

The Impact of Social Crowding on Consumers' Online Mobile Shopping: Evidence from Behavior and ERPs

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Danfeng Cai^{1,2,*}
Lian Zhu^{3,*}
Wuke Zhang^{2,4}
Hao Ding^{2,4}
Ailian Wang⁵
Yao Lu¹
Jia Jin⁵

¹College of Science & Technology, Ningbo University, Ningbo, People's Republic of China; ²Academy of Neuroeconomics and Neuromanagement at Ningbo University, Ningbo, People's Republic of China; ³School of Journalism and Communication, Shanghai International Studies University, Shanghai, People's Republic of China; ⁴Business School, Ningbo University, Ningbo, People's Republic of China; ⁵Laboratory of Applied Brain and Cognitive Sciences, School of Business and Management, Shanghai International Studies University, Shanghai, People's Republic of China

*These authors contributed equally to this work

Purpose: Social crowding refers to the extent of social presence and proximity to others. A large number of studies have explored the effect of social crowding on consumers' feelings and behaviours in real shopping scenes, whereas few studies have examined the potential marketing effect of social crowding on online mobile consumption behaviour despite mobile commerce's increasing popularity in recent years. The current intends to explore the effect of social crowding on online mobile purchase and its underlying neural basis.

Methods: The current study employed a questionnaire survey and an implicit panic buying experiment, in which the participants were asked to press the button as soon as possible to buy the showed product. A 2-level social crowding (low vs high) × 2-level feedback of panic buying (success vs fail) design was employed to test the negative impact of social crowding on consumers' online mobile purchase intention by using electroencephalogram (EEG) recordings.

Results: Behaviorally, participants showed higher purchase intention in low social crowding environment compared with the high crowding condition. The event-related potentials (ERPs) results indicated that consumers had a higher affective/motivational evaluation (reflected in a smaller feedback-related negativity (FRN) amplitude) regarding the successful rather than the failing feedback in the low social crowding condition. However, this difference was not detected in the high social crowding condition. Meanwhile, more attentional resources (reflected in a greater P300 amplitude) were directed toward processing the feedback outcomes in the low rather than the high social crowding condition.

Conclusion: The current study provided neurophysiological response that social crowding negatively influences consumers' online purchase intention. Some implications for theory and practice were also discussed.

Keywords: social crowding, online purchase intention, ERP, FRN, P300

Introduction

In recent years, with the development of mobile electronic commerce, consumers can shop online through their mobile phones in various daily scenes (eg, subway cars, restaurants, and offices), which is one of the main differences between mobile shopping and traditional online shopping.

Based on the offline shopping environment, many studies have consistently found that the crowding environment has a significant influence on consumers' satisfaction,¹ product evaluation,² brand preference,³ shopping duration,⁴ and even

Correspondence: Jia Jin
Email jinjia.l63@163.com

purchase intention.² This is because environmental crowdedness can have various consequences on consumers' feelings, and further influence consumers' evaluations about products or services, resulting in the influencing of behaviors.⁴⁻⁶ For example, highly crowded waiting areas in restaurants will trigger customers' loss of control over their environment, causing perceived intrusions into their personal space, and ultimately negatively influence consumers' service satisfaction.⁷ Therefore, we suspected that the consumers' feelings caused by the environmental crowdedness might also influence consumers' evaluations about products or services in online mobile shopping and further influence the mobile purchase behaviors.

However, there is still a lack of evidence on whether and how the environment's crowdedness will influence consumers' online mobile shopping. In order to fill this research gap, the current study intends to investigate consumers' emotion and cognition during the evaluation of the same product under the high vs low crowd environment in mobile shopping as an exploratory study. More specifically, we intend to conduct a consumer neuroscience lab experiment to implicitly measure the variance in consumers' emotion and cognition across different crowding levels.

Consumer neuroscience was defined as applying neuroscientific tools and theories to better understand decision-making and processes in marketing-related behaviors.⁸ Some studies⁹⁻¹² have also introduced the idea of drawing upon neuroscience tools and theories in studying online consumer behavior. There are several advantages in studying how social crowding influences consumers' online mobile shopping in the consumer neuroscience domain. First, it can help to uncover the neural bases of cognitive, emotional,⁸ which offer new insights into the complex interplay between consumers and crowd environment. Second, it can measure the neural correlates of marketing constructs or capture hidden mental processes among consumers to provide a window into the consumers' implicit motivations and serve as a complement to or explanation of self-reported results.¹³⁻¹⁵ That is, brain responses could be eventually translated into more indexes, which would help marketing professionals better understand the motives underlying consumer behaviors.

To the best of our knowledge, the current exploratory study is the first to preliminarily identify how social crowding influence mobile shopping from the insight of consumer neuroscience and contributes to the research on

social crowding marketing effects and mobile shopping. Furthermore, the results can also help marketing practitioners to develop marketing strategy on product recommendations or personalized service with the help of mobile location technology.

Literature Review

Social Crowding and Consumer Behavior

Social crowding refers to the extent of social presence and proximity to others in consumption contexts.¹⁶ Previous studies have suggested that consumers' emotion and behavior can be influenced by social crowding in offline shopping. For instance, it was reported that a crowded environment might induce consumers' negative emotions easily.⁵ Consumers are more likely to feel nervous and confused in a crowded environment, compared to pleasurable and relaxing feelings in a less crowded environment.¹⁷ Meanwhile, these negative feelings/emotions will further negatively influence consumers' evaluations about products, services, and shops.^{4,6} Furthermore, social crowding can also induce consumers' stress¹⁸ and feelings of a lack of control,¹⁹ and moreover, it results in avoidance behavior,⁶ such as a lower willingness to pay for products they encounter.² For example, a previous study found that consumers' inferences of an anthropomorphized brand's intentionality to interact with them in a socially crowded context triggered greater social withdrawal, resulting in lower preferences for the brand.³

In contrast, some studies also found social crowding can promote the reputation of experiential consumption and compensatory consumption. Although previous studies have found that perceived space congestion can bring negative emotions, perceived crowd congestion can bring positive emotions.²⁰ It is easy to induce consumers' belief that "what is popular is good" in a crowded environment. Therefore, in an experiential consumption scenario, crowding becomes an inferential clue. The more crowded it is, the better the reputation of the consumption scenario will be. For example, Tse et al found that perceived crowding was positively correlated with restaurant reputation.²¹ Consumers judge the quality of restaurant food by the degree of crowding. The more crowded the restaurant is, the higher the consumers' evaluation is. Similarly, in the bar scene, the crowded environment will enhance consumers' excitement and arousal, and then make consumers produce more positive evaluation.²² Furthermore, previous studies have shown that social

crowding can enhance the relationship between consumers and brands, that is, brand attachment, and promote the interaction between consumers and online people, and improve the willingness of word-of-mouth sharing. The common mechanism comes from consumers' compensatory psychology.^{5,23} Some researchers believe that the crowded environment makes the interpersonal interaction of consumers frustrated, the connection with society destroyed, and the sense of belonging lost.²⁴ At this time, consumers tend to search for other individuals around to establish a relationship again, so as to make up for the lack of sense of belonging.

In recent years, with mobile commerce development, studies also started to focus on how the environment crowding influences online mobile shopping. For example, it was reported that in the mobile consumption mode, the crowded environment could promote the interaction between consumers and online people, and improve the willingness of word-of-mouth sharing.²³ Because the crowded environment will lead to the lack of consumer control, to make up for the sense of control, consumers tend to choose to interact with online people and make positive behavior of sharing more online word-of-mouth. However, due to the popularity of mobile e-commerce only started in recent years, the related research is in its infancy. How social crowding induces consumers' various temporary effects and emotions and further significantly influences consumers' online mobile purchase intention and behaviors, as well as its underlying mechanism, still lacks empirical exploration. To address this issue, the current study employs an implicit experimental design by the method of electroencephalogram (EEG) recordings to explore the effect of social crowding on online mobile purchase intention and its underlying neural basis.

Affective, Motivation and ERPs

Event-related brain potentials (ERPs), which have a high temporal resolution, have been proven to be a valuable technique to illuminate peoples' cognitive processes underlying emotions, attitudes, and motivations.^{14,25–28} In particular, a considerable number of studies have employed ERPs to detect consumers' brain responses to understand consumers' attitudes toward brands and products better.^{29–32} Brain responses can be detected and measured by neuroscience tools like EEG, can be eventually translated into more indexes, and help scholars better understand the feelings, thoughts, and motives underlying consumer behaviors.^{8,30,33,34} There are two

commonly examined ERP components, feedback-related negativity (FRN) and P300, which can be translated into affective and motivation of the product evaluation in the feedback stage.

FRN is a negative deflection ERP component over front-to-central regions and reaches maximum amplitude between 200 and 300 ms following the outcome presentation.³⁵ Converging evidence has suggested that the amplitude of FRN is negatively related to affect, motivation, and subjective evaluation at the feedback stage.³⁶ For example, a prominent differentiated FRN (d-FRN) toward the divergence of the loss-gain feedback was observed and was suggested to reflect the subjective motivational and affective evaluation of the revealed outcome in a previous study.³⁷ Meanwhile, this negative relationship between FRN amplitude and subjects' affective/motivational evaluation of outcomes has also been found by other studies.^{38–40}

P300 is another typical ERP component that often appears in the outcome feedback stage together with FRN.³⁸ It is a positive ERP component peaking approximately 200–600 ms after the onset of feedback.⁴¹ It has been reported that P300 amplitude is positively related to the attentional resources that allocated.^{42,43} In the outcome evaluation stage, P300 is reported to reflect the attentional allocation. For example, in Qiang Shen 2021's work, the P300 difference was found for valence and stage effect.⁴⁴ The author explained the valence effect as the positive outcome will induce a larger attention resource. While they explain the stage effect participants' motivation will be reduced gradually as the time elapses during the task proceeded, resulting in decreased attention resource toward the outcome feedback. These two effects of P300 were also found in a large number of studies.^{41,45,46}

Hypothesis Development

Just as mentioned, previous studies about social crowding in offline shopping were found both positive and negative effects on consumers and behaviors. According to S-O-R theory, the environment will influence consumers' feelings and emotion.^{47,48} Regardless of offline and online behavior, the crowded environment is the same for consumers. Therefore, we supposed that consumers would experience the same feelings as offline shopping environment. According to previous studies, the positive effect of social crowding is mainly on experiential consumption and compensatory consumption,^{5,20,49} which is unrelated to the content of the current study. Thus, we supposed that

a crowded environment would also induce negative feelings/emotions in online consumption, resulting in avoidance behavior. Thus, the first hypothesis of the current study is proposed.

H1: Social crowding has a negative impact on consumers' online mobile purchase intention.

Except for the questionnaire survey, the current study also employs ERPs to investigate consumers' product evaluations under high and low social crowding environments with an implicit panic buying experiment. Specifically, the current study aims to explore consumers' purchase intention by detecting their brain responses to successful or failing panic buying feedback under different social crowding conditions. As we stated in the literature review part, two classical ERP components named the FRN and P300 can be translated into the stimuli evaluation index at the feedback stage, since they are sensitive to affect, motivation, and outcome evaluation at the feedback stage.³⁸

As we stated in the literature review part, FRN can reflect subjective motivational and affective evaluation about the feedback according to the reinforcement learning theory. The larger deviation between success and failure outcome can reflect participants' higher motivational and affective evaluation toward the outcome.^{37,45} In the current study, we have inferred that social crowding has a negative impact on consumers' online purchase intention (H1). Following this assumption, people maybe have a higher purchase intention and thus should have a higher expectation of seeing successful rather than failing feedback in the low social crowding condition of the panic buying experiment, which can also be reflected in the large deflection of FRN amplitude across success and failure outcome. On the other hand, according to hypothesis 1, people's avoidance behaviors will be induced, and their purchase intention will be restrained in the high social crowding condition of the panic buying experiment. The deviation of consumers' subjective motivational and affective evaluation about the successful and failing feedback may be smaller, reflecting in the smaller deflection of FRN amplitude across failing and successful panic buying outcomes. Therefore, a greater differentiated FRN toward the divergence of the failing-successful feedback (named as d-FRN) will also be observed in the low social crowding condition than in the high one.

Therefore, the following hypotheses are proposed.

H2: Participants' motivational and affective evaluation about the panic buying feedback will be larger in the low social crowding condition than that of the high crowding condition, reflected in greater FRN deflection for failing and successful outcomes.

Furthermore, for the P300 component, as we stated in the literature review part, it can reflect the attentional resources during the stimulus evaluation process.^{50,51} Both the valence of a reward or an outcome^{41,52,53} and motivational affective⁵⁴ can induce high attentional resources. For the current study, because successful panic buying outcomes are more positive than failing ones, we infer that a greater P300 amplitude will be induced in the successful condition rather than the failing one. Meanwhile, compared with the high social crowding condition, people should have a relatively considerable purchase intention and should have a greater motivation to see the panic buying results in the panic buying experiment's low social crowding condition. In this behavioral pattern, people may also devote more attentional resources to processing the feedback outcomes in the low but not the high social crowding condition, which can be reflected by a greater P300 amplitude.

H3a: Participants will pay more attentional resources to outcome of the low social crowding condition rather in the high one

H3b: Participants will pay more attentional resources to the successful panic buying outcomes rather than the failing ones, reflected in the greater P300 amplitude.

Study I

In this study, 101 (46 males) respondents from Ningbo University were recruited and were randomly assigned into high or low social crowding conditions, resulting in 53 participants in the low social crowding condition and 48 participants in the high social crowding condition. Their age ranged from 18 to 25, with mean age of 20.80, S.D.=1.06.

For each participant, they were induced to feel crowded by displaying pictures (as shown in Figure 2A) and then reported their purchase intention. This manipulation method for social crowding level was consistent with a former study on social crowding.² Purchase intention was measured from 3 items by 1–7 scale ($\alpha = 0.939$), such as “your probability of buying the product”, “your intention to buy the product”, and “your willingness to buy the product”. The independent

Table 1 The Behavioral Results of Independent *t*-test for Purchase Intention of High and Low Social Crowding Conditions

<i>t</i>	<i>df</i>	Sig.	Mean (S.D.)		95% Confidence Interval of the Difference	
			Low Social Crowding	High Social Crowding	Lower	Upper
3.438	99	0.001	4.415 (1.596)	3.403 (1.335)	0.428	1.597

t-test was conducted for the purchase intention under the high and low social crowding conditions.

As shown in Figure 1 and Table 1, there is a significant difference [$t(99) = 3.438, p = 0.001$]. The purchase intention under the low social crowding condition ($M = 4.415, S.D. = 1.596$) is larger than that of the high social crowding condition ($M = 3.403, S.D. = 1.335$). These results provide preliminary support for the main hypothesis that social crowding negatively influences consumers' online purchase intention from the behavioral level. Based on these results, the following formal EEG experiment was then conducted.

Study 2

Methods

Participants

Twenty-four (12 females, 20.58 ± 1.56) native Chinese students, who have shopping experience on mobile were randomly recruited from Ningbo University as participants, with a mean age of 20.96 ± 1.68 , ranging from 18 to 24 years. All participants were undergraduates or graduate students and had normal or corrected-to-normal visual acuity. They self-reported right-handed and had no history

of neurological disorders or mental diseases. The study was approved by the Internal Review Board of the Academy of Neuroeconomics and Neuromanagement in Ningbo University and in accordance with the Declaration of Helsinki⁵⁵ and reference number ANN202001. Written informed consent was provided by each participant before the experiment.

To determine how many participants needed, we checked via a power analysis, G*Power 3.⁵⁶ Given an effect size of 0.40 (a large effect size), a power of 0.80, and an alpha level of 0.05, the result of power analysis estimation was a sample size of 22. Thus, we stopped the study when the number of participants was 24.

Materials

The current experiment employed a modified priming-probe paradigm, in which we added a feedback stage after the participants give their response. In this experiment, the participants were asked to press the button as quickly as possible to buy the shown product successfully; we named it as a panic buying task. Actually, the result of success or failure was given randomly by the computer. We intend to measure participants' different brain responses to the result of panic buying and regarded it as an index of product evaluation.

The first priming stage comprises 2-level social crowding (low vs high), the probe stage is the potential product, and the feedback stage includes 2-level feedback to panic buying (success vs fail). All stimuli were presented as in mobile Taobao interface, with 270×360 pixels. It resulted in four conditions: high social crowding with successful panic buying, high social crowding with failed panic buying, low social crowding with successful panic buying, and low social crowding with failed panic buying.

The social crowding level was induced by picture in the priming stage as shown in Figure 2A. A questionnaire was used to check the social crowding picture's modulation. The participants were asked to answer seven questions about their feeling regarding the two kinds of pictures using a 7-point Likert scale. The scale was modified from Machleit et al

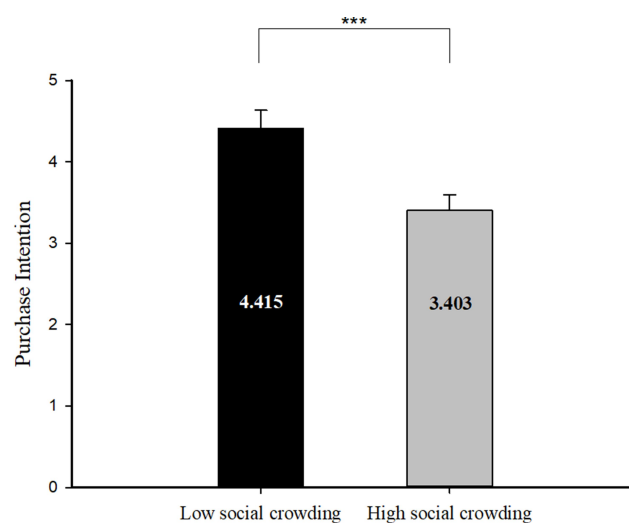


Figure 1 Questionnaire results of purchase intention: the purchase intention of under high and low social crowding. $p < 0.001$ ***.

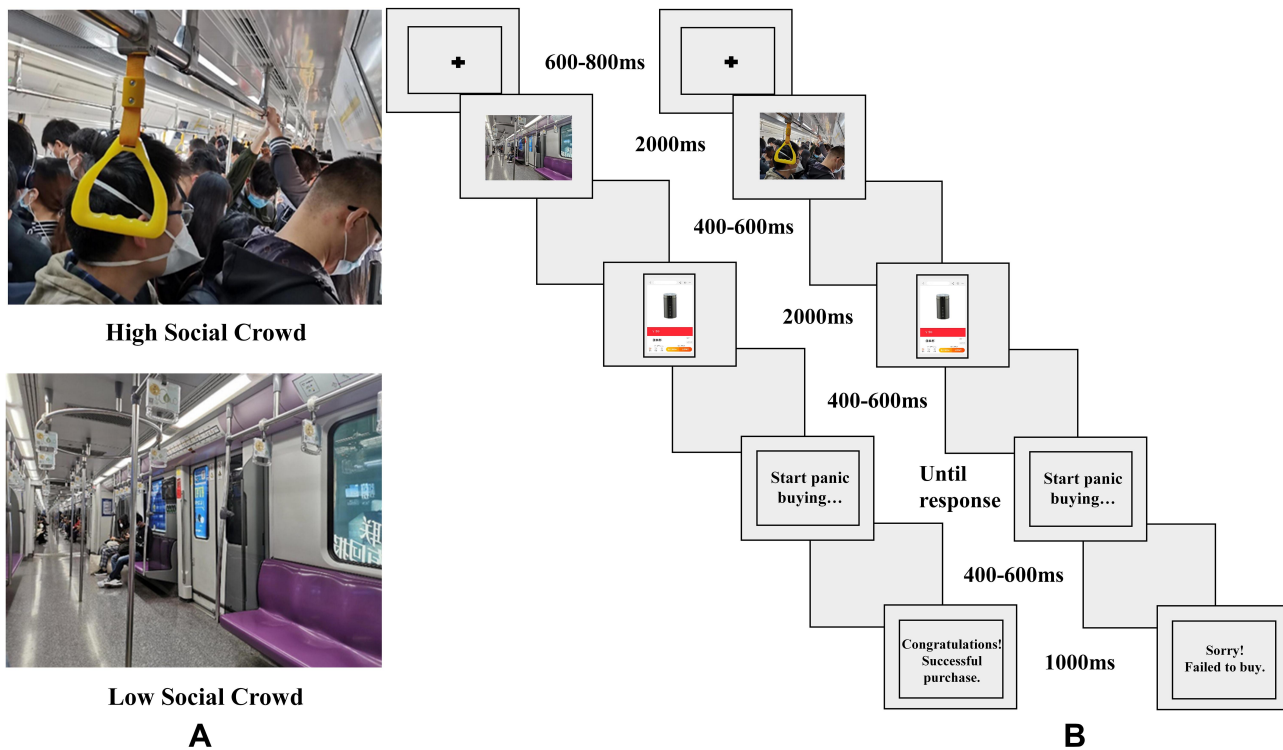


Figure 2 (A) Stimuli to induce social crowding. **(B)** Experimental task. Participants were instructed to press the button as soon as possible in order to buy the shown product. EEGs were recorded from the subjects throughout the experiment.

(1994) and included two dimensions, perceived crowding in space (3 questions, eg, “It seems spacious on the subway”; I feel very crowded to stay on the subway; The subway environment makes me feel constrained) and people (4 questions, eg, “There are too many passengers on the subway”; It’s a bit too frequent and noisy for passengers to get up and down on the subway; There is not much traffic on the subway; It is too crowd for me), with $\alpha = 0.762$. A pairwise t -test was conducted for social crowding evaluation. There were significant differences between the high and low social crowding pictures [$t(1, 23) = -15.09, p < 0.001$]. These results suggested that the high social crowding picture made participants have higher perceived crowding [$M = 6.50, S.D. = 0.58$] than the low social crowding picture [$M = 2.47, S.D. = 1.08$].

In the probe stage, to pursue high signal-to-noise ratio, forty different products were chosen, including vacuum cups, mouses and desk lamps. Since vacuum cups, mouses and desk lamps are all search products in online shopping, participants may have the similar cognitive pattern for search product.^{57,58} That is, there are 40 stimuli for each condition, with 160 total trials in the whole experiment.

In the feedback stage, the result of panic buying the previous showed product was showed with success and failure.

Procedure

Participants were comfortably seated in a sound-attenuated and electromagnetically shielded room. During the experiment, participants were provided with a wireless keypad to make responses. Situated approximately 100 cm away from the participant was a computer-controlled monitor, on which all stimuli were presented centrally. Each participant first received a brochure including the cover story for the current task, experimental procedure, and experiment’s announcements.

The experiment procedure is shown in Figure 2B. According to previous studies, which also employed priming-probe paradigm^{59–62} and studies with feedback stage,^{63–65} each trial began with a fixation cross displayed against a black background for 600–800 ms, and participants were instructed to keep their eyes fixated throughout the task. After fixation, the social crowding picture was shown for 2000 ms. Afterward, the product for panic buying appeared for 2000 ms after a 400–600 ms blank screen. After another 400–600 ms of a blank screen, the participants were asked to press the button as quickly as possible to buy the shown product successfully. Finally, the feedback for panic buying was presented for 1000 ms. They were given a short 2-minute break after each block.

The stimuli and recording triggers were presented using the E-Prime 2.0 software package (Psychology Software Tools, Pittsburgh, PA, USA). Participants were asked to minimize blinks, eye movements, and muscle movement during the experiment. The formal experiment started after 6 practice trials. After finishing the experiment, participants were asked to answer a questionnaire.

Electroencephalogram (EEG) Recording and Analysis

EEG data were recorded with a sample rate of 500 Hz by using a cap containing 64 Ag/AgCl electrodes and a Neuroscan Synamp2 Amplifier (Curry7, Neurosoft Labs, Inc). Left mastoid was used for reference, and a cephalic (forehead) location between PFz and Fz was used as the ground. Electrooculograms (EOGs) were recorded from electrodes placed at 10 mm from the lateral canthi of both eyes (horizontal EOG) and above and below the left eye (vertical EOG). The experiment started only when electrode impedances were reduced to below 5kΩ.

First, data were transferred off-line to the average of the left and right mastoid references. Then, EOG artifacts were corrected off-line using the method proposed by Semlitsch et al.⁶⁶ EEG recordings were digitally filtered with a low-pass filter at 30 Hz (24 dB/Octave). It was segmented for the epoch from 200 ms before the onset of the target appearing on the video monitor for 800 ms after this onset, with the first 200 ms pretargets as a baseline. Trials containing amplifier clipping, bursts of electromyography activity, or peak-to-peak deflections exceeding $\pm 100 \mu\text{V}$ were excluded. The EEG recordings over each recording site for each participant were averaged separately within two conditions in the product evaluation stage (ie, under high/low social crowding) and averaged within four conditions in the feedback stage (ie, high social crowding with successful panic buying, high social crowding with failure panic buying, low social crowding with successful panic buying, and low social crowding with failure panic buying).

According to the visual observation of the grand averaged waveforms and the guideline proposed by Picton et al⁶⁷ two ERP components were analyzed in the feedback stage, which were the FRN and P300, respectively.

The mean amplitude of FRN component in the feedback stage was analyzed within 150–200 ms after the result onset, which also included five electrodes (FP1, FPz, FP2, AF3, and AF4) in the frontal-central area. The 2 (crowding level: under high/low social crowding) \times 2 (feedback: success vs failure) \times 5 (electrodes) ANOVA was conducted for FRN amplitudes.

Difference FRN was extracted by the failure condition minus successful condition under each crowding level. The 2 (crowding level: under high/low social crowding) \times 5 (electrodes) ANOVA was conducted for difference FRN amplitudes for the same time window of FRN. Similarly, the P300 component in the feedback stage was analyzed within 270–340 ms after the result onset, which also included six electrodes (C1, Cz, C2, CP1, CPz, CP2, P1, Pz and P2) in the central-parietal area. The 2 (crowding level: under high/low social crowding) \times 2 (feedback: success vs failure) \times 6 (electrodes) ANOVA was conducted for P300 amplitude.

If there were an interaction effect between the two factors, a simple effect analysis was conducted. The Greenhouse-Geisser correction was applied for the violation of the sphericity assumption for appropriate parts of the ANOVA.⁶⁸

Results

FRN Analysis in the Feedback Stage

As shown in Figure 2 and Table 2, a three-way 2 (crowding) \times 2 (feedback) \times 5 (electrodes) ANOVA was conducted for FRN in the chosen time window. As shown in Figure 3, there was no significant main effect for crowding level [$F(1, 23) = 2.175, p = 0.155$] and feedback [$F(1, 23) < 1, p > 0.1$], but the interaction effect between crowding level and feedback was significant [$F(1, 23) = 4.703, p = 0.041, \eta^2 = 0.170$]. Therefore, a simple effect analysis was conducted. Under the low social crowding condition, the success and failure feedback of panic buying shows significant difference [$F(1, 23) = 4.96, p = 0.036, \eta^2 = 0.177$], which suggests that the failure feedback ($M = 1.246 \mu\text{V}, \text{S.E.} = 0.872$) elicited significantly larger FRN amplitudes than the successful feedback ($M = 2.061 \mu\text{V}, \text{S.E.} = 0.871$). Meanwhile, the success and failure feedback of panic buying has no significant difference under the high social crowding condition [$F(1, 23) = 1.657, p = 0.211$]. These results support the hypothesis of H2.

Difference-FRN Analysis in the Feedback Stage

A three-way 2 crowding level \times 5 electrode ANOVA was conducted for d-FRN amplitude in the chosen time window. As shown in Figure 2 and Table 2, there was significant main effect for crowding level [$F(1, 23) = 4.703, p = 0.041, \eta^2 = 0.170$], which suggested that the low social crowding condition ($M = -0.815 \mu\text{V}, \text{S.E.} = 0.366$) elicited significantly larger d-FRN amplitude than the high social crowding condition ($M = 0.795 \mu\text{V}, \text{S.E.} = 0.618$). The current results are also shown in Figure 3. These results further support the hypothesis of H2.

Table 2 The FRN and d-FRN Results for High and Low Social Crowding Conditions

	<i>F</i>	<i>df</i>	<i>Sig.</i>	Mean (S.E.)	
Crowding for FRN	2.175	23	0.155	High: 1.062 (1.074)	Low: 1.654 (0.852)
Feedback for FRN	<1	23	>0.1	Success: 1.363 (1.023)	Fail: 1.353 (0.901)
Crowding*Feedback for FRN	4.703	23	0.041*	N/A	N/A
Crowding for d-FRN	4.703	23	0.041*	High: 0.795 (0.618)	Low: -0.815 (0.366)
Feedback for low social crowding condition	4.96	23	0.036*	Success: 2.061 (0.871)	Fail: 1.246 (0.872)
Feedback for high social crowding condition	1.657	23	0.211	Success: 0.664 (1.229)	Fail: 1.459 (0.994)

Note: $p < 0.05^*$.

P300 Analysis in the Feedback Stage

As shown in Figure 4 and Table 3, a three-way 2 (crowding) \times 2 (feedback) \times 6 (electrodes) ANOVA was also conducted for P300 amplitude in the chosen time window. Figure 3 shows significant main effect for crowding level [$F(1, 23) = 7.393, p = 0.012, \eta^2 = 0.243$] and feedback [$F(1, 23) = 18.556, p < 0.001, \eta^2 = 0.447$], but the interaction effect between crowding level and feedback was not notable [$F(1, 23) < 1, p > 0.1$]. It showed that the low-level social crowding condition ($M = 6.005 \mu\text{V}$, S.E. = 1.197) elicited significantly larger P300 amplitudes than the high-level social crowding condition ($M = 4.927 \mu\text{V}$, S.E. =

1.413), and the successful feedback ($M = 6.941 \mu\text{V}$, S.E. = 1.459) elicited significantly larger P300 amplitudes than the failure feedback ($M = 3.990 \mu\text{V}$, S.E. = 1.208). These results support P300 hypotheses that a greater P300 amplitude will arise in the low social crowding condition than in high one (H3a) and that successful panic buying outcomes will induce a greater P300 amplitude than failing ones (H3b).

Discussion

The current paper employed a questionnaire survey and an ERPs study to explore whether and how social crowding

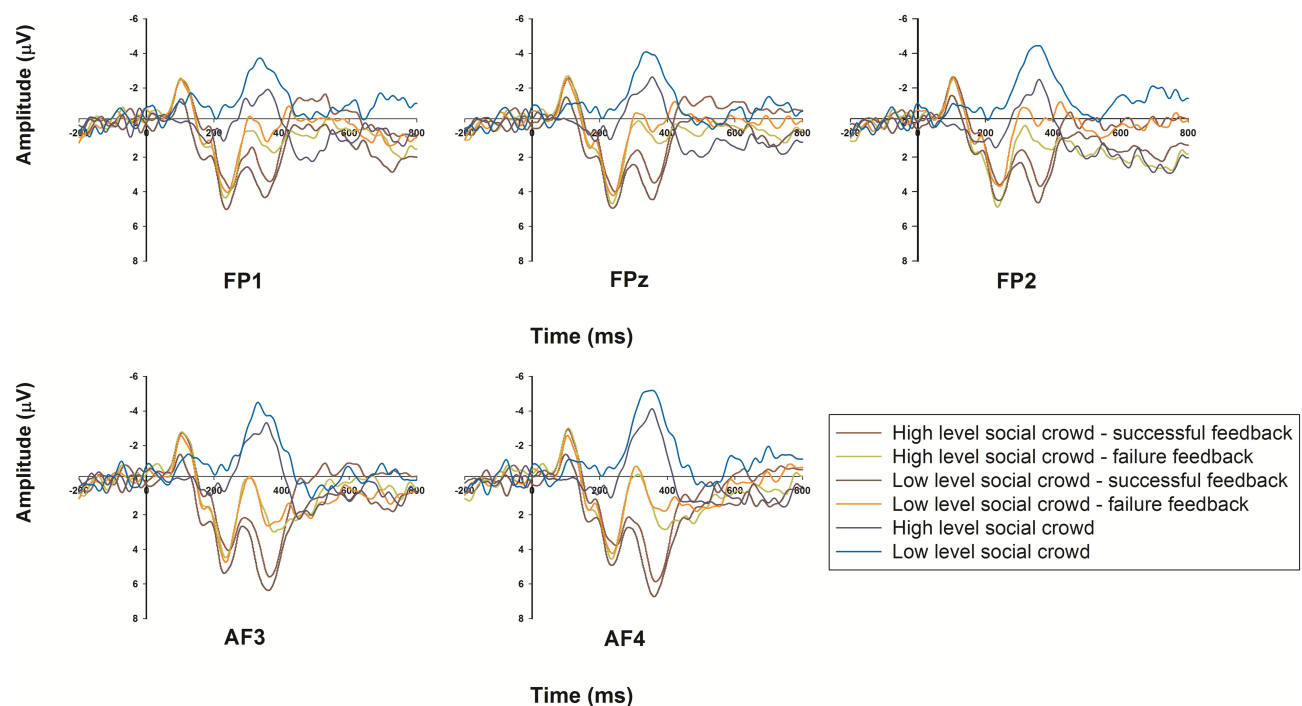


Figure 3 FRN and d-FRN results. Grand-average ERP waveforms from channels FP1, FPz, FP2, AF3, and AF4 as a function of social crowding (high vs low) and valence (success vs failure) for feedback outcomes, as well as the FRN difference waveform at these channels based on social crowding.

Table 3 The P300 Results for High and Low Social Crowding Conditions

	<i>F</i>	<i>df</i>	<i>Sig.</i>	Mean (S.E.)	
Crowding for P300	7.393,	23	0.012*	High: 4.927 (1.413)	Low: 6.005 (1.197)
Feedback for P300	18.556	23	0.000***	Success: 6.941 (1.459)	Fail: 3.990 (1.208)
Crowding*Feedback for FRN	<1	23	>0.1	N/A	N/A

Note: $p < 0.05^*$, $p < 0.001^{***}$.

impacts consumers' online purchase behavior. Study 1 was conducted to provide preliminary behavioral support for the behavioral hypothesis. The results showed that purchase intention under the low social crowding condition is greater than that under the high social crowding condition.

In study 2, ERP results showed that failing panic buying outcomes elicited significantly larger FRN amplitude than successful ones under the low social crowding condition. However, this difference was not found in the high social crowding condition. As reviewed in the literature review and hypothesis development section, several studies have consistently suggested that the amplitude of FRN is negatively related to affective/motivational evaluation of outcomes at the feedback stage.^{36,38,39} Thus, the current FRN results may indicate that consumers had a higher affective/motivational evaluation to the successful rather than failing feedback in the low social crowding condition of the panic buying experiment. Concerning the high social crowding condition, the FRN results indicated that the subjective motivational and affective evaluation across successful and failing feedback was not significantly different. Meanwhile, a greater differentiated FRN (d-FRN) toward the divergence of the failing-successful

feedback was observed in the low social crowding condition rather than in the high one also supported that people expected to buy the products successfully in the low rather than in the high social crowding condition. All of these FRN results support the primary hypothesis that social crowding has a negative impact on consumers' online purchase behavior.

Regarding the P300 component, successful panic buying outcomes induced a greater P300 amplitude than did failing ones. As indicated in the literature review and hypothesis development section, P300 is sensitive to the valence of reward or outcome.^{41,52,53} Thus, the current study identified a greater P300 amplitude in the successful than the failing feedback of the panic buying. More importantly, the current study also observed a greater P300 amplitude in the low social crowding condition than in the high one. Because P300 can also reflect attentional resources during the stimulus evaluation process^{50,51} and there is a robust positive relationship between P300 amplitude and the amount of attentional resources allocated,^{42,43} the above result may indicate that consumers devoted more attentional resources to process the feedback outcomes in the low but not high social crowding condition.

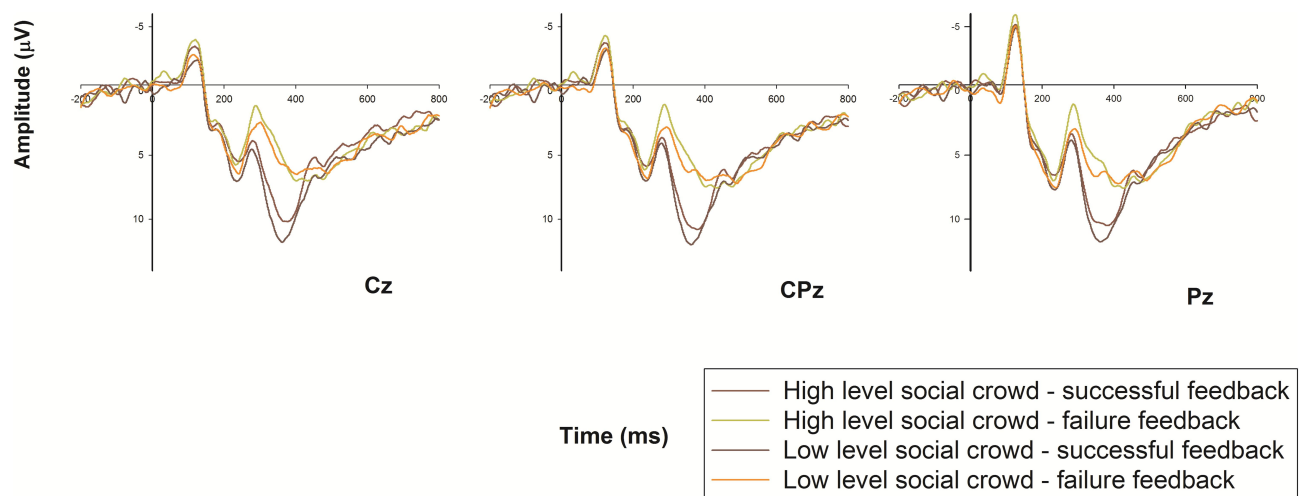


Figure 4 P300 results. Grand-average ERP waveforms from channels Cz, CPz, and Pz as a function of social crowding (high vs low) and valence (success vs failure) for feedback outcomes.

In other words, compared with the high social crowding condition, consumers had a greater motivation to see the panic buying results and had a relatively considerable purchase intention in the low social crowding condition of the panic buying experiment. This P300 result also supported the main hypothesis that social crowding has a negative impact on consumers' online purchase intention.

The two studies showed that the high social crowd environment would decrease consumers' subjective evaluation of a product, which reflected in the deflection of FRN and P300 amplitude. It also reported the result of lower purchase intention for a high social crowding environment in online mobile shopping. The current results were consistent with previous studies, which suggested that crowded environments might easily induce consumers' negative emotions⁵ and negatively influence consumers' evaluations about products, services and shops.^{3,69} In the current study, the negation emotion reflected in the deflection P300 amplitude, while the negative product evaluation reflected in the deflection FRN amplitude. However, previous studies also reported the positive effect of social crowding for experienced product.^{5,23} The products employed in the current experiment are vacuum cup, mouse and desk lamp, which are search products. Therefore, we found different results with these studies.

Theoretical Contributions and Practical Implications

For theory, this study explores the impact of social crowding on consumers' online mobile purchase intention and contributes to social crowding marketing effects. In the past, numerous studies have explored social crowding's effect on consumers' various feelings and behaviors, such as consumers' positive, and negative emotions,^{5,17–19} evaluations about products, services and shops;^{4,6} and avoidance behaviors.^{2,3,6} However, almost all related studies have focused on real shopping scenes (eg, restaurants, supermarkets, and department stores). Because consumers can now shop through their mobile phones in various daily contexts, the current study, which preliminarily identifies the negative impact of social crowding on online purchase intention, contributes to the research on social crowding marketing effects.

Second, the current study employs an implicit experimental design to explore the marketing effect of social

crowding with electroencephalogram (EEG) recordings and provides some insights into using neuroscience technology and tools. As previous studies have suggested, individuals' self-reports and behavioral responses in a research context may not reflect their actual thoughts.^{8,29} Sometimes, participants in studies may give "corrected" responses if they recognize or learn scholars' research purpose in the research process. For example, participants frequently need to make dozens of decisions under each condition in some consumer behavior and marketing studies, and they may gradually recognize or learn scholars' research purpose in some special situations. In this case, the data collected may be biased. Thus, if necessary, some implicit experimental designs with neuroscience technology may be employed to conduct research similar to that presented in the current study.

This study also has implications for practice. The current study's results indicate that social crowding negatively influences consumers' online purchase intention. With the help of positioning technology, marketing practitioners can accurately estimate consumers' environments according to their real-time positioning.⁷⁰ In this situation, marketing practitioners can pay more attention to consumers' position when recommending products or advertising. For example, product recommendation and advertising could be conducted in off-peak hours rather than a rush hour around the metro area. Nonetheless, users' privacy rights and related laws should be respected when specific ads and recommendation messages are sent to consumers according to their environment.

Limitations and Future Research

This study is not without limitations. One simultaneous strength and shortcoming of the current study is the lab experiment. This method enabled us to understand consumers' feelings, thoughts and intentions under different social crowding conditions from the perspective of neuropsychology. However, the current research included a questionnaire survey and a lab experiment, both of them are in a controlled environment. Therefore, it still leaves an open question regarding whether the same findings can be found in the real marketing place. In future studies, field studies can be conducted to examine the generalizability of this study's findings.

Besides, given that major previous studies on social crowding have focused on its marketing effect in retail scenes,^{1–3,22} the current study preliminarily explored the impact of social crowding on online mobile shopping.

However, what are the potential positive and/or negative impacts of social crowding on e-consumers' other feelings and behaviors, such as consumers' satisfaction, product evaluations, brand preferences, and even shopping duration? All of these questions, which are significant in contemporary marketing research and practice, require future study. Last but not least, participants' attitude, feeling and emotion before the experiment may influence their purchase intention. Although the participants were randomly recruited and the social crowding effect was found both in behavioral and brain experiments, we still think that consider participants' pre-experiment feels will make the current results more reliable.

Conclusion

This study primarily investigates the impact of social crowding on consumers' online purchase behavior with a 2-level social crowding (low vs high) \times 2-level feedback of panic buying (success vs failure) implicit experimental design by using electroencephalogram (EEG) recordings. The ERP results indicated that consumers had a higher affective/motivational evaluation (reflected in a smaller FRN amplitude) regarding the successful rather than the failing feedback in the low social crowding condition. However, this difference in affective/motivational evaluation was not observed in the high social crowding condition. Meanwhile, more attentional resources (reflected in a greater P300 amplitude) were devoted to processing the feedback outcomes in the low but not high social crowding condition, indicating that consumers had a greater motivation to see the panic buying results in the low social crowding condition. To summarize, all of the above results provide evidence that social crowding has a negative influence on consumers' online purchase behavior.

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Disclosure

All of the authors report no conflicts of interest for this work.

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