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RESEARCH REPORT

# Decision on Queue—A Study of Cognitive and Brainwave Responses

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Queuing phenomena are common in service industries. For a service company, the willingness of customers to queue for a service implies the potential revenue. However, how to retain waiting customers or increase customer willingness to queue is an unanswered question. Generally, front desk clerks provide customers with information about the waiting time to help customers decide whether to queue. A clerk can provide the pure situation of waiting or the waiting time to customers. The pure situation of waiting is just related to the fact of queue, but not the waiting time. Brainwaves caused by a stimulus are a vital signal because they can represent customer response to the information of queue. Restated, brainwave changes reflect the different responses between the information of waiting time and information of pure waiting situation. Therefore, this study performed a brainwave experiment to compare between the information of waiting time and pure waiting situation. This study also surveyed customers to find their willingness to queue. The analytical results show that of providing information of waiting time is more useful than provide information of pure waiting situation. From the analysis of brainwave patterns, we can see the differences between the stimuli of pure waiting situation and waiting time statistically.

**Keywords:** *queuing phenomenon, waiting time, brainwave*

## Summary

This study uses surveys and an analysis of brainwaves to explore how front-desk clerks' provision of wait time information affects consumers' queuing behavior. This study uses questionnaires to understand the participants' cognitive status with regard to the information provided by the front-desk clerks. The study also collects brainwave data to study participants' decision-making processes. Studies have shown that announcements about wait times by service providers can effectively reduce consumers' negative perceptions of queuing (Bielen & Demoulin, 2007; Liang, 2017). Furthermore, information about waiting may have a psychological impact on consumers that further affects their decisions on whether to queue (Rozgić, Vitaladevuni, & Prasad, 2013; Zhang & Zhou, 2007). Restated, not only information, but also vital signals stimulated by psychological cognition can shape consumers' actual behaviors. To find the relations among consumer responses, survey results, and vital signals, this study uses two messages about waiting as stimuli. In the study, brainwaves are the vital signals that are a direct response to the stimulation. For stimuli, this study uses messages about anticipated waits that indicate wait times and messages about waits that do not indicate wait times. This study also surveys customers to verify their cognition of and emotional reaction to the received messages.

## Literature Review

### Queuing

Queues are common in service industries. When customers want a product or service that a company cannot offer right away, they must wait before being served. The willingness to wait is the result of social influence, the bandwagon effect, word of mouth, or promotion (Friman, 2010; Liang, 2017; Lotrakul, Sumrithe, & Saipanish, 2008). A consumer's decision to queue depends on the perceived wait time and his/her purchase intention. Perceived wait times are related to consumers' awareness of the wait (Hui, Tse, & Zhou, 2006). The wait time perceived by a customer who is bored is longer than the actual wait time. Consumer perception of wait times is the main determinant of queuing decisions (Liang, 2017). A customer might underestimate wait times when he/she is experiencing a positive emotion and a customer might pay more attention to wait times when he/she is experiencing a negative emotion. Information about wait times also affects consumers' perceptions of waiting. Therefore, providing customers with information about wait times not only reduces consumer attention to and negative emotion about wait times, it also has positive effects on purchase intentions and evaluations of service quality (Cui & Veeraraghavan, 2016; Lin, Xia, & Bei, 2015).

### Waiting and Brainwaves

An electroencephalogram (EEG) is a graphic record of a brain's electrical activity. Brainwaves are commonly used in medical sciences. For example, EEGs are used to check the brain activity of patients diagnosed with mental illnesses. The EEG collects signals between 10 uV and 100 uV. The frequencies used in an EEG are between 0.1 Hz and 70 Hz (Agarwal & Dutta, 2015; Zurawicki, 2010). Eight brainwave bands can be parsed from an EEG: δ band (0.1–3 Hz), θ band (4–7 Hz), low α band (8–9 Hz), high α band (9–12 Hz), low β band (12–20 Hz), high β band (21–30 Hz), low γ band (31–39.75 Hz), and high γ band (41–49.75 Hz).

Recently, as the technology has evolved, marketing researchers have used a lightweight device that is easy to operate to detect brainwaves. Traditionally, brainwave experiments have been difficult because of the complicated set-up procedures, the amount of preparation before the experiment, and the sensitivity of electromagnetic waves to the environment (Telpaz, Webb, & Levy, 2015; Gajewski, Drizinsky, Zülch, & Falkenstein, 2016). However, brainwaves are a vital signal that directly reflects humans' reactions to stimuli such as queuing. Brainwaves can be evidence of consumers' decision-making behaviors. For example, the decision process can be reflected in changing brainwaves (Blakemore & Frith, 2005; Luck, Woodman, & Vogel, 2000) or in changes in brainwave bands (van Ede, de Lange, Jensen, & Maris, 2011). Brainwaves can be used to detect emotions (Farwell & Smith, 2001; Murugappan et al., 2008), perceive stimuli (Shibasaki & Masataka, 2014), and classify emotions (Rozgić et al., 2013; Zhang & Zhou, 2007). Therefore, brainwaves can be used to not only survey consumers' emotions during a marketing event, but also to study the effect of the decision to queue.

## Research Methods

Based on the literature, the study proposed four hypotheses about consumers' reactions to messages with and without wait times:

*H1: Customer perceptions of a message about wait times impacts negative and positive emotions.*

*H2: Personal style/reaction to wait times has a conditioning effect on H1.*

*H3: Personal tolerance of long waits has a conditioning effect on H1.*

*H4: The brainwave patterns after a message with wait times are significantly different to the brainwave patterns after a message without wait times.*

This study used laboratory experiments, as it is difficult to control interference in the field. Additionally, to make sure that all of the participants' awareness of the messages was consistent, the messages were given in text format instead of verbally (Mayer, 2005; Schnotz, 2005).

This study adopted the questionnaire designed by Usunier and Valette-Florence (2007) to find participants' linearity of economicity of time, temporal orientations, obedience to time, and temporal persistence. Additionally, the questionnaire about queuing information designed by Hui and Tse (1996) and the Positive Affect and Negative

Affect Schedule (PANAS) designed by Waston, Clark, and Tellegen (1998) were administered to the survey participants.

This study adopted a signal-channel device powered by a NeuroSky chip to collect brainwave data. The sampling rate of the device is 512 Hz. The single-channel device collected brainwave signals from the FP1 (frontal polar–left hemisphere) using the International 10–20 Electrode Placement System. The brainwaves from the FP1 are generated by decision-making or high-order cognition (Buckner, 2013; Schemichel, Zemlan, & Berridge, 2013). Therefore, using the signal-channel device to collect the brainwaves generated after reading the wait messages was appropriate (Kivikangas et al., 2011; Wang & Hsu, 2014).

This study used an online game design and the wait time message was associated with logging in to the game system. The system showed two wait messages: A pure wait message (e.g., "The system is busy, please wait") and a wait time message (e.g., "The system is busy, please wait N minutes"). A post-survey questionnaire indicated that all of the participants thought that they were waiting to test an online game, which suggests that the experiment successfully detected the participants' perceptions of waiting. Additionally, if a participant clicked the "Retry" button, he or she re-entered the queue. Finally, the brainwave data were managed using the EEGLAB toolbox (Delorme & Makeig, 2004).

In this study, the P300 was the target for the brainwave observation. The P300 wave is an event-related potential (ERP) component elicited in decision making. Generally, the so-called P300 appears between 250–420 ms after the stimuli. In this study, the observing interval was 500 ms after the stimuli, which encompassed the 250–420 ms range (Smith et al., 2012).

This study sample included 104 surveys and 93 valid samples of brainwave data. Some of the subjects did not respond seriously or behaved so exaggeratedly that the brainwave signals were not stable or the device fell off. This study also classified participants into two groups based on their different reactions to clicking the "Retry" button. In the experiment, the 57 participants who did not click the "Retry" button were classified in the Insistent group, and the remaining 47 participants, who clicked the "Retry" button, were classified as the Partial-Insistent group. Based on these new groupings, a fifth hypothesis was proposed:

*H5: The message about wait times has a greater impact on the negative emotions of the Partial-Insistent group than on those of the Insistent group.*

Additionally, it was not possible to test H2 because of the results of the group analysis of the responses to the questionnaire designed by Usunier and Valette-Florence (2007). Prime (1994), Hsiao, Tsai, and Lin (2012), and Jou, Huang, Chen, and Yang (2006) found that the personal style/reaction to wait times can be classified into "*passive impatience*" and "*active impatience*." However, in this study, the two groups were classified as "*high perception of wait times*" and "*low exception of wait times*," which are different from the groups defined in previous studies. Therefore, a sixth hypothesis was proposed based on the new groups:

*H6: Perception of wait times has a conditioning effect on H1.*

## Analytical Results

This study found that providing wait time information can elicit positive emotions, but there was a significant difference between the groups. Therefore, H1 was partially supported.

This study adopted a spotlight analysis to verify H3, H5, and H6. The analytical results showed that H3 was not supported ($\beta = -0.07$, $t = -0.50$, $p = .62 > .05$; lower limit 95% confidence interval [LLCI] = -0.33, and upper limit 95% confidence interval [ULCI] = 0.20, which includes 0). H5 was not supported ($\beta = -0.12$, $t = -0.59$, $p = .56 > .05$; LLCI = -0.51, and ULCI = 0.27, which includes 0). H6 was not supported ($\beta = 0.21$, $t = 1.12$, $p = .26 > 0.05$; LLCI = -0.16, and ULCI = 0.59, which includes 0).

In addition, the analytical results of the brainwave patterns showed that the participants exhibited a high wave at FP1 between 300 and 350 ms after receiving a message that specified wait times; a message without wait times produced a brainwave with a larger change between 0 and 250 ms after receiving the message (Figure 1). The results of a paired *t*-test showed that the brainwaves generated by the two messages were significantly different ($p = .045 < .05$).

## Conclusions

This study found that messages about wait times have a major impact on customers. A company should improve service messages to avoid negative customer emotions. Companies should consider providing wait time information to customers (Gillam, Simmons, Stevenson, & Weiss, 2014; Park & Kim, 2007). Additionally, this study proposed a new scale for evaluating perceptions of time. The proposed scale should be studied further before it is adopted as a measurement tool.

The analysis of brainwave patterns showed that there was a significant difference between consumers' reactions to messages with or without wait times. The relationship between marketing events and brainwave changes has important implications for marketing research.

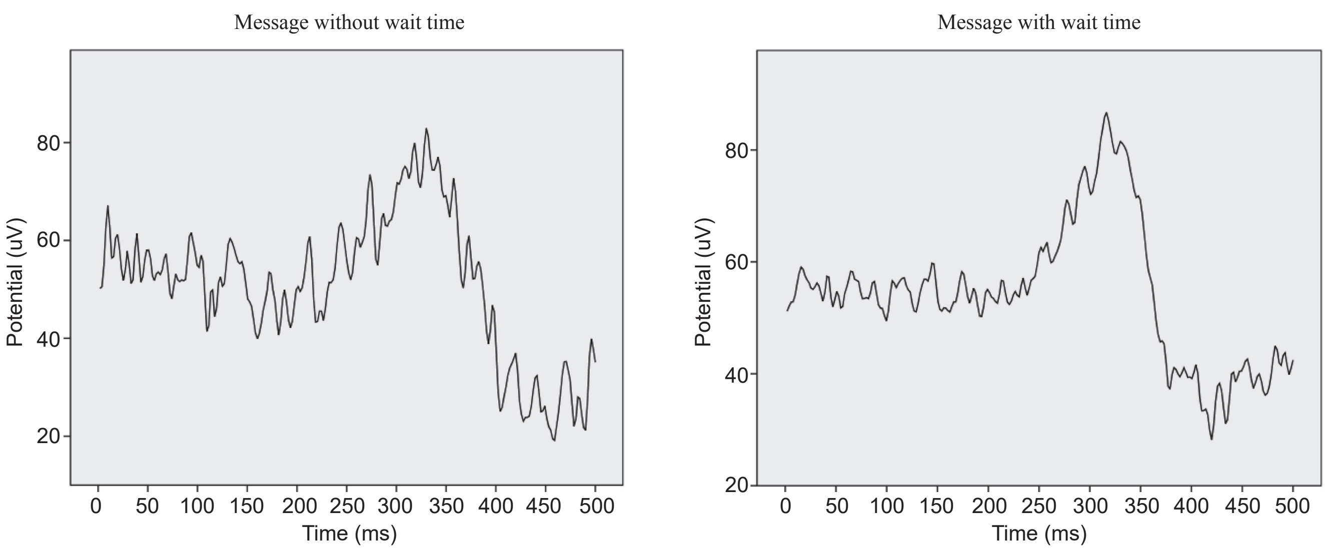


***Figure 1.*** **Comparison of the brainwave reactions to the two waiting messages.**