig. 1. Condition 1 included the 24 services with the highest emotional value, whereas condition 2 included the 24 services with the lowest emotional value.

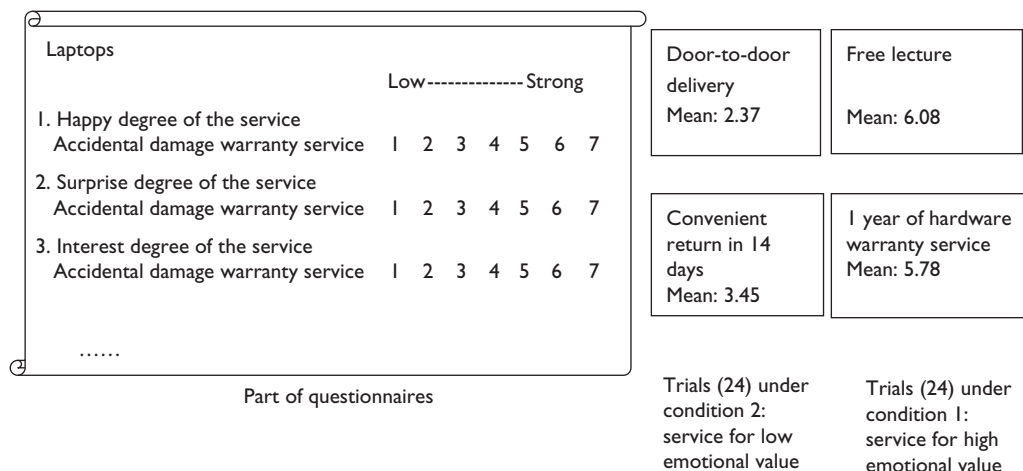
Stimulus presentation and timing

The participants were instructed to avoid blinking or moving their eyes and to place their fingers on the keyboard with their left index finger on the F key and their right index finger on the J key. They were seated in a comfortable armchair in a sound-attenuated room. The stimuli comprised 72 combinations of products and services, which reflected 12 products \times one expected product attribute \times six services. Each trial began with a fixation point (+) that appeared for 2000 ms. The PSS name and price then flashed for 2000 ms, and this was followed by a product attribute for 2000 ms, a related service for 2000 ms, and then a stimulus question for 4000 ms. The participants were shown stimuli of the products and related services that were available for purchase. The participants had to decide whether to buy the product as quickly as possible. Importantly, the design separated the following four periods of time: product name and price presentation, product attribute presentation, service presentation, and decision. This allowed the investigators to identify the different neural signals that contribute to decision-making in this case. Figure 2 presents a pictorial overview of the task. The participants pressed the F key if they wanted to buy the given PSS, whereas if they did not want to buy the PSS, they pressed the J key after the stimulus question appeared. The next trial began after the participant pressed a key. Trials without responses were considered invalid.

Electroencephalogram recording and analysis

The continuous EEG was rereferenced to an average reference and filtered with a 35 Hz low-pass filter into 1000 ms stimulus-locked epochs (from 200 ms before stimulus to 800 ms after stimulus). The continuous EEG was then segmented by different service conditions, particularly the high-emotional value and low-emotional value service conditions. Artifact detection and correction were used to eliminate epochs that were contaminated by vertical eye movements (eye blinks; $\pm 140 \mu\text{V}$) and horizontal eye movements ($\pm 55 \mu\text{V}$). The averaged ERP

Fig. 1



Legend of the questionnaire and classification of trials.

Fig. 2

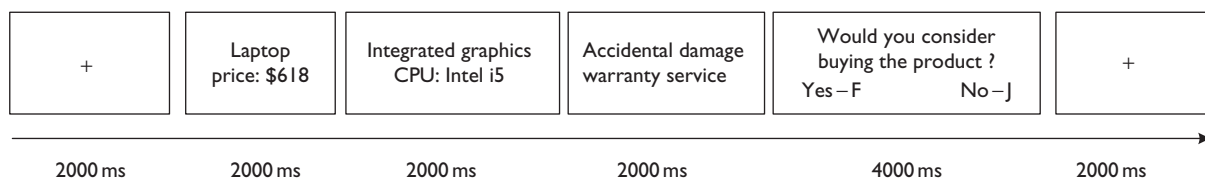


Illustration of the experimental task.

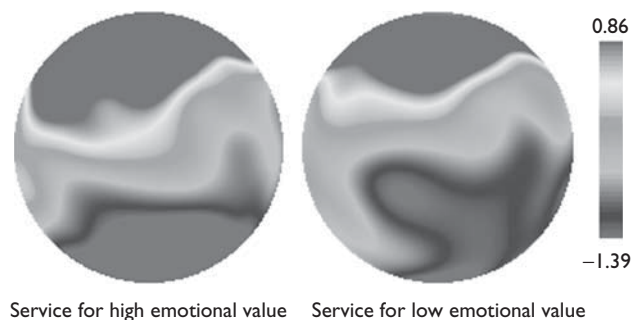
data were baseline corrected for prestimulus (200 ms) ERP activity. The channels in the left frontal (F1, Fz, and F3), left forehead (AF3, AFz, and AF5), and left frontal central (FCz, FC1, and FC3) regions were then analyzed.

Results

Late positive potential

The late positive voltage change obtained for services with a high emotional value was significantly larger than that found for services with a low emotional value. Following the onset of the service configuration, the LPP (latency of 520–660 ms) [19] was recorded for each service condition. Figure 3 shows the brain topography at 550 ms, including that of the left forehead and frontal channels, which indicates the importance of these brain regions for emotion processing. Figure 4 shows the grand-averaged ERP waveforms of the two conditions in the left forehead (AF3 and AFz), the left frontal (Fz, F1, F3, and F5), and the left frontal central (FCz, FC1, and FC3) channels. Table 1 shows the mean amplitudes of the ERPs in the related time windows, as well as the analysis of variance (ANOVA) results in these channels

Fig. 3

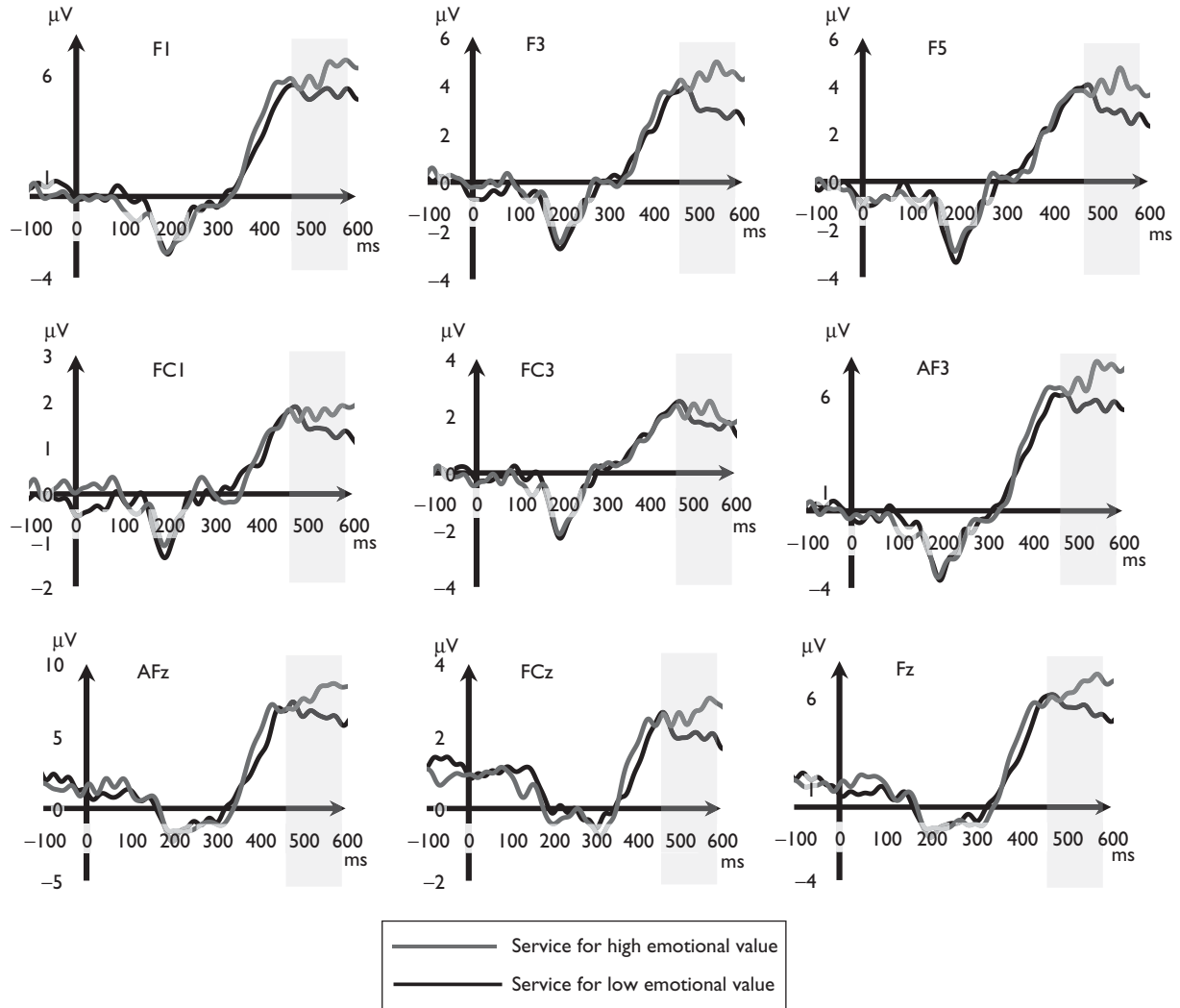


Topographic plots of maximal amplitudes of the LPP (550 ms). LPP, late positive potential.

for the low-emotional value and high-emotional value service conditions.

The LPP components showed obvious differences between the different service conditions in the 500–600 ms time window. To observe the influence of the service attributes, we compared the mean LPP

Fig. 4



Grand averaged ERPs of 20 participants at nine selected channels in response to different stimulus conditions. ERPs, event-related potentials.

Table 1 Mean amplitudes of the event-related potentials (SDs are shown in parentheses) for the 500–600 ms time window and results of the analysis of variance under the two conditions at different channels

Channel	Low emotional value	High emotional value	F-value	P-value
Fz	5.24 (0.28)	6.78 (0.33)	638.086	0.000
F1	5.09 (0.17)	6.26 (0.45)	300.777	0.000
F3	2.87 (0.13)	4.51 (0.21)	67.140	0.000
F5	2.76 (0.21)	4.03 (0.34)	510.053	0.000
AFz	6.35 (0.28)	8.19 (0.45)	604.750	0.000
AF3	5.47 (0.18)	7.18 (0.47)	578.011	0.000
FCz	1.98 (0.09)	2.73 (0.23)	466.490	0.000
FC1	1.34 (0.07)	1.79 (0.09)	700.993	0.000
FC3	1.69 (0.09)	2.10 (0.27)	101.767	0.000

amplitudes (500–600 ms) under the two conditions using a 2 (high and low emotional value) × 9 (scalp channels) within-participant repeated-measures ANOVA.

Between 500 and 600 ms, the results showed that the positive components were significantly different with respect to the high-emotional value and low-emotional value services [$F(1,19)=77.756, P=0.000, \eta^2=0.080$] and channel factors [$F(8,12)=5350.019, P=0.000, \eta^2=0.990$], and there was a significant interaction between the conditions and channels [$F(8,12)=33.452, P=0.000, \eta^2=0.998$].

Behavioral data

All of the trials were valid because the participants responded after the question stimulus. Statistical testing was performed using SPSS 18.0 (SPSS Inc., Chicago, Illinois, USA). The mean difference (MD) in the purchase rate for the products with a low emotional value was 32.98%, and the SD was ~0.18, whereas the MD in the purchase rate for the products with a high emotional

value was 56.07%, and the SD was ~ 0.17 . The repeated-measures ANOVA between the two conditions indicated that the service content had a highly significant main effect on the buying decision [$F(1,19)=5.471$, $P < 0.05$, $\eta^2=0.126$]. Comparisons of participants' affirmative decisions have also been analyzed. The results indicated that 62.32% of the product purchase rate pertained to the high-emotional value condition in the total purchase rate, whereas 34.34% of the product purchase rate pertained to the low-emotional value condition in the total purchase rate [$F(1,19)=110.514$, $P < 0.05$, $\eta^2=0.467$], which showed that more affirmative decisions were made under the high-emotional value service conditions than under the low-emotional value service condition. The MD in the response time for the products with a low emotional value was 699.74 ms, whereas the MD in the response time for the products with a high emotional value was 624.88 ms. There was no statistically significant difference between the conditions in terms of response time [$F(1,19)=0.854$, $P > 0.05$, $\eta^2=0.022$]. This method confirms that the high-emotional value service has a positive impact on buying decisions.

Discussion

Stimuli classification and emotional valence of service

The design and marketing of PSSs are of growing importance in markets where many of the consumers' basic needs have been satisfied. Firms are shifting their competition strategy away from concrete product characteristics toward less tangible features, such as services. The LPP components of ERPs were observed in this study to evaluate the emotional valence evoked in the consumers by the service stimuli. Services can give a product a competitive advantage and help increase product demand, which makes them potentially crucial for the growth and competitiveness of manufacturing firms. Therefore, we divided the stimuli into different emotional services to confirm the consumers' emotion evocation.

According to the special role that emotions play in the buying process and the unique services in the PSSs [20], we argue that customers' emotions toward a PSS are more positively affected by the service provided. Because of service invisibility, there is lack of an objective evaluation of service design and quality, which mainly rely on the levels of consumer expectations and perception. A questionnaire is commonly used to measure service quality, but it is difficult to extrapolate the consumers' real perceptions during the buying event. In this sense, we expected that consumers would demonstrate differences in the measured ERPs that suggest emotional processing in the brain. Many studies have shown a certain relationship between emotion and services, such as the emotional factors that affect tourism product consumption and the key role that positive emotions play in

restaurant management. Affective reactions are important in the buying decision process because feelings can occur very rapidly [3] and may influence the consumer decision-making process. Service-triggered feelings can therefore potentially influence the evaluation of both products and services in the PSS. These issues have important implications in understanding the role of emotion in an evaluative buying process and in assessing products and services.

Left frontal regions and positive emotion evocation

The left frontal area is different from the right areas of the brain, a phenomenon called frontal brain asymmetry, which is associated with emotional valence in research [21]. Many studies involving frontal brain asymmetry have focused on emotional valence, indicating the important role of the left frontal region in positive emotions [22]. Most of the scholars used the film type (positive or negative) as stimulus type in their studies, to record the report of affective responses. Similarly, Davidson *et al.* [22] found that individuals with greater left frontal activity responded with more intense positive affect to positively valenced films [22]. Emotions can be functionally considered as action dispositions preparing the organism for either avoidance or approach-related actions [21], and Sutton and Davidson [23] found that more frontal movement on the left side represented the adoption orientation, whereas more frontal movement on the right side represented the avoidance orientation. Collet and Duclaux [24] found that the left hemisphere's electrical activity increased under positive emotions. Dietrich *et al.* [13] developed experiments using emotional words, and their participants showed increased amplitude in the left hemisphere when they were shown positive words. It has been found that activation of the left frontal lobe and left temporal lobe cortex is significantly correlated with the level of neuroticism when participants are presented emotional images [19], showing the importance of the emotion-processing regions in the frontal and temporal lobes. In short, EEG and neuroimaging studies found that left hemisphere activation reflects the closely related state and positive emotion. As a result of this finding, we analyzed the left prefrontal region in this experiment.

LPP is an important ERP component involved in emotional processing, particularly in the left prefrontal regions. In our experiment, the high-emotional value services evoked a greater LPP, which was distributed over the left frontal regions. This enlarged LPP shows that these services can motivate more positive emotions during the buying process. This finding supports the notion that positive emotions are processed mainly in the left hemisphere. According to the pretest of emotion evocation in the trial, the emotions induced by services in the experiment were all positive emotions. Thus, our results further support the idea that activities in the left

frontal regions provide useful tools for understanding positive emotions. Therefore, according to the role of the brain hemispheres in the processing of emotions, this study confirms that the positive emotions evoked by services appear in the left prefrontal regions with an LPP.

Implications for late positive potential and consumer buying decision

Previous studies utilizing rapid picture or word presentations found that emotionally significant stimuli consistently modulate both early and late ERP components [10,11,19]. When emotional and neutral words are detected by ERPs, emotional stimuli produce greater LPPs, which are topographically maximal in the frontal and frontocentral electrode sites, reflecting the neurophysiological mechanisms of positive emotions [11]. Pleasant pictures prompted greater LPP amplitudes compared with neutral pictures, which shows that the LPP reflects emotional processing [19]. In our experiment, a greater amplitude of the LPP component was obtained for high-emotional value services. These results support our hypotheses on the functional role of emotional ERP components in the processing of a buying decision involving a service. The LPP reflects the general evaluation of the emotional significance of the service stimuli in the left frontal region. The differentiation of emotional connotations of service stimuli based on ERPs shows that the emotionally significant stimuli are processed in a specific manner. Substantial differences in different emotional value service stimuli were demonstrated in part through the LPP components. The results presented in this manuscript also clearly show the importance of the LPP in the evaluation of the consumers' emotions.

ERP measures have the unique advantage of having high temporal resolution [10], and it will be concluded that they serve as a useful tool to study the emotional guidance of consumers' buying processing. The main finding of this study is that services elicit an LPP, indicating an emotional measurement of the PSS. Therefore, on the basis of the emotional motivation of the consumer, the LPP may be an emotional indicator for measuring the consumers' evaluations of the PSS, providing a neural view of buying decisions in the PSS.

Conclusion

The PSS is a comprehensive business model that is able to fulfill user requirements by providing a mixture of products and services [25]. Services can improve the competitiveness of products and enhance customer satisfaction [26], but there is a lack of research on the root of service competitiveness. Many scholars have acknowledged that emotions play a large role in consumer behavior and have shown that emotions can influence buying decisions. The power of emotions has been demonstrated in several studies conducted in the

context of advertising and brand attitudes [1]. We strive to extend the PSS evaluation through the use of ERPs to detect emotions, particularly positive emotions, in consumers' decision-making processes. This study confirmed that services may generate emotional rewards in the left frontal region of the brain, which may be associated with emotion. An LPP was recorded for each service condition, and high-emotional value services evoked a greater LPP amplitude. Our findings help elucidate the consumers' positive emotions during the PSS decision-making process and the different emotional valences of the service elements. The decision-making process is a black box, and this is particularly true for the buying process for combinations of products and services. These findings show how consumers evaluate the service elements in the PSS, providing insight into the design of services in the PSS.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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