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Emotional contagion triggered by online consumer reviews: Evidence from a neuroscience study

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ABSTRACT

People tend to align with the emotional state of the person that is talking to them (the observed). Similarly, while processing information consumers can also experience this emotional contagion. Emotional contagion can activate in those who process information (the observer) similar responses in the autonomic nervous system and the neural responses as in those who create such information (the observed), triggering a certain level of arousal. Neuroscience enables researchers to study emotional contagion by monitoring the activation of neural structures and physiological responses. This study draws on the theory of arousal to investigate how different combinations of online consumer review (OCR) valence can trigger different emotions and customer experiences in the observer (the one who reads the OCRs). This study conducts a consumer neuroscience experiment to monitor emotional arousal. The physiological analyses (through skin conductance response) confirm that the emotional arousal of the observer aligns with that of the observed. The neural analyses (through electroencephalography) show the valence of the arousal, which indicates that negative OCRs activate arousal and pleasure in the observer, while positive OCRs are associated with arousal deactivation and displeasure.

1. Introduction

> *"When people are free to do as they please, they usually imitate each other."*
>
> – Erin Hoffer (1955)

Identifying emotions during information processing is crucial for marketers and businesses to generate an effective customer experience (Kranzbühler et al., 2020; Lemon and Verhoef, 2016; Manthiou et al., 2020; Verhulst et al., 2020). In this regard, previous literature has shown the importance of online consumer reviews (OCRs) during the decision-making process because they are a trigger to emotions (Zablocki et al., 2019). A recent study found that 20% of users trust OCRs, and this percentage increases to 25% when there are multiple customer reviews to read (Statista, 2020a). Previous research has focused on how OCRs valence and volume affect purchases, but the effect of emotions on consumers' behavior needs further examination (Zablocki et al., 2019). In particular, users associate positive product ratings with positive emotions, and low or negative ratings with negative emotions (Septianto et al., 2020; Xu et al., 2020).

Emotions can be contagious when one person listens to another, reads about others' experience, or even just imagines others' emotional states (Dixon et al., 2017; Hatfield et al., 1994; Kramer et al., 2014; Tombs and McColl-Kennedy, 2003). Research on emotions has shown that people tend to align with the emotional state of the other person, including mimicking expressions and bodily changes due to emotional arousal (Hatfield et al., 1994). Moreover, emotional contagion implies behavioral synchrony (Hatfield et al., 1994). Thus, reading OCRs could transfer the emotions contained in them to the readers, affecting their behavioral response to them. However, when reading OCRs it is common that you face reviews with positive, negative and neutral valence. That is, the information shared can show positive, negative or neutral customer experiences. So, not only one emotion is contagious, but a combination of all the OCRs the observer reads.

Previous research has focused on proving that one type of emotion

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can be contagious from the observed to the observer (one-to-one contagion). In the case of processing information based on OCRs, observers read several OCRs from different people and, consequently, encounter several emotions (contagion based on the combination of OCRs). In addition, it has been demonstrated that this combination of OCRs with different valence can trigger different customer experiences (Gottschalk and Mafael, 2017; Purnawirawan et al., 2015). These extant studies have found that online customer experience is shaped by the overall processed information and, thus, that all the processed emotions influence customer behavior. To date, however, no study has considered the impact of emotional contagion on the consumer based on several combinations of OCRs (not just one-to-one). In order to address this research gap, the present study investigates emotional contagion when several valence combinations of OCRs are read. In terms of positive, neutral or negative OCR valence, the observer could find a combination of OCRs mainly positive, mainly negative, neutral or a balanced combination.

Emotional contagion has been studied using common marketing research tools, leading to the conclusion that it evokes in the observer a similar emotional state to that experienced by the observed (Hatfield et al., 1994; Kramer et al., 2014). Recent marketing works have shown renewed interest in the study of emotions within the customer experience (Kranzbühler et al., 2020; Lemon and Verhoef, 2016) because many individual internal neurophysiological processes remain unknown or are inaccessible through traditional marketing methods (Boksem and Smidts, 2015; Verhulst et al., 2019, 2020). Neuroscience stands out as an interesting method for understanding emotional arousal, offering the possibility to study emotional contagion by measuring the activation of neural structures (e.g. brain waves' activity) and physiological responses (e.g. skin sweat reaction) (Lin et al., 2018).

Consumer neuroscience therefore provides the tools to monitor emotional arousal during information processing. Despite the clear research focus on OCR information processing in the marketing literature, it remains unclear as to whether reading different combinations of OCRs can trigger different emotions. Thus, following the assumption that a subjective emotional experience may influence people's emotional states (Hatfield et al., 1994), the purpose of our study is to monitor emotional arousal contagion after a subject has read different valence combinations of OCRs. To do this, we first conducted an exploratory analysis to deeply study the state-of-the-art of OCRs and to select the stimuli for the experiment; next, we analyzed and monitored the neurophysiological emotional arousal triggered by different stimuli combinations of OCR valence through a neuroscience experimental design.

2. Theoretical background

2.1. Emotional contagion

Emotions have been considered an important topic in marketing research (Bagozzi et al., 1999; Tombs and McColl-Kennedy, 2003), and recent research on customer experience in service settings has shown renewed interest in the topic (Chuah and Yu, 2021; Kranzbühler et al., 2020; Manthiou et al., 2020).

The study of emotions by social psychologists has provided evidence that both positive and negative emotions can be contagious, with similar physiological experiences being transmitted from the observed to the observer in each case (Schachter and Singer, 1962). Based on this approach, Russell (1980) described emotions as simple feelings of pleasure (positive–negative) and arousal (energized–enervated), grounded in the notion that emotional contagion converges in mental and bodily arousal (Schachter and Singer, 1962). Emotions have also been in focus in service research, because of their ability to influence other customers' emotions (Tombs and McColl-Kennedy, 2003). Tombs and McColl-Kennedy (2003) extended the servicescape model proposed by Bitner (1992) to include emotional contagion as an important element of the customer's social environment. This extended model from Tombs and McColl-Kennedy (2003) was aimed to explain behavioral responses based on theoretical developments of the theory of arousal (Mehrabian, 1996; Russell, 1980).

Among behavioral theories, social learning theory (Bandura, 1973) states that people typically learn new behavior by observing others' behavior and its consequences. Social exchange theory (Emerson, 1976) and word-of-mouth research (Engel et al., 1969) claim that customers consider other users' opinions when making purchasing decisions. With respect to the customer experience, the similarity-attraction paradigm states that when customers process information they also process emotions (Kidwell et al., 2020). This approach posits that when customers process information they interpret the emotions of the observed, which influences their behavior.

Emotional contagion refers to positive or negative emotional stimuli that can be reflected not only in facial, vocal, and postural expressions, but also in neurophysiological (body and mind reaction) and autonomic nervous system (ANS) responses (Hatfield et al., 1994). The important consequence of emotional contagion is attentional, emotional, and behavioral synchrony (Hatfield et al., 1994); the attention of the observer can go to the same focus as the observed; the observer can experience similar emotions as the observed; and he or she can imitate the behavior of the observed. Therefore, emotional contagion seems to be crucial for understanding emotional states.

2.2. Emotional arousal

The theory of arousal (Mehrabian, 1996; Russell, 1980) is undoubtedly at the center of emotional contagion research (Hatfield et al., 1994). This theory explains how emotional arousal can be activated or deactivated with positive or negative emotional valence, helping to explain different emotional appraisals. In the study of affect or emotions, Mehrabian (1996) theorized that in the pleasure–arousal–dominance emotional state model cognitive judgments of evaluations correspond to higher evaluations of stimuli, resulting in greater pleasure being induced by the stimuli.

Among theories of emotions, cognitive appraisal theory maintains that the subconscious evaluation of a stimulus determines emotions (Moors et al., 2013; Smith and Ellsworth, 1985). Cognitive appraisal theory has been used to explain how the observer can copy consumers' emotions during the decision-making process (Cai et al., 2018; Choi and Choi, 2019; Le et al., 2020). However, cognitive appraisal is based on how the individual interprets the emotional experience, while emotional contagion focuses directly on transferred emotions. Therefore, when classifying emotions according to the level of pleasure–displeasure valence and the degree of arousal, arousal theory helps to explain how these emotions are experienced (Russell, 1980).

In a similar vein, the affect–integration–motivation framework—which is grounded in valence and arousal—has been used to study individual behavior through neural data in the prefrontal cortex (PFC) (Genevsky et al., 2017). Extant research has confirmed that individuals, after affectively evaluating objects, integrate these evaluations and then translate them into motivation or avoidance behaviors. Also drawing on Russell's (1980) theory of arousal, Kranzbühler et al. (2020) described emotions as a change in the core affect, arguing that an emotional experience causes a change in the core affect or neurophysiological state (in terms of valence and arousal), resulting in an appraisal of these emotions.

3. Literature review and hypothesis development

3.1. Previous research on OCRs using traditional tools

OCRs' valence refers to "whether a review set (single review set or a set of several reviews) is predominantly positive or negative" (Purnawirawan et al., 2015, p. 19). Previous marketing research has highlighted the importance of understanding the effect of positive, negative, and neutral OCRs' valence on the decision-making process (Zablocki et al., 2019). Using traditional marketing methods, researchers have come to several conclusions regarding the valence of emotions in OCRs (e.g., Purnawirawan et al., 2015). Emotional states, both positive and negative, can be transferred via emotional contagion (Kramer et al., 2014). Dellarocas et al. (2007) theorized that positive OCRs encourage other consumers to adopt a product, whereas negative OCRs discourage them from doing so. While negative OCRs may lead to anxiety and higher levels of arousal (Fox et al., 2018; Wakefield and Wakefield, 2018), the observation of positive OCRs contributes to positive experiences for other people (Kramer et al., 2014). However, not all positive emotions have a similar positive effect on consumers (Septianto and Chiew, 2018). A recent study found that some discrete positive emotions can result in negative OCRs (Septianto et al., 2020). The results from these previous studies support the idea that, psychologically reading a negative review does not have to imply negative emotions (Septiano and Chiew, 2018; Septianto et al., 2020). This counterintuitive finding raises the concern of how the customer's subconscious processes information that contains a combination of OCR valences. Septianto and Chiew (2018) test the effect of the combination of different positive emotions on reviews' acceptance, but just positive emotions, not the combination of positive and negative. Later on, Septianto et al. (2020) highlight the need for furthering the research on emotions by stating that it might be the combination of positive and negative what influences consumer judgment process. Moreover, the usefulness of positive and negative OCRs is also related to their valence combination of exposure (Gottschalk and Mafael, 2017; Purnawirawan et al., 2015).

3.2. Previous research in emotions using neuroscience tools

Neuroscience research has shown that positive and negative emotions are found in the frontal regions of the brain (Davidson et al., 1990; Hamzei et al., 2016; Xu et al., 2020). Moreover, different emotions are accompanied by the same pattern of undifferentiated physiological arousal (Davidson et al., 1990). The mere observation of others' reported experiences can affect the experience of the observer (Kramer et al., 2014), even by simply imagining the emotions of the other person (Dixon et al., 2017). Therefore, based on the idea that emotional stimuli evoke conditioned emotional responses (Hatfield et al., 1994), our initial hypothesis is that emotions are contagious through the mere fact of reading OCRs (see the conceptual model illustrated in Fig. 1). In other words, if the observed valence combination of OCRs is mainly positive, the observer will experience a predominately similar positive emotional arousal. In contrast, if the observed valence combination of OCRs is mainly negative, the observer will experience an overall negative emotional arousal. The neutral valence combination can be assumed to entail neutral arousal. This initial hypothesis reveals the relevancy of monitoring emotional contagion in the case of a mixed valence combination.

3.3. Physiological correlations of emotions with arousal

Researchers have found that some emotions can be directly linked to a given state of arousal (Caruelle et al., 2019; Hatfield et al., 1994; Schachter and Singer, 1962). In service experience research, Bitner (1992) categorized internal responses as cognitive, emotional, or physiological, considering emotional arousal as mood and attitudes, and physiological arousal as the bodily activation representing emotional states (such as pain, comfort, etc.). As one of the main ANS physiological tools, skin conductance response (SCR) can measure physiological arousal to monitor emotional processes (Caruelle et al., 2019; Lajante and Ladhari, 2019; Verhulst et al., 2020). Early research found that ANS activation covaries with the intensity, rather than the valence, of emotions (Hatfield et al., 1994). Empirical evidence has supported the relationship between high SCR and anxiety, using physiological arousal as an index to monitor anxiety (Hatfield et al., 1994). According to Mehrabian (1996, p. 287), anxiety is associated with "worrying, complaints, and general preoccupation with negative affective states." Furthermore, a combination of high arousal and displeasure can be qualified as anxiety (Russell, 1980). SCR studies have associated negative OCRs with emotional arousal related to anxiety (Fox et al., 2018).

Based on the preceding argument, we consider that the ANS activity through the SCR can be used to monitor emotional arousal in order to study the emotional contagion triggered by OCRs. Therefore, we hypothesize that the observed emotional arousal will trigger a similar physiological emotional arousal in the observer.

H1. The emotions transmitted by several valence combinations of OCRs will trigger similar emotional arousal in the observer's physiological reaction.

Under the assumption that users read several OCRs during an online experience, emotional arousal is not triggered by each single review (one-to-one), but rather is the result of reading a combination of OCRs. To date there is no study aims to analyze emotional contagion when reading different combinations of OCR valence. Commonly, researchers have focused on analyzing emotional contagion only from positive or negative emotions. This study offers a different perspective by analyzing the emotions transmitted by combinations of OCRs with different valence. These combinations are categorized as mainly positive OCR valence, mainly negative OCR valence, balanced OCR valence (equal amount of positive and negative OCR valence) and neutral OCR valence (see Appendix A for further details). This research contributes to bridging a gap concerning the sequence of exposure containing a balanced valence combination, which is in fact a common online scenario.

3.4. Neural correlations of emotions

In marketing studies that have applied consumer neuroscience techniques, researchers have identified that brain activity predicts consumer behavior (Casado-Aranda et al., 2020). Along the same lines as in ANS activation, the level of arousal is linked to the activity in the frontal cortex (Dixon et al., 2017). Specifically, the brain regions in the frontal cortex can help to monitor emotions (Boksem and Smidts, 2015; Xu et al., 2020). Empirical evidence has shown that the left PFC region is activated more during emotion evaluation by positive stimuli than by negative stimuli, and that it is activated more by arousal than by neutral stimuli (Dolcos et al., 2004). More precisely, left frontal activation is directly linked to anger and motivation (Kranzbühler et al., 2020). The

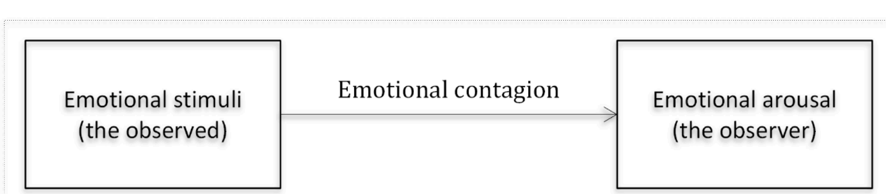

Fig. 1. Conceptual model.

PFC is involved in processing information and regulating emotions, though its role in the emotion appraisal process is a topic that has only recently attracted research interest (Dixon et al., 2017).

Neural measurements, such as EEG (electroencephalography) records, have gained considerable popularity in consumer neuroscience in recent years (Boksem and Smidts, 2015). EEG is a useful tool for increasing the internal validity when measuring consumers' real-time internal processes (Lin et al., 2018; Zhang et al., 2021). Theta waves in the frontal lobe (as measured by EEG) reflect activity related to mental concentration (Niedermeyer and Da Silva, 2005). Moreover, there is evidence that the level of theta waves in the frontal lobe increases when relieved from anxiety during attentive states (Mizuki et al., 1997). Furthermore, PFC activity can be used to monitor anxiety and relaxation (Dixon et al., 2017). Beta wave activity is related to the experience of pleasure, such as an experience with a favorite brand, while theta waves are related to displeasure (Lucchiari and Pravettoni, 2012). Moreover, studies on consumer emotional neural responses indicate that the experience of pleasure reflects happiness and satisfaction (Bettiga et al., 2020). In research on consumer neuroscience, Ramsøy et al. (2018) underlined the role of beta oscillations in decision-making. However, this relationship remains unexplored by information processing studies. In any case, brain signals seem to reflect a combination of valence and arousal.

Hence, theta wave activity can be used to monitor the level of arousal (activation/deactivation, or excitement/relaxation), while beta wave activity can be used to monitor the level of valence (pleasure/displeasure). This is helpful for uncovering implicit processes based on the theory of arousal. In other words, arousal activation (excitement) can have a positive or negative connotation; positive excitement, such as being happy and exuberant, means high pleasure and high arousal, while negative excitement, such as being annoyed and anxious, entails low pleasure and high arousal (Bettiga et al., 2020; Mehrabian, 1996). Therefore, adding the measurement of EEG brain signals to the measurement of SCR helps to refine the study and obtain more robust results. According to the preceding argument, we suggest that EEG signals can be used to monitor emotional arousal in order to study the emotional contagion triggered by OCRs. Therefore, we hypothesize that the observed emotional arousal triggers similar neural emotional arousal and valence in the observer.

H2. The emotions transmitted by several valence combinations of OCRs will trigger similar emotional arousal and valence in the neural activity of the observer.

Higher levels of theta signals, in particular, will be associated with arousal activation (and lower levels with arousal deactivation), and higher levels of beta signals will be associated with positive valence or pleasure (and lower levels with negative valence or displeasure).

4. Methods

4.1. Step 1: exploratory analysis of the state-of-the-art of OCRs

To explore more deeply the state-of-the-art of OCRs before designing the experiment, the first step was to carry out a focus group study to investigate how OCR valence is processed. In addition, this step facilitated definition of the experimental conditions that were used in the next step of this research: the consumer neuroscience experiment. The focus group consisted of nine participants, aged 20–63, four of whom were female. The participants were recruited by advertising the focus group in a large university in the Netherlands, and comprised students from different degree programs or staff from different faculties.

The aim of the focus group was to explore several issues that still need further research and were critical for the design of the experimental conditions in this research. These issues can be summarized as follows. The first concerns the number of OCRs that customers read when they are processing information prior to purchase. According to a Statista (2020b) report, 34% of customers read 4–6 reviews, 29% read 2–3, and 20% read 7–10 before they feel they can trust a business. Based on these findings, we wanted to check the average number of OCRs that users read in the pre-purchasing process. Second, we wanted to check whether users need to find a positive or a negative review before making their choice, as well as the order of OCR disposition (based on Purnawirawan et al., 2015). Third, we wanted to ensure that everyone perceives the same direction of OCR valence chosen for the experimental conditions, which were previously filtered by Amazon and TripAdvisor.

The focus group data analysis sheds light on the above-mentioned critical issues in three respects. First, when users were browsing OCRs (which were often product-dependent and context-dependent), they read at least five reviews before making up their minds. Second, depending on the OCRs' valence, users felt the need to read more or fewer reviews. If the exposed OCRs' valence was only positive or only negative, users decided to look for OCRs with the opposite valence than that displayed. Third, participants agreed that the optimal scenario consisted of a balance of both positive and negative OCRs, which were considered the most useful and most important for them. If such a balance was missing, they were inclined to mistrust the credibility of the information. Moreover, the participants were asked to highlight the words or expressions of the reviews that triggered positive or negative associations. Based on this, OCRs that contained both negative and positive words were not included in the examples we used in the experimental conditions. Appendix A outlines the OCRs selected by the focus group.

4.2. Step 2: neuroscience experiment

4.2.1. Experimental design and procedures

The neuroscience study was designed as an experiment with one manipulation: OCR valence. Four combinations of experimental conditions were designed: mainly negative OCR valence, mainly positive OCR valence, balanced OCR valence, and neutral OCR valence. Table 1 illustrates the experimental design. The order of exposure to the experimental conditions was fixed and the order of the reviews' valence exposure within each experimental condition was controlled by rotation (see Appendix A for detailed information). In each experimental condition, the participants read several original reviews extracted from Amazon (for a computer and for sneakers) and TripAdvisor (for a hotel and for a paella restaurant). The selection of products was based on the findings of a recent neuroscience study indicating that consumers' emotional responses can depend on the hedonic or utilitarian nature of the product (Bettiga et al., 2020). Utilitarian products are those related to function and practicality, while hedonic products are associated with affective fulfillment (Woods, 1960). In our experiment, we selected these four products to ensure the inclusion of both utilitarian (computer and sneakers) and hedonic (hotel and restaurant) products.

At the beginning of the experiment, the participants were asked to read the OCRs of each of the four experimental conditions. Between each experimental condition, they had to self-report their level of anxiety arousal. This short survey conducted after each experimental condition consisted of the three items that constitute the anxiety scale of Wakefield and Wakefield (2018) (adapted to: "How anxious did you feel while reading these OCRs?", "How worried did you feel while reading these OCRs?" and "How nervous did you feel while reading these OCRs? "). The Cronbach's alpha value (0.841) confirmed the reliability of the scale. The analysis of variance (ANOVA) indicated the existence of significant differences in the self-reported degrees of anxiety arousal across the different stimuli ($F = 6.717$, $p = 0.000$). Moreover, to test the main effects of the manipulated stimuli, the participants were asked to what degree reviewers had positively evaluated the products, indicating their responses on a seven-point Likert scale ($F = 178.211$, $p = 0.000$; mean of mainly negative OCRs: 1.87; mean of balanced OCRs: 4.23; mean of neutral OCRs: 4.39; mean of mainly positive OCRs: 5.81).

At the end of the experiment, the participants had to answer a final

Table 1
Experimental design.

EEG + SCR recordings	Experimental condition (EC)	Computer	Sneakers	Hotel	Restaurant
	EC1. Mainly negative OCR valence	4 negative & 1 positive OCR	4 negative & 1 positive OCR	4 negative & 1 positive OCR	4 negative & 1 positive OCR
	Self-reported anxiety arousal scale for EC1				
	EC2. Balanced OCR valence	3 negative & 3 positive OCRs	3 negative & 3 positive OCRs	3 negative & 3 positive OCRs	3 negative & 3 positive OCRs
	Self-reported anxiety arousal scale for EC2				
	EC3. Neutral OCR valence	4 neutral OCRs	4 neutral OCRs	4 neutral OCRs	4 neutral OCRs
	Self-reported anxiety arousal scale for EC3				
	EC4. Mainly positive OCR valence	4 positive & 1 negative OCR	4 positive & 1 negative OCR	4 positive & 1 negative OCR	4 positive & 1 negative OCR
	Self-reported anxiety arousal scale for EC4				
	Final short survey				

short survey indicating their level of previous involvement with the products (mean [standard deviation] for each product: computer: 4.13 [1.52]; sneakers: 4.13 [1.36]; hotel: 4.61 [1.52]; and restaurant: 4.61 [1.49]) and whether they were currently thinking about buying a computer (2.03 [1.42]) or sneakers (3.39 [1.58]), or booking a hotel (3.39 [2.02]) or restaurant (3.81 [1.66]). All of the survey items were answered on a seven-point Likert scale.

4.2.2. Subjects

In total, 40 people were recruited to participate in the experiment; however, due to technical failures and other unexpected events, the final sample consisted of 31 subjects (age mean: 20.39; standard deviation: 2.74; 80% female), in line with other consumer neuroscience studies (samples of 20–30 participants in neuroscience research studies are considered acceptable, i.e. Boksem and Smidts, 2015; Casado-Aranda et al., 2018; Casado-Aranda et al., 2019; Lin et al., 2018; Verhulst et al., 2020; Zhang et al., 2021). Informed consent was obtained from all participants when they registered to be part of the experiment, which had been approved by the Ethics Committee of the university.

4.2.3. Data collection

Neurophysiological tools are broadly used in emotion research and are commonly used in combination (Davidson et al., 1990; Verhulst et al., 2019, 2020). This combination of tools addresses the limitations of self-reported data by increasing the predictive validity and offering robust results.

The SCR and EEG results were recorded simultaneously under the four experimental conditions, accurately synchronized with the biometric research synchronization platform iMotions. The SCR signals were recorded using a Bluetooth Shimmer3 device with two sensors placed via Velcro straps on the index and middle fingers of the left hand. The EEG signals were recorded using 29 electrodes following the International 10–20 System. Vertical electrooculogram (vEOC) results were recorded using electrodes on the supraorbital and infraorbital regions of the left eye, placed in line with the pupil to measure vertical eye movements and blinks. Moreover, two electrodes were placed on each mastoid bone to operate as a reference (baseline), and one electrode was placed in the center of the forehead as a ground.

Due to the association of the frontal region with the regulation of emotions and neurophysiological arousal (Davidson et al., 1990; Dixon et al., 2017), this research analyzed the EEG signals of beta and theta waves in this region of the brain. Moreover, in psychophysiological research on emotions, several authors have highlighted the relationship between behavior and activity in the left hemisphere (Davidson et al., 1990). Therefore, as suggested by other researchers, the electrodes (F3 and F7) in the left hemisphere were averaged, with a focus on the frontal region (Zhang et al., 2021). As suggested by Davidson et al. (1990), the data were log-transformed to normalize their distribution because the power values were positively skewed.

4.2.4. Data preprocessing

Before conducting the analyses, the data were preprocessed with MATLAB. The EEG signals between 1 and 30 Hz (Hz) were filtered into the following frequency bands: theta (4–7 Hz) and beta (16–20 Hz). After this, the data were preprocessed with a pipeline of algorithms (ASR, ICA, and MARA). The first step of the data preprocessing was to remove the artifacts using stringent criteria (Hamzei et al., 2016). Finally, the spectral power density of each neural band was calculated to obtain the mean power of each band. Regarding the SCR, the data were preprocessed to work with the average amplitude of the SCR in each experimental condition, with records less than 0.5 μS being discarded.

5. Results

Our first step was to uncover any differences in the results of the physiological SCR according to the four product categories and the four experimental conditions. The statistical software IBM SPSS version 23 was used to examine the preprocessed data. We performed ANOVA, which indicated significant differences ($F = 8.465$, $p = 0.000$). This result is supported by the *post hoc* analysis (Scheffe test), which showed differences between the experimental conditions EC1–EC3 and EC1–EC4 (p-values < 0.05). The effect size was calculated using the partial eta squared, based on Cohen's (1992) interpretation; it showed a large effect ($\eta^2_p = 0.199$) that surpassed the threshold of ≥ 0.14. Detailed findings from the four product categories and the four experimental conditions can be found in Table 2.

These findings suggest that physiological arousal is activated when users experience mainly negative OCRs. The negativity expressed in the OCRs is transferred to the observer. In the opposite direction, neutral OCR valence is reflected in the deactivation of arousal—that is, in low arousal or low bodily reaction. In terms of the medium ANS reactions, balanced OCR valence and positive OCR valence call for further analysis. According to the theory of arousal, arousal activation/deactivation (excitement/relaxation) should be considered in relation to positive/negative valence (pleasure/displeasure). In other words, it is necessary to monitor whether the level of arousal is due to positive excitement, such as being happy and exuberant (high pleasure, high arousal), or due to negative excitement, such as being annoyed and anxious (low pleasure, high arousal) (Mehrabian, 1996). Hence, neural analyses were conducted next in order to reach a better understanding of the arousal and valence dimensions.

The EEG analyses were performed alongside the ANOVA of the beta and theta oscillations in the left frontal region of the brain. The brain signals suggested the same pattern of emotional arousal activation as the SCR (beta: $F = 2.377$, $p = 0.074$; theta: $F = 4.074$, $p = 0.009$). As in the SCR analyses, these results were supported by the post-hoc analysis (Scheffe test), showing differences between the experimental conditions EC1–EC3 and EC1–EC4 (p-values for beta <0.10; p-values for theta ≤ 0.05). The strength of the effect sizes was moderated (≥ 0.06) for both types of brain signals (beta oscillations: $\eta^2_p = 0.060$; theta oscillations: $\eta^2_p = 0.098$) (Cohen, 1992). Detailed findings from the four product

Table 2
Means of SCR basal measures.

Experimental condition →	Mainly negative OCRs (EC1)	Balanced OCRs (EC2)	Neutral OCRs (EC3)	Mainly positive OCRs (EC4)	F	Sig.
Computer	0.1100853	0.1025299	−0.067876	0.0310713	2.263	0.087*
Sneakers	0.1961809	−0.026391	−0.647195	−0.0525520	5.039	0.003***
Hotel	0.0337200	−0.071178	−0.113409	−0.1083431	1.873	0.141
Restaurant	0.0916221	0.050069	−0.101754	−0.0939835	2.221	0.092*

Note: Significant p-values: * 0.10, **0.05, ***0.01.

categories and the four experimental conditions can be found in Table 3.

The beta oscillation findings indicate that negative OCR valence (EC1) and balanced OCR valence (EC2) are the most pleasurable combinations. According to the level of theta activation, emotional arousal is highly activated under these two conditions (EC1 and EC2), which indicates a relief from anxiety. By contrast, neutral OCR valence (EC3) and positive OCR valence (EC4) suggest not only displeasure (low beta oscillations) but also anxiety (low theta oscillations).

6. Discussion and conclusions

In this study, we assumed that emotions are not one-to-one contagious; rather, it is the combination of emotions that causes an overall reaction in the user. According to the focus group discussion and the physiological and neural findings, the valence combination of OCRs read by the observer matters. The outcomes of the focus group indicate that around five or six OCRs on average need to be read before a person makes up their mind. The discussion in the focus group aligns with findings of previous literature (Purnawirawan et al., 2015), confirming that OCRs should contain a combination of valence. This suggests that users do not look only for positive reviews to reinforce their decision; rather, they seek a combination of positive and negative OCRs that enable them to make a decision based on full information from both points of view. In addition, the findings from the physiological and neural responses indicate that the most pleasurable OCR combinations are the balanced combination and the combination containing mainly negative OCRs. This counterintuitive finding aligns with the idea that emotions are not one-to-one contagious, but are generated as a combination of exposure (Gottschalk and Mafael, 2017; Septianto et al., 2020). This finding seems to contradict research focused on direct emotional contagion and studying the one-emotion-one-reaction case (e.g., Kramer et al., 2014). However, similar findings are supported on the basis that users are always exposed to a combination of emotions (Septiano et al., 2020). Consequently, the exposure of a certain OCR combination triggers a specific emotional contagion reaction in the observer, which does not necessarily have the same valence sign as the overall valence.

Our findings are consistent with the assumption that emotional arousal can be contagious (hypothesis 1), but the valence of this arousal does not contain the overall sign of the combination (hypothesis 2). In other words, these results are in line with those of previous research that used the SCR as a measure of physiological arousal (Hatfield et al., 1994). Nevertheless, according to the theory of arousal, it is also necessary to monitor the valence of this arousal in terms of pleasure and displeasure (Mehrabian, 1996; Russell, 1980) so as to obtain a deeper understanding of emotional contagion. In relation to this concern, some researchers have highlighted that ANS activation covaries with the intensity, rather than the valence, of emotions (Hatfield et al., 1994). SCR enables the physiological emotional arousal to be measured, and EEG enables emotional arousal and valence to be measured. The combination of both techniques provides robustness to the results.

The neural analyses conducted allow us to understand the appraisal of the emotions shared through OCRs by the observer. When analyzing the effect of the combination of arousal (excitement/relaxation) and valence (pleasure/displeasure) on the observer through brain signals, the results uncover deeper insights into the arousal approach. We find support for the idea that the arousal of the observed can be contagious to the observer, and that this is reflected in physiological and neural emotional arousal. Furthermore, the valence of the arousal (positive/negative or pleasure/displeasure) indicates that this excitement is positive. A combination of mainly negative OCRs is associated with a higher level of arousal, but, contrary to expectations, this arousal is positive. This means that the combination of negative OCRs awakens pleasurable arousal in the observer. Similarly, a combination of balanced OCRs is associated with pleasure and medium–high arousal. By contrast, a combination of mainly positive OCRs is associated with displeasure and low–medium arousal. Finally, the apathy of neutral reviews is also transferred to the observer, causing arousal deactivation and displeasure. Thus, negative OCRs, a domination of negative valence, or a balanced valence combination need to be present to fulfill users' expectations. A combination of mainly positive OCRs provokes displeasure and low–medium arousal, perhaps as the result of the user failing to find the information they are looking for in the form of a discussion or a variety of critical points of view. Neutral OCRs do not have any impact on the observer. These findings are partially consistent with the focus group discussion, in which participants agreed that the optimal (i.e., the most useful and important) scenario is to read a balance of both positive and negative OCRs. Considering all the quantitative and neuroscience measures in combination, the results of our study confirm that users need to see a clear tendency toward critical thinking in OCRs to make their decisions.

7. Theoretical and practical implications

Several authors have highlighted the need to refine existing theories on emotions to uncover implicit processes through neuroscience measures (Plassmann et al., 2015; Verhulst et al., 2019). Our study

Table 3
Means of EEG beta and theta signals basal measures.

Brain signal	Experimental condition →	Mainly negative OCRs (EC1)	Balanced OCRs (EC2)	Neutral OCRs (EC3)	Mainly positive OCRs (EC4)	F	Sig.
Beta	Computer	0.205607 (0.38992)	0.085479 (0.29961)	−0.054193 (0.410842)	−0.005606 (0.334839)	2.622	0.054*
	Sneakers	0.112675 (0.31629)	−0.01698 (0.25438)	−0.097182 (0.421853)	−0.016372 (0.510853)	1.209	0.310
	Hotel	0.118230 (0.33390)	0.007893 (0.36113)	−0.158995 (0.380179)	−0.009605 (0.479548)	2.270	0.084*
	Restaurant	0.035257 (0.24254)	0.105555 (0.34808)	−0.116689 (0.380393)	−0.004361 (0.382515)	2.139	0.099*
Theta	Computer	0.112512 (0.23525)	0.070834 (0.28761)	−0.049978 (0.236229)	−0.090235 (0.257708)	3.862	0.011**
	Sneakers	0.112504 (0.19494)	0.059738 (0.29371)	−0.079885 (0.265110)	−0.089981 (0.304733)	3.378	0.013**
	Hotel	0.129704 (0.22862)	0.066419 (0 31240)	−0.084571 (0.251836)	−0.042211 (0.293746)	3.342	0.019**
	Restaurant	0.134147 (0.24272)	0.028800 (0.25687)	−0.068209 (0.226907)	−0.056348 (0.289214)	3.443	0.019**

Note: Significant p-values: * 0.10, **0.05, ***0.01.

contributes to advancing the theory of emotions by shedding light on the implicit processes of human behavior that are inaccessible when using conventional marketing methods. In particular, the combination of physiological and neural measures permits researchers to apply the theory of arousal to study emotional contagion in depth. In other words, the arousal and valence dimensions can be monitored in unison to identify the underlying mechanisms related to OCR information processing.

With regard to its practical implications, this study expands the horizons for marketers. First, it supports the use of neuroscience in consumer research, encouraging both marketers and researchers to use a combination of conventional and neuroscience techniques for more accurate and comprehensive results. Second, it helps practitioners to understand how emotions can be contagious merely through reading OCRs and being exposed to the experiences of others. Third, one of the most important business implications of this study is that it highlights the importance of exposing readers to a combination of OCR valence.

In line with this, it is clear that the readers' perfect scenario for decision-making is that in which they are able to access both positive and negative OCRs. Online marketing practitioners using customer reviews as components of their online presence should design their websites in a way that provides users with a first impression of a balanced valence combination of around six OCRs.

Contrary to the business practice of showing mainly positive experiences, this research suggests that the existence of only positive OCRs drives users to deactivate their arousal. The insights of this research indicate that negative OCRs awaken users' arousal to a greater extent than positive OCRs do. In line with the focus group results, the neuroscience findings highlight that a balanced combination of positive and negative OCRs can be considered an optimal scenario, with observers finding the information more useful and credible. These findings emphasize that knowing how to interpret different OCRs' valence combinations can be key to marketers improving OCRs' exposure on their website in order to trigger certain emotions.

8. Limitations and avenues for future research

This study is not without limitations. A recent neural study revealed that variations in information processing are also associated with internal factors of consumers' profiles (Guerrero Medina et al., 2021). Thus, future lines of research should consider the personalities of participants as a moderating variable. Similarly, people's susceptibility or vulnerability to contagion should also be taken into account (Hatfield et al., 1994).

Moreover, consumer neuroscience studies must face the challenge of "reverse inference" (see Casado-Aranda et al., 2019; Plassmann et al., 2015; Poldrack, 2006). Reverse inference refers to the idea that the activation of a certain part of the brain can affect many cognitive functions, and that it is not an exclusively mental process. A proposed solution to address the problem of reverse inference is to implement a theory-driven experimental design (Plassmann et al., 2015). For this reason, our study is strongly linked to the theory of arousal also commonly used in consumer behavior studies. Nevertheless, for a general discussion, further research on consumer neuroscience and psychological process is required. As suggested by Poldrack (2006), future research would particularly benefit from combining neuroscience with behavioral data.

Finally, some consumers can see the existence of positive reviews with skepticism (Sher and Lee, 2009). This study has not considered consumer skepticism towards positive reviews. Experimental condition 4, containing mainly positive OCR valence, includes one negative review to overcome this limitation. However, it would be interesting to analyze consumer skepticism to OCRs in future lines of research.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jretconser.2022.102973.

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