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What is Unique in the Brains of Frontline Employees? A Structural Neuroimaging Study

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Abstract

Picking up nuances of facial expression is a crucial part of frontline employee–guest interaction, yet little is known about its neurocognitive mechanism. We use a neuroimaging approach to explore the individual differences in cognitive processing style of front-of-house (FoH) employees by comparing their brain structures with those back-of-house (BoH). A voxel-based morphometry analysis of 63 senior hotel executives' brain images reveals that the grey matter volume in the occipital and fusiform face areas of FoH employees is greater than that of BoH employees and does not depend on the length of frontline experience. These regions have been implicated in facial expression recognition that is critical to the success in frontline roles. Our findings support the social brain hypothesis. To support sophisticated social cognition, resources are diverted to brain development associated with facial expression recognition. This development trajectory follows deferred adaptation, rather than conditional adaptation, proposed in developmental evolutionary psychology.

Keywords

frontline employee, facial expression recognition, magnetic resonance imaging, structural brain difference, neurotourism

> There are cells in the brain that respond to faces. This is one of the reasons that I deal with portraiture. We can learn a lot about our perception of facial expression from the behavior of these cells.
>
> —*Eric Kandel*

Frontline employees (FLEs) determine the success of service organizations (Chehab et al., 2021). FLEs help form first impressions and set service expectations (Kumar et al., 2014), thereby contributing to customer satisfaction (Albrecht et al., 2016). Even with the impact of COVID-19, the number of jobs in travel and tourism reached almost 290 million in 2021 (Statista, 2022). Many of these are in frontline roles. In order to provide good service and keep up with today's competition, tourism operators must ensure that their frontline employees are effective. They are part of the customer-related knowledge acquisition, seeking competitive advantage and quality improvements (Bouncken, 2002). Given the topic's importance, research on frontline service employees has been conducted for more than four decades (Subramony et al., 2021), including examination of different factors that contribute to the success of FLEs (see Miao et al., 2021; Zhu et al., 2022 for reviews on emotional intelligence). The ability to recognize customers' emotions has been identified as the most important skill of a FLE (Zhang et al., 2021). FLE training programs have included improving frontline employees' capacity to pick up emotional cues from facial expressions (Koc & Boz, 2020).

The ability to deduce the thoughts, intentions, and feelings of others is innate and uniquely human (Adams et al., 2010). Recognizing visual cues such as facial expressions is a basic and crucial factor in the effective social interaction between FLEs, their co-workers, and customers (Koc & Boz, 2020). The phenomenon of facial mimicry has been shown as a means for individuals to display emotional empathy with others (Drimalla et al., 2019), whereby individuals recognize, display, and feel the emotions of others (Olszanowski et al., 2020). Those observing mild distress such as fear or sadness expressions may respond with a greater sympathy and willingness to help the distraught individual (Marsh & Ambady, 2007). While some research acknowledges the importance of FLEs acquiring knowledge through visual cues (e.g., Bouncken, 2002) and refers to the importance of neurological reactions of employees and the differences between emotions, feelings, and moods of tourists (e.g., Godovykh & Tasci, 2022), this analogy is presented in the absence of these

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physical states being scientifically investigated through neuroimaging studies. It has been proposed that tourism research can benefit from the use of neuroscientific tools such as electroencephalography (EEG; Li et al., 2022). Our study in particular aims to answer this research question on how facial expression recognition among FLEs is supported by neurocognitive resources and its developmental trajectory.

There has been a call to develop more innovative tourism research approaches to provide richer analysis and insight, which may not be sufficiently represented through solely numbers, graphs, and tables, an example being the use of visual methods (Rakić & Chambers, 2010). Neuroscientific methods have emerged in recent years in various disciplines such as management and organizational behavior research (Waldman et al., 2017), and education (Christodoulou & Gaab, 2009). Neuromarketing goes beyond the possible biased self-reporting methods to investigate effects of subtle marketing stimuli real time on the consumer's brains (Sung et al., 2020). Brain activity has been measured during the purchase decision-making process, evaluating brain activations on consumer brand purchases, going beyond conventional marketing research approaches (Al-Kwifi, 2016). For instance, fMRI has been used to study the neural mechanisms of celebrity endorsement (Chang et al., 2016), with emotional appeals such as sadness (Bakalash & Riemer, 2021), and fear (Mostafa, 2020), in advertisements. Neuromarketing is seen as a new opportunity in applied neuroscience (Sung et al., 2020). Similarly, although nascent in hospitality and tourism, neuroscience can provide an additional research method to the future exploration of human brain stimuli and cognition. EEG for example, has been used to analyze the emotional response to TV commercials using event-related components, resulting from an unconscious process rather than conscious responses common in self-reports (Bastiaansen et al., 2022). There have been recent attempts to also use fMRI in tourism research, to examine customer and employee interactions (Choi et al., 2022), and destination selection (Al-Kwifi, 2015).

For the first time in the literature, our study addresses this gap by conducting an interdisciplinary study on the brain structural differences of FLEs. Cognitive neuroscience provides a way to learn "how complex cognitive skills are acquired and how variations in behavioral aspects of those skills manifest in neural differences" (Weisberg & Ekstrom, 2021, p. 102). It was also argued that "by providing insights into the abilities and constraints of the learning brain, neuroscience can help to explain why some learning environments work while others fail" (Stern, 2005, p. 745). The individual differences in brain structures can reveal the neural underpinning of individual differences in cognitive abilities, such as facial expression recognition (Weisberg & Ekstrom, 2021). Importantly, observing neural variations can isolate specifically what contributes to the development of a complex cognitive skill.

Providing high quality service, employee mindfulness, and employee engagement with guests are key aspects of tourism employee work engagement, with tourism management tasked to ensure that FoH staff meet performance standards (Rescalvo-Martin et al., 2022). The continuous need to deliver quality services through interactions with guests can create stress and burden to frontline employees, thereby diminishing employee work engagement (Tsaur & Hsieh, 2020). In our study, we examine the unique structural brain differences of FLEs, and more specifically facial recognition areas as these would be linked to the level of engagement quality, a crucial aspect of service delivery. Relying on existing knowledge of the brain and theories in evolutionary development psychology, our findings augment the understanding of the underlying mechanism of the cognitive processes involved in FLE neurology variations. Our study also has important practical implications and contributes to staff training and job placement. A meta-analysis on employee EI literature recommended interventions at the recruitment phase to identify employees with higher EI (Zhu et al., 2022). Through integrating neuroimaging we advance the EI literature, suggesting that hospitality and tourism job placement consider the contribution of the individual's brain, including whether service training interventions create impact in the brain and particularly on the individual's interpersonal skills.

Theoretically, we contribute by identifying the defining property of the frontline role at the neural level. Previously, EI has been studied among FLEs. Different properties has been examined. We study the same question neuroscientifically and find that a part of the brain that is associated with facial expression recognition is more developed among FLEs. Our results shed light on the nature versus nurture debate. Supporting the social brain hypothesis, this ability is critical and requires a special wiring of the brain circuit to support. Using this innovative neuroscientific approach, our study supports and advances the assertion on the effect of EI on FLEs comparing FoH to BoH that have, to this date, used mainly self-reporting methods. More interestingly, this development occurs before their careers and the brain region does not seem to further develop with the exposure to the environment that is rich in social interaction and favors individuals better in this cognitive ability. Such developmental trajectory has theoretical implication. More specifically, in developmental evolutionary psychology, behavioral traits often exhibit one of the two developmental trajectories. They either display *deferred adaptation*—that traits develop early in response to the individuals' childhood environments and as a preparation for the individuals' adult lives—or *conditional adaptation*, that traits show continuous development over the lifespan to adapt to particular adulthood environments. Our findings do not support conditional adaptation, but rather deferred adaptation, in which the neurocognitive resources for facial expression recognition developed early to prepare individuals for their frontline roles.

In addition to its theoretical contribution, this study also represents the first attempt in tourism research to use voxel-based morphometry (VBM), which is a computational approach to localize individual differences in neuroanatomy.

In particular, this permits the comparison of brain structures between groups of individuals—for example FoH and BoH employees in our case. The methodology can be applied to study individual differences in other tourism contexts, such as differences in tourist role typology (Cohen, 1972), to gain deeper insights into the underlying process of various tourist behaviors.

Literature Review

Frontline Employee

In tourism settings, FLEs are “the face of the first and often the only interaction between the service organization and its customers” (Kumar et al., 2014, p. 369). Consequently, FLEs are the ones who contribute to customer experiences, determine service quality expectations, and thus help define customer satisfaction (Chehab et al., 2021). Research has shown that hotel guests feel that certain attributes of frontline staff such as perceived honesty and ethical behavior would impact their experiences in the hotel (Wong, 2000). In some extreme cases, FLEs may create service brand differentiation (Crawford et al., 2022). FLEs are especially important in tourism settings, as they interact with tourists from different places with various cultural backgrounds (Lam et al., 2021).

FLEs must manage their display of emotions, due to a transmission of affect during the interactions with customers (Zhu et al., 2022). As such, FLEs have different cognitive processing styles in their daily work role than other workers, such those in BoH. FLEs are required to express desirable emotions such as happiness and enthusiasm. Service organizations invest in making sure their FLEs display authentic and positive emotions (Lechner et al., 2022). This ability is often referred to as *emotional labor*, that is, “the management of feeling to create a publicly observable facial and bodily display” (Hochschild, 1983, p. 7), and it is indispensable among FLEs as they interact intensively with customers daily (Viglia & Rodrigo, 2020). There are two types of emotional labor strategies—*deep* and *surface acting* (Hochschild, 1983). Deep acting involves the modulation of experienced emotion whereby the displayed emotion is aligned with the felt one. Surface acting is mere mimicry of the desired displayed emotion through suppressing the actual felt emotion (Hochschild, 1983). Both approaches are commonly used by FLEs (Diefendorff et al., 2005). Whereas there are different motivations leading to the adoption of either approach (Hur et al., 2022), personality types are associated with different emotional-labor abilities (Diefendorff et al., 2005).

In a tourism paper, neuroimaging was used to examine the consequences of emotional labor (Choi et al., 2022). It is well-known that the emotional nature of a job can lead to stress and even burnout over time (Han et al., 2016). This is especially the case with customer incivility (Choi et al., 2022). In order to cope with the emotional dissonance experienced, FLEs resort to *habituation*, a term for the blunted responses that occur through repeated exposure to the same stimuli (Harris, 1943). In a functional magnetic resonance imaging (fMRI) study, a group of FLEs was compared to employees with minimal interaction with customers through their neural responses to different facial expressions (Choi et al., 2022). The authors found that FLEs, compared with the control group, had reduced neural response to angry faces, to which the FLEs were assumed to be habituated, but not happy or neutral faces in brain regions such as the posterior cingulate cortex, middle frontal gyrus, middle temporal gyrus, and precuneus. Such findings cannot be scientifically accomplished without the adoption of neuroimaging.

On top of regulating their own emotions, it is equally important (if not more so) for FLEs to be empathetic to customers’ feelings (Lee & Ok, 2012). They have to be able to perceive the emotion of their guests through accurately employing both verbal and non-verbal cues (Tusell-Rey et al., 2021). “This perception includes the messages that are transmitted through personal appearance, clothing, posture, gestures, eyes, and everything that can disqualify or affirm what is said with words” (Tusell-Rey et al., 2021, p. 234). The reliance on non-verbal components in the communication is critical in the perception of customers’ emotions, especially by reading their facial expressions and body language (Miao et al., 2021). This implicit expression of emotions sets the tone in the face-to-face interaction in any service encounter, but the employees’ ability to recognize customers’ emotions has only been studied recently (Zhang et al., 2021).

In our study we compare FoH with BoH hotel executives. This distinction is important. Those in FoH positions such as front office, concierge, security, and dining, have greater levels of customer engagement than those in BoH roles such as audit and accounting, information technology, human resource management, and facilities management. The members of our FoH executive study sample have spent many years on the frontline and worked their way up to their current positions in which they are still engaging in frontline duties. Service organizations will purposely place employees in FoH positions with the understanding that there will be a level of customer and employee interaction. Employees may also choose to engage in FoH roles based on their understanding of their own abilities, personality, and preferences.

Previous tourism research investigated differences between FoH and BoH employees in terms of their effective use of emotion. It was suggested that there is a relationship between the ability to manage emotion and job performance (Miao et al., 2021). This ability was found to determine the quality of service encounters in a casino setting where gamblers’ consumption is emotionally rich (Prentice & King, 2011). In another study, the engagement in organizational citizen behaviors was found to be affected by the ability to use emotion among FoH employees, while absent in BoH (Jung & Yoon, 2012).

Table 1. Review of Hospitality FLE Emotional Response Literature.

Research purpose	Research method	References
Study on the interrelationships among the EIs of employees	Questionnaire survey of 319 food and beverage employees in a deluxe hotel	Jung and Yoon (2012)
Impact of FLE autonomous and controlled motivations on behavior and performance	Questionnaire survey of 483 hotel employees and 21 hotel general managers	Hur et al. (2022)
Impact of job standardization on emotional labor	Questionnaire survey of 292 restaurant employees	Chehab et al. (2021)
Recognition of customer's facial expressions	Questionnaire survey of 398 tourism and hospitality employees	Koc and Boz (2020)
Impact of emotional labor and cultural intelligence on hotel FLEs	Questionnaire survey of 671 hotel FLEs	Lam et al. (2022)
Impact of EI on FLE's creativity	Questionnaire survey of 289 hotel FLEs	Darvishmotevali et al. (2018)
Influence of FLE emotion displays on customers	Questionnaire survey of 104 restaurant customers	Lechner et al. (2022)
Impact of EI on FLE personal accomplishments and job satisfaction	Questionnaire survey of 309 hotel FLEs	Lee and Ok (2012)

A major limitation in tourism methodological and theoretical studies on emotion responses has been the common use of self-reporting approaches (see Table 1 for a review). As self-report measures are biased by factors including social desirability concerns, neuroscientific methods have the capability to provide accounts that do not match self-reported attitudes (Bell et al., 2018). To illustrate this disconnect, self-reporting in one study showed a consumer's preference to purchase green products, although this was not reflected in purchase behaviors (Vezich et al., 2017). To explain this lapse of social desirability at the point-of-purchase, the fMRI revealed a different neural pattern with regards personal value and reward (in the ventromedial prefrontal cortex and ventral striatum).

Noting that words such as "emotions," "feelings," and "moods" have appeared in over 100 peer-reviewed papers in leading hospitality and tourism journals, coupled with the need to provide research techniques to encapsulate them more comprehensively in tourism studies, Godovykh and Tasci (2022) recommended self-report scales and interviews, including physiological methodologies such as electrodermal activity, pupillometry, and electrocardiography. Undetected by self-reporting methods, we argue that the inclusion of neuroscientific technique advances tourism research on FLE by revealing the underlying neural mechanisms that truly influence FLE behavior.

Emotional Intelligence

Koc and Boz (2020) cited the World Economic Forum and highlighted that emotional intelligence (EI) is one of the top 10 skills for business success. The term EI was introduced by Salovey and Mayer (1990, p. 189), defined as "the subset of social intelligence that involves the ability to monitor one's own and others' feelings and emotions, to discriminate among them, and to use this information to guide one's thinking and actions." Similar conceptualizations of EI have followed (e.g., Goleman, 1996).

Tourism research on EI emerged only in the past decade (Zhu et al., 2022). A major focus of this line of work is the relationship between EI and job performance of FLEs. EI was found to be positively associated with job performance, especially among jobs that involve high emotional content (Daus et al., 2004). FLEs who engage in emotional labor on a daily basis, for example, require a high level of EI input for their jobs (Viglia & Rodrigo, 2020). Therefore, it is not surprising to observe that professionals in the hospitality industry are often people with higher EI (Scott-Halsell et al., 2008), with EI ability also essential to senior positions in the industry (Miao et al., 2021).

In an early conceptualization, social awareness—referring to the ability to read and react to others' emotions—emerged with self-awareness, self-management, and relationship management as the four components of EI (Goleman, 1996). The ability to accurately perceive and understand others' emotions is a key component of EI according to another study (Miao et al., 2021). This ability is also referred to as interpersonal intelligence (Gardner, 1993). It is evolutionarily advantageous for us to be able to understand others' emotions (Salovey & Mayer, 1990). Believed to be an innate characteristic, the disposition and ability to recognize, process, and make use of others' emotions vary from individual to individual (Zhu et al., 2022), being particularly relevant for hospitality FLEs (Prentice & King, 2011). It is known that emotions of those deployed in frontline roles will influence customer service quality perceptions (Kearney et al., 2017). EI were found to be a significant predictor of service performance by casino FLEs (Prentice & King, 2011). Tour leaders' emotional intelligence was found to have a direct positive effect on tour members' satisfaction (Tsaur & Ku, 2019). Koc and Boz (2020) investigated the emotion recognition ability of tourism and hospitality employees by looking at photos of customers with different facial experiences.

As the ability to relate to and understand each other's internal states and emotions, empathy is a basic element in our social skills (Koc & Boz, 2019). Individuals with high EI can empathize with other people's feelings (Zhu et al., 2022). They are better able to identify another person's state of mind. One way we empathize with others is by direct association (Loo, 2019). This is a process wherein we associate emotions from others with the ones we experienced in the past; this association in turn triggers our emotions (Hoffman, 1984). This innate ability to identify others' emotion is often done through *classic empathic conditioning* by observing non-verbal cues such as facial expression (Salovey & Mayer, 1990). This unconscious contagion of emotion can be reflected at times in the mimicking of facial expression when FLEs interact with customers (Prentice & King, 2011). Such mimicking of facial expressions also articulates empathy through recognizing and displaying emotional expressions (Drimalla et al., 2019).

The Specificities of Emotional Intelligence in the Tourism Industry

The effect of EI on job performance is stronger in the tourism industry, as this requires a higher level of emotional labor compared to other industries (Zhu et al., 2022). These front-line employees often entail deep acting during prolonged interaction with customers, going beyond surface acting in highly scripted interactions as in other industries such as retailing (Lee et al., 2018). In the context of chefs working in open kitchens, Graham et al. (2020) argued that these "front-line" chefs also "perform emotional labor (Hochschild, 1983), . . . servicing customers is a performative doing and a bodily performance which involves ways of delighting and entertaining the customers visually and audibly" (Graham et al., 2020, p. 26). These highlight the uniqueness of the role of EI in the tourism industry.

Facial Expression Recognition

Facial expressions, as well as cues such as body language and voices, are used to perceive the emotions of others (Mayer et al., 2008). This implicit expression of emotions sets the tone in the face-to-face interaction in any service encounter (Prentice & King, 2011), yet employees' ability to recognize customers' emotions has become a subject of study only recently (Zhang et al., 2021). In particular, the ability to utilize facial expression cues is critical in interacting with others and relationship building (Manohar, 2020). These cues facilitate social learning, coordination, and identifying others' intentions. Such non-verbal communications through facial expression are often implicit, occurring subliminally (Zhang et al., 2021).

Recognizing customers' emotions accurately and quickly is especially important among FLEs (Koc & Boz, 2020). As part of the customer experience, FLEs need to act appropriately, reacting to customers' emotions based on their facial expressions (Koc & Boz, 2019). It has been argued that recognition of facial expression is "the first and most important element of emotional intelligence" (Koc & Boz, 2020, p. 124). Indeed, facial expression is measured explicitly in most of the popular EI tests (e.g., Ciarrochi et al., 2001; Petrides et al., 2004; Schutte et al., 1998), with facial expression recognition comprising 20%–50% of the total questions in these studies.

Individuals differ in their ability and disposition to use, and their interpretation of, facial expressions (Salovey & Mayer, 1990). This ability can be developed. It was found that a 40-s training can improve the accuracy and speed of facial expression recognition significantly (Koc & Boz, 2020). In our research, we are interested in how facial expression recognition, and ultimately the ability to empathize, is initiated through the wiring in the brain and reflected in the differences in neurocognitive structure.

The Neuroscience of Facial Expression Recognition

Evolutionary psychologists put forth the social brain hypothesis (Dunbar, 1998; aka. Machiavellian intelligence hypothesis), which depicts that "large brains and distinctive cognitive abilities of humans have evolved via intense social competition in which social competitors developed increasingly sophisticated 'Machiavellian' strategies as a means to achieve higher social and reproductive success" (Gavrilets & Vose, 2006, p. 16823). Maintaining a large brain is costly as it consumes around 20% of total energy intake (Dunbar, 1998). They evolve because the extra neural resources support more sophisticated social cognition that help humans navigate the complex social world (Lucas et al., 2018). Specifically, the development of the neocortex was found to be highly correlated with sociality across species (Dunbar, 2003).

Facial expression recognition is one of the most important social cognition. To support the human social-interaction function, individuals are equipped with a highly developed and sophisticated face-processing system (Manohar, 2020). It takes us as little as 70 ms to recognize a face (Nemrodov et al., 2016), and 100 ms to judge its trustworthiness (Willis & Todorov, 2006). These split-second processes enable us to navigate the social world where interpersonal relationships are paramount to our survival (Manohar, 2020). The ability to track faces is believed to develop as early as 2 months old (Collins & Olson, 2014).

Neuroscientists have identified the brain network that specializes in processing faces. This began with locating a group of neurons in the superior temporal sulcus that responds to face stimuli in the rhesus macaque (Bruce et al., 1981). When neuroimaging techniques became available, studies on human face recognition emerged. In an early fMRI study, it was found that the fusiform gyrus is the dedicated brain region for face recognition (Kanwisher et al., 1997). A magnetoencephalography study revealed that the misperception of other objects as faces evoked a similar activation at the fusiform gyrus in roughly 165 ms, suggesting that face processing at the fusiform gyrus is a primitive type instead of a reappraisal cognition (Hadjikhani et al., 2009). The fusiform gyrus is located on the brain's basal surface of the occipital and temporal lobe, bounded laterally by the occipito-temporal sulcus, and medially by the collateral sulcus.

Other neural studies have found a network of brain regions that are involved in face processing, such as the occipital face area. Studies show that damage to the occipital face area, fusiform gyrus, and the superior temporal sulcus may result in *prosopagnosia* or face blindness, an inability to recognize familiar and famous faces. Those with prosopagnosia cannot associate faces with identities. One study revealed that a patient had problems in facial recognition with a lesion to her right occipital face area, although with fusiform gyri bilaterally intact (Rossion et al., 2003). Research on the inability to recognize face identity given a lesion in the occipital face area provides evidence that the fusiform gyrus alone is insufficient for face recognition (Steeves et al., 2006). Furthermore, temporary experimental disruption of the occipital face area by repetitive transcranial magnetic stimulation (TMS) results in impairment in face identity discrimination (Solomon-Harris et al., 2013). Together these neuroimaging, lesion, and TMS studies identify the functioning of a brain network of the fusiform gyrus and occipital face area in the neural processing of faces.

More importantly, these brain areas also support facial expression processing. For example, the fusiform gyrus has been associated with recognition of facial expressions (Guyer et al., 2008). Specifically, the right fusiform gyrus is more activated by fearful than neutral faces (Vuilleumier et al., 2001). The bilateral fusiform gyri respond to the intensity of the happiness of a facial expression (Morris et al., 1998). Therefore, the ability to process facial expression is associated with the structure of the brain. It was found that the grey-matter density of the fusiform gyrus was positively correlated with performance in an emotion conflict-resolution task in which participants had to regulate their emotion induced by observing others' facial expressions (Deng et al., 2014).

Not only is the fusiform gyrus involved in facial expression recognition, the neighboring occipital face area is too (Nagy et al., 2012). This became evident in studies on brain lesions. A patient with bilateral occipital face area damage exhibited a severe impairment of the ability to recognize emotional expressions (Steeves et al., 2006). This finding is corroborated by a TMS study in which disruption to the occipital face area by TMS impaired the facial expression recognition ability (Pitcher et al., 2008).

Sometimes we receive inconsistent or mixed signals from non-visual cues of others' emotions through different modes (Koc & Boz, 2020). Guest emotional responses and perceptions of service quality will be influenced by non-visual paralanguage communication and vocal qualities such as tone, intonation, accent, volume, pitch, and patterns of stress (Sohn & Lee, 2018). In a review, the fusiform gyrus was found to be consistently activated through its integration of tone of voice and facial expression in the perception of others' emotions (Klasen et al., 2012). In one study, this integrative process was found to involve a network of brain regions including the fusiform gyrus (Kreifelts et al., 2010). Interestingly, these authors also find a positive correlation between the sensitivity of non-verbal information from faces in the fusiform gyrus and trait EI.

It was shown that the aptitude for emotional communication can be enhanced through non-verbal emotion communication training (NECT; e.g., Costanzo, 1992). Hospitality and tourism research indicate that non-verbal expressions and gestures by employees are a crucial part of determining service experience, and can have a significant effect on customers' positive emotions and dining satisfaction (Jung & Yoon, 2011). Gabbott and Hogg (2000) used an experimental research approach providing consumers with video scenarios to rate their reaction to non-verbal behaviors of the service provider. The important role and influences of non-verbal communication in service encounters means it must be part of service standard benchmarking and assessment (Gabbott and Hogg, 2000). Adopting neuroscience on hospitality non-verbal studies by tracking neural cues from customers and employees would provide insight into what non-verbal dimensions have greatest impact on the service experience. One neuroscientific study on behavioral sensitivity to non-verbal emotional expressions replicated the effect of NECT, showing that a 4-week training, compared with a Sudoku training, can modify the neuronal processing of non-verbal cues (Kreifelts et al., 2013). Interestingly, the right fusiform gyrus was found to be more responsive to emotional non-verbal cues, with an increase in grey-matter volume of the same brain area observed. In response to the training, the face-processing system demonstrated functional and structural plasticity, which refers to the brain's ability to change its activities by reorganizing its function and structure.

The Developmental Trajectory

The social brain hypothesis is also used to explain differences at the individual level (Lucas et al., 2018). "Individuals in many social species have advanced cognitive skills that are selected for by their more complicated levels of sociality. This complex sociality, in turn, selects for advanced levels of communicative skills in individuals" (Lucas et al., 2018, p. 443). This individual difference in sociality within species is often studied among baboons (Dunbar, 2003). Specifically, sociality among female baboons are found correlated with their infants' survival and fitness. This evolutionary advantage is thought to be associated with the cognitive ability to learn others' social intentions.

The employee's cognitive abilities will impact service routine and behavior (Tsai, 2009). Employee cognitive skills considers several general intelligence and key competencies for those working in tourism and hospitality (Chapman & Lovell, 2006). These include verbal comprehension, memory, spatial ability, which at a higher level entails the ability to use judgment and discretion (Chapman & Lovell, 2006). The importance of employee abilities will differ on performance importance according to job tenure length, with conscientiousness foremost for predicting performance for longer employed hospitality staff, compared to general mental ability for new recruits (Tracey et al., 2007).

Cognitive abilities such as facial expression recognition are one critical way to learn others' intentions and developed early in our lives. The individual differences can be determined by genetic dispositions and guided by environmental influences. In the 17th century, the English philosopher John Locke proposed the *blank slate* view that human behavioral traits are shaped exclusively by environmental influences. While the complete denial of herticability is unrealistic, this view was popular in the 20th century. In order to find the answer to this debate, geneticists decompose the genetic and environmental factors by comparing monozygotic and dizygotic twins. It is not surprising that behavioral traits are shaped by both factors. These twin studies often found that heritability contributes around 40% to 50% to different traits. Thus the discussion of nature versus nurture has been diverted into one focusing on the interaction of these two factors.

In developmental evolutionary psychology, it is commonly believed that the development of different cognitive abilities is shaped by both genetic and environmental factors. These developments are highly sensitive to the contexts. Childhood is an important period when these developments occur through social interaction with other members of the community. There are two patterns of developments relevant to our context. First, some behavioral traits exhibit *deferred adaptation* in which traits develop early depending on their environments during childhood and adolescence (Bjorklund, 1997). These early developments prepare the individuals for adult life later. Second, the development of other traits displays developmental plasticity throughout the individuals' lives (Boyce & Ellis, 2005). This *conditional adaptation* allows the trait to develop contingent on the environment. The adaptative feature facilitates social learning even after the adolescent period. The environmental factors continuously exerts an influence in shaping the trait to be adaptive to particular environments. Hospitality employee adaptation has been especially apparent during the COVID-19 pandemic through complying with safety measures, and mitigating negative emotions (Zhang et al., 2021).

Neuroplasticity

The developments of behavioral traits are supported by the feature of neuroplasticity and likely leave traces to the structural reorganization in the brain. The long-held view that the brain does not change after childhood has been refuted (Livingston, 1966). Instead, the human brain shows considerable degree of plasticity and these changes can be activity-dependent (Ganguly & Poo, 2013). It was found that healthy development, memory formation, learning, and brain damage induce functional and structural changes through molecular mechanisms of long-term potentiation and long-term depression (McClung & Nestler, 2008). These lead to rewiring of the brain in terms of changes in neurons and synaptic connections. The development through neuroplasticity is believed to be the brain mechanism of learning new skills and languages throughout the lifespan.

Given the constant interaction between employees and guests continually changing preferences, business success means that employee skills and knowledge advancement must keep relevant with these rapid changes (Dolasinski & Reynolds, 2020). Solnet et al. (2016) noted the growing need for high-level hotels in the future to have FLEs with abilities to be emotional and intuitively adept, with heightened social and communication skills. Neuroplasticity can contribute to our understanding of FLE learning and development.

Structural Brain Difference

Our aim is to study potential differences in how the brain may organize structurally between FoH and BoH employees. The study of structural brain difference (SBD) can potentially reflect individual differences in cognitive abilities and styles at a trait level (Weisberg & Ekstrom, 2021). Studies of brain structure differences often examine grey-matter volume, as this is linked to differences in brain function, cognitive styles, personality traits, behaviors, and choices (Plassmann & Weber, 2015). Studies on brain structure differences can shed light on the underlying processes of behavioral differences. The idea is that grey matter is where the neural cell bodies, axon terminals, dendrites, and nerve synapses are. Thus grey-matter volume will reflect the number and size of neurons and synaptic connections of different brain regions.

SBD also offers opportunities to investigate the neuroanatomical basis for differences in behavior, personality, and professions. Studies have found SBDs among symphony orchestra musicians (Sluming et al., 2002), musicians with perfect pitch (Bermudez et al., 2009), mathematicians (Aydin et al., 2007), endurance athletes and martial artists (Schlaffke et al., 2014), expert jugglers (Gerber et al., 2014), and professional divers (Wei et al., 2009). SBD has been an important tool in identifying neuroanatomical biomarkers for neurological disorders (Scarpazza & De Simone, 2016) including Alzheimer's disease (Ferreira et al., 2011), obsessive compulsive disorder (Huyser et al., 2014), schizophrenia (Honea et al., 2005), and Parkinson's disease (Kobayakawa, 2017). Aside from the study of neurodegenerative disease, SBDs have also been used to examine brain changes in healthy aging (Hutton et al., 2009).

A famous example of SBD was the London taxi driver studies (Maguire et al., 2000). In order to qualify as a London taxi driver in 3 to 4 years (Woollett & Maguire, 2012), an individual is expected to demonstrate a thorough knowledge of the city within a six-mile radius originating at Charing Cross (Griesbauer et al., 2022). The taxi drivers were found to have greater grey-matter volume in the mid-posterior hippocampi than London bus drivers, who although matched with driving skills and levels of stress, had a fixed driving route (Maguire et al., 2006). The hippocampus has been implicated in the storing of spatial information such as mental maps of the environment. The hippocampal volume were also found to increase with the amount of time the taxi driver had been driving (Maguire et al., 2000). These studies demonstrate the plasticity of the human brain and its capacity to change in response to extensive experience and learning (Maguire et al., 2006). The neuroplasticity observed in the hippocampus supports the conditional adaptation. Learning to navigate can be acquired during the lifespan and induce the rewiring of adult brains.

Another interesting hypothesis on the hippocampal volume could be that those becoming London taxi drivers had an innate ability to navigate and an increased likelihood of becoming a taxi driver (Maguire et al., 2000). Such deferred adaptation is not supported. In our study, we test whether the cognitive ability of emotion expression recognition follows conditional adaptation or deferred adaptation.

Method

Participants

Sixty-eight senior executive participants from FoH and BoH positions were recruited from a large integrated resort in Macao. The study was approved by the ethics review committee of the authors' university. Participants gave written informed consent to take part in the MRI study and our analysis using their brain structural images. Only right-handed participants above 18 years of age with normal or corrected to normal vision were allowed to participate. Those with general contraindications for MRI (e.g., metal implants, claustrophobic, pregnant, weigh over 135 kg, or history of anxiety disorder) were excluded. Two of the participants did not meet our inclusion criteria. Three were excluded at the MRI laboratory due to possible movable body metal implants that were identified during the final body check prior to entering the MRI. As a result, structural brain images of 63 participants ($M_{age} = 42.63 \pm 6.84$ *SD*) were collected. After the brain scanning, participants filled out a questionnaire on their demographics and job nature. The median annual income ranged between USD 100,000 and 125,000. The average working experience was 11.06 years (± 6.31 *SD*).

Control Group

The selection of a comparable control group is important (Griesbauer et al., 2022). In the case of the London taxi driver study, the drivers were compared to a group of bus drivers to determine SBDs related to cognitive ability (Maguire et al., 2006). Since the bus drivers drove daily and had extensive exposure to the city of London similar to the taxi drivers, the SBDs were then safely attributed to the extensive spatial knowledge of the taxi drivers. We chose BoH executives as a control group, who like FoH were exposed to the same industry and company culture, with similar incomes and other demographics (age, gender). Taking all these into consideration, we conclude that the BoH employees should be the ones that meet all criteria. We have a balanced sample. Among the 63 participants, 24 of them were FoH employees and 39 BoH ones (see Table 2). No significant difference was observed in age ($M_{FoH} = 43.29$; $M_{BoH} = 42.23$; $t = 0.61$, $p > .5$) and gender distributions ($z = 1.22$, $p > .1$).

Structural Brain Image Acquisition

The participants underwent a MRI on a 3.0 T Siemens MAGNETOM Prisma MRI scanner with a 32-channel head coil at the authors' university. Whole-brain T1-weighted images with resolution of $1 \times 1 \times 1$ mm were collected in transversal orientation. The sequence parameters were TR = 2,300 ms, TE = 2.26 ms, flip angle = 8°, and FOV = 256 mm.

Voxel-Based Morphometry

We are interested in discerning the SBD between the FoH and BoH employees using VBM (Ashburner & Friston, 2000). VBM is the most common method to study structural brain differences (Plassmann & Weber, 2015). We conducted a whole-brain VBM analysis to test whether the grey-matter density of specific brain structures differed between the two employee groups. This enables voxel-wise statistical tests for

Table 2. Demographics of the FoH and BoH Executives (Standard Deviations in Parentheses).

	Front-of-house	Back-of-house
Age	43.29 (6.36)	42.23 (7.18)
Gender		
Male	13.00	16.00
Female	9.00	21.00
Not reported	2.00	2.00
Experience	11.13 (7.11)	11.03 (5.87)

macroscopic grey-matter asymmetries (Ocklenburg & Güntürkun, 2018). There are several steps to this. First, the brain image is segmented into three different tissues: grey matter, white matter, and cerebrospinal fluid. Second, the brain image is spatially normalized to a standard template to allow comparisons across participants. Third, the images are then smoothed with a Gaussian kernel of 10 mm half-width. Fourth, to account for interpersonal variations of brain sizes, we apply a proportional scaling for global normalization using the total intracranial volume. Finally, a statistical analysis is conducted to localize brain structures that are significant between groups of interest. A statistical parametric map is created revealing regions with different grey-matter volumes.

The VBM analysis is conducted using SPM12 (Ashburner & Friston, 2000). The 63 high-resolution brain images were processed as follows. A whole-brain analysis was conducted to identify any brain regions with significant differences in grey-matter density. We repeated the same analysis by entering age and gender as covariates, as these have been shown to correlate with grey-matter volume (Hutton et al., 2009; Luders & Toga, 2010). To test the hypothesis regarding developmental trajectory, we extracted the estimates of grey-matter volume from our regions of interest (ROIs) using MarsBar (Brett et al., 2002), and further regressed these with regard to the participant's frontline role, experience, and interaction, including age and gender as covariates.

Results

Manipulation Check

FoH employees reported more contact with customers ($M=7.17$) than BoH employees ($M=3.87$, $t=4.66$, $p<.001$).

Structural Brain Differences

The FoH group displayed increased grey-matter density in the occipital face area extending to the fusiform gyrus compared with the BoH group (see Figure 1). The peak voxel of difference in grey-matter volume was found in the occipital face area ($x=51$, $y=-86$, $z=-20$; $t=5.05$, $p<.05$, FWE-corrected) and the fusiform gyrus ($x=48$, $y=-32$, $z=-29$; $t=3.15$, $p<.001$).

On the other hand, the BoH employees showed greater grey-matter volume in the right dorsal lateral prefrontal cortex (dlPFC; $x=-26$, $y=39$, $z=44$; $t=3.79$, $p<.001$) and the left dlPFC ($x=30$, $y=36$, $z=38$; $t=3.70$, $p<.001$; see Figure 2).

To test whether variations in grey-matter volume of these three regions (our ROIs) were dependent on the number of years working in the industry, the estimated volumes were regressed against the frontline role (dummy variable: FoH=1, BoH=0), experience, and their interaction, as well as age and gender as covariates (see Table 3). Neither experience nor interaction with the frontline role was significant.

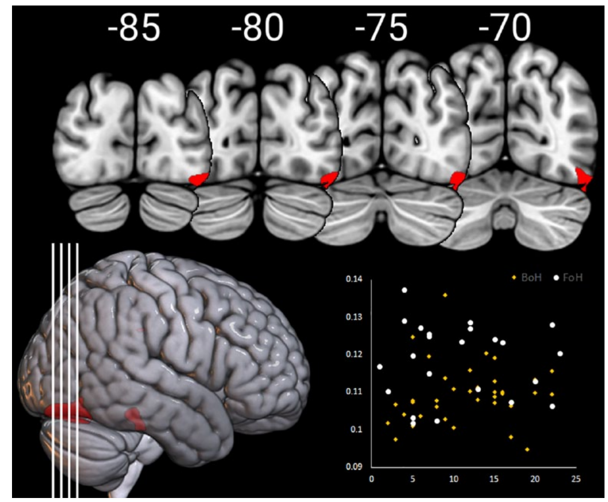

Figure 1. Structural brain difference, with members of the FoH group displaying greater grey-matter volume than members of the BoH group. Coronal view (upper panel) and render view (bottom left panel) of the OFA extending to the FFA. Grey-matter volume is plotted against experience (bottom right panel).

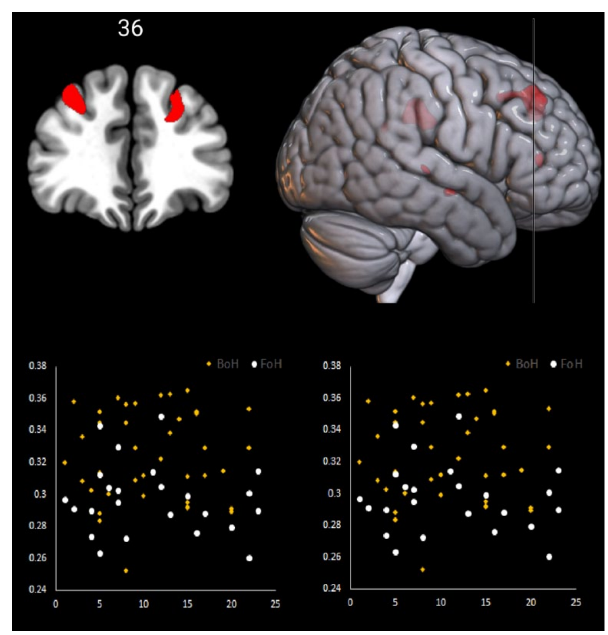

Figure 2. Structural brain difference, with members of the FoH group displaying greater grey-matter volume than members of the BoH group. Coronal view (upper left panel) and render view (upper right panel) of the bilateral dlPFC. Grey-matter volume is plotted against experience (dlPFC left: bottom left panel; dlPFC right: bottom right panel).

Discussion

We study the effect of being a FLE in the tourism industry through investigating the organization of employee brain

Table 3. Regression Results of Grey-Matter Volume on Frontline Role and Demographic Variables.

		Frontline	Gender	Age	Experience	Experience × Frontline	R^2
Occipital face area	(1)	0.0100 (4.23)***					.2270
	(2)	0.0086 (3.72)***	−0.0063 (−2.82)**	0.0001 (0.31)			.3197
	(3)	0.0062 (1.79)*	−0.0060 (−2.63)**	0.0000 (0.28)	0.0001 (0.44)	0.0003 (0.95)	.3322
dlPFC (L)	(1)	− 0.0265 (−3.91)***					.2008
	(2)	−0.0240 (−3.52)***	0.0077 (1.16)	−0.0008 (−1.68)*			.2531
	(3)	−0.0358 (−3.54)***	0.0088 (1.31)	−0.0008 (−1.54)	0.0001 (0.24)	0.0014 (1.58)	.2849
dlPFC (R)	(1)	−0.0281 (−3.73)***					.1856
	(2)	−0.0272 (−3.5)***	0.0010 (0.13)	−0.0006 (−1.11)			.2025
	(3)	−0.0287 (−2.46)*	0.0020 (0.26)	−0.0007 (−1.26)	0.0005 (0.87)	0.0002 (0.2)	.2134

Note. *t*-statistics in parentheses.
***$p < .001$. **$p < .05$. *$p < .1$.

structures. A VBM analysis was performed on high-resolution structural brain scans of 63 senior executives from an integrated resort to examine the variations in grey-matter density of different brain regions and reveal individual SBDs in the roles these executives hold. A comparison between FoH and BoH employees found that the FoH employees' occipital face area extending to the fusiform gyrus had higher grey-matter density than the same brain area of the BoH employees. The occipital face area and fusiform gyrus are associated with the processing of visual information from facial expressions and nuances. EI has been emphasized as essential in FLEs (Viglia & Rodrigo, 2020), with our study suggesting that FoH employees have greater neural resources to process visual cues than BoH.

A strong cognitive ability to recognize facial expression is attributed to the FoH employees (Koc & Boz, 2020). Our findings suggest that this important quality of EI among frontline employees is hardwired in the brain. It is well established in the neuroscience literature that the fusiform gyrus and occipital face area are associated with facial expression recognition. For the first time we show this to occur in the tourism workforce. Our executive participants were senior in their careers, as reflected in their remuneration and number of years in their profession. The SBDs, and in particular in the facial expression recognition areas, are good indications of what it takes to succeed in these frontline roles. Research in neuroscience has demonstrated that non-verbal emotion communication training will increase grey-matter volume in the right fusiform gyrus (Kreifelts et al., 2013). We extend these findings to show that based on job-related exposure, we can identify significantly larger grey-matter volume in the same brain region.

Theoretical Contributions

We build on current neuroscientific knowledge of facial expression recognition to explore how FLEs may differ from other employees in their processing of facial expressions. The results support the social brain hypothesis which depicts that resources are diverted to brain development for supporting sophisticated social cognition. Individuals with more developed social cognition are better prepared to survive in frontline roles.

There are two possibilities for why members of our FoH employee sample have more developed neural systems for recognizing facial expressions. First, their brains may adapt to environmental factors. FoH employees are regularly exposed to situations that exercise their abilities of facial expression recognition. This developmental trajectory is referred to as conditional adaptation in developmental psychology. The brain has the ability to change structurally after prolonged exposures such as training and education. For example, London taxi drivers displayed greater grey-matter density in their hippocampus, an area associated with spatial navigation, such that the size correlated with the number of years the driver had been in the profession (Maguire et al., 2000). However, the FoH employees seem to show brain structural changes in areas that are associated with facial expression recognition before their careers. There is no evidence for further development in these brain regions. Further studies would be needed using interventions such as specific training or job-shadowing programs to confirm the effect of training and education on the neural system.

Second, equally plausible is the possibility that employees with better facial expression recognition, supported by a more developed neural system, are more suitable for FoH roles. The lack of moderation by the length of experience suggests that the difference in the grey-matter volume between the two groups most likely occur prior to their FoH careers and may not be developed during their tenures. These employees with a more developed neural system for facial expression recognition are predisposed to choose a career characterized by frontline responsibilities. Potential FoH employees may either self-select these roles during the recruitment process or thrive better in these roles, or both. The superior development occurs early in the individuals' childhood and adolescent period to prepare for their adult lives. Behavioral trait following this pattern of developmental pathway is referred to as deferred development. This neurodevelopmental perspective has been adopted in other fields such as education research and can be used to provide evidence-based recommendations to practice (Stern, 2005). It was hypothesized that the gender difference in student performances in mathematics and science arose from differences in the ability to use visual–spatial representations as reasoning tools. A brain structural imaging study supported this hypothesis, finding that the volume of the inferior parietal lobe, associated with mental rotation task performance, was on average 20% bigger among males than females (Goldstein et al., 2001).

The decreased grey-matter volume in the bilateral dlPFC among FoH employees is another interesting finding. The dlPFC has been associated with high cognitive functions such as executive functioning, conscious decision making, reasoning, and control of cognitive processes. More interestingly, it is involved in cognition in social contexts. Using the UCLA Loneliness Scale (Russell, 1996), researchers found that lonelier individuals had larger grey-matter volume in the dlPFC (Kong et al., 2015). This relationship was further found to be mediated by extroversion. In particular, introverts reported being lonelier, and they happened to have larger dlPFC volume. Another study documented that individuals with larger dlPFC volumes were less cooperative in the Prisoner's Dilemma game. These more proself individuals also showed greater dlPFC activity when they made social dilemma decisions (Fermin et al., 2016), leading to the conjecture that being cooperative is a natural tendency, down-regulated by the more "rational" process at the dlPFC (Fehr & Krajbich, 2014). The study most relevant to our finding is one that shows a negative correlation between grey-matter volume of dlPFC and EI (Xiang et al., 2017). Thus it makes sense to observe larger grey-matter volume in the dlPFC of BoH executives.

Our findings contribute to collective understanding of the unique cognitive abilities shared by FLE executives. The quality is likely to be rooted at a neuroscientific level. Tourism studies on EI had primarility focused on self-reporting methods. Studies have affirmed the weakness of self-reporting methods due to biases such as social desirability concerns, affirming the ability of neuroimaging to overcome this by identifying the underlying brain mechanisms with pinpoint accuracy (Bell et al., 2018). As a first step, our work sheds light on the underlying mechanism contributing to the necessary condition for customer service and highlights the importance of facial expression recognition. This observation together with the dlPFC result just described suggest that the provision of customer service is less about higher cognitive or rational processes such as reappraisal of perceived emotions, and more about the direct and authentic empathetic responses to customers' emotions. The learning and development of these skills may be limited, as brain areas associated with these cognitions do not seem to develop much along their tenures in the frontline roles.

Our findings seem to contradict the extant literature on training and development of EI in psychology (e.g., Mayer & Salovey, 1997) and tourism (e.g., Lam et al., 2021) research. We believe there are two possible reconciliations. First, there are two conceptualizations of EI: *ability* and *trait* (Hodzic et al., 2018). Ability EI refers to the few aspects or skills such as an individual's ability to perceive emotions, facilitate thought, understand emotions, and manage emotions (Mayer et al., 2004). Trait EI is conceptualized as emotion-related dispositions and is more basic than personality traits (Petrides et al., 2007). Genetic factors explain about 40% of the variance in trait EI (Petrides, 2017). Thus our findings point to the latter. The basic process of facial expression recognition is supported by a highly dedicated neural system. The individual differences in this cognition are reflected in the relative development of this neural system. It has been argued that EI trainings lead to improvements in ability rather than trait EI (Hodzic et al., 2018), which our findings suggest is more resistant to changes.

Second, training and education are fundamentally different from daily experience on the job. The former is more targeted to particular aspects. Training is more successful in improving "what is denominated as declarative knowledge, factual information about emotions, and emotional abilities, not the actual skills to use this information. . .[and] increasing explicit knowledge, enhancing awareness about different emotional abilities or aspects of EI, not on how they actually are used in every-day situations" (Hodzic et al., 2018, p. 145). By contrast, development in EI with environmental stimuli through life experience can be much slower (Mayer & Salovey, 1997). The success of such development may also depend on contextual factors such as transformational leadership (Yuan et al., 2012). Trainings may improve short-term job performance involving emotional labor (Miao et al., 2021), but the long-term effect is not known (Koc & Boz, 2020). It is likely that employees with better trait EI are the ones who can survive the stress from emotional labor and thrive as the senior FoH executives in our sample.

Future Considerations

There are recent calls for using neuroscientific tools in tourism research (Koc & Boz, 2014; Li et al., 2022). Ma et al. (2014, p. 1637) first coined the term *neurotourism* to describe research that "explores the neural mechanism underlying tourists' behaviors and aims to advance tourism research." From the study of neural mechanisms we see that there are quite a few tools to use in neurotourism such as electrodermal activity measure; eye tracking; magnetoencephalography; facial electromyography; and fMRI. These tools extend our ability to observe the formerly invisible underlying processes of different behaviors. As proposed by Plassmann and Weber (2015), other imaging tools such as structural brain imaging can complement fMRI. Ours is a good example of such complementation in our effort to gain a better understanding of frontline employees. In one fMRI study (Choi et al., 2022), FLEs were found to be habituated in their neural responses to customer incivility. We suggest that more successful FoH executives may be those who have a more developed ability to pick up the nuances of customers' emotional expressions. An important difference between our study and that of Choi et al. (2022) was that members of our FoH group were more senior. Choi et al. (2022) showed that habituation is common among junior FoH employees. Our findings instead show that more successful executives may have a more efficient brain network for processing emotions. This is quite possible, as suggested by the taxi driver study. Only the ultimately qualified drivers displayed an increase in their hippocampal size, while those who went through the same training but did not succeed were left with no changes in their hippocampi (Woollett & Maguire, 2011).

Neurotourism is at a nascent stage, but meanwhile neighboring fields such as neuromarketing have advanced and can present possibilities for use of neuroscientific tools in tourism research. For instance, Plassmann et al. (2008) showed that price can modulate experience utility. In this seminal work, while the respondents could taste five different wines with different prices, it was unknown to the respondents that there were only three different wines. The participants were asked to focus on the taste, and they reported increasing pleasantness ratings as prices increased. The higher taste expectations lead to a higher activity in the medial orbitofrontal cortex of the brain, a part of the brain encoding pleasantness. Thus the effect is not a mere artifact of socially desirable response or experimenter effect but is "real" in the sense that our bodies are automatically reacting to prices during our consumptions. Again, like the study by Choi et al. (2022), this price-label effect on experienced utility cannot be shown without neuroimaging tools, as the whole point of the investigations was to observe the once unobservable responses, compared to those easily observed with self-report responses. The neuroscientific tools open up many new opportunities to dig into untapped territories in tourism research, including the type of studies that have for decades relied on self-reported responses.

Despite the importance of the role of FLEs, there has been no SBD research conducted in this area. Our study represents the first attempt to apply a popular neuroimaging tool in tourism research. A similar method was successfully adopted to study individual cognitive-process differences in consumer research. It was used as a moderator when determining underlying consumer behavior by Plassmann and Weber (2015), who asserted that SBDs can be useful tools to study individual differences in personality and cognitive processing. They found that the marketing placebo effect—a reference to the change in consumption experience due to the expectations created by marketers' actions—was predicted by variations in grey-matter volume in a few brain regions. An example of the marketing placebo effect is the price-tag effect on wine consumption mentioned above (Plassmann et al., 2008). Based on our knowledge of the functioning of these few structures, we gain a new perspective on the underlying process of the marketing placebo effect.

Practical Contributions

As we enter new territory to investigate the neuroscientific basis of frontline roles in the tourism literature, there are key human resources management implications for work placement and service training of employees, as well as executives who will lead and mentor teams. Specifically, employees should choose their careers carefully at the beginning. The neural resources for facial expression recognition among FLEs seems to be fixed and does not show development along the trajectory of one's career.

Through the comparison in SBD, we illustrate that brain regions are implicated in FLE cognitive processing, showing differences in the structural brain images between FoH and BoH employees. With the ability of fMRI improving predictions on the behavior of potential and current employees in tourism and hospitality, the following are recommended. First, core soft skills including communication, professionalism, and decision-making have been identified by companies as key in tourism (Wesley et al., 2017). Whereas a brain scan can be costly and is not interpretable without comparing against a decent sample size, it does not take neuroscience to understand one's own strength in aspects such as interpersonal skills and facial expression recognition. For instance, there are EI tests relying on self-reporting that can help employees and employers to better identify and align their strengths (Zhu et al., 2022). Second, our study could guide future FoH employment selection procedures. Research on performance pressure, mindfulness, and engagement among FoH employees recommended hospitality managers use the results for recruitment and training policies (Rescalvo-Martin et al., 2022). Skill needs will also differ during the staff tenure (Tracey et al., 2007). A key finding in our study was that FoH employees had more developed neural systems to recognize facial expressions. These brain stimuli could be tested at the outset of a recruitment process. Third, research has highlighted the importance of monitoring FLE stress and burden as this influences service delivery (Tsaur & Hsieh, 2020). Neuroscience supports conditional adaptation and neuroplasticity, with traits developed by environmental influences. Fourth, an employee development strategy can include coaching, mentoring, and job shadowing to encourage FLE behaviors, appreciation, and emotional state that are congruent to the guest's culture (Lam et al., 2022). The neuroimaging tool can determine the effectiveness of cross-cultural training in areas such as identifying visitor emotional cues. With neuroplasticity, and the ability of the brain to structurally reorganize, the employee's grey matter volume in brain could be monitored throughout the development scheme.

Coaching and mentoring interventions could be conducted based specifically on employee neural responses to verbal and nonverbal cues. Given the importance of nonverbal communication in the FLE and customer exchange, a number of staff training techniques have been recommended such as simulated customer contact scenarios and service inclination personality testing (Gabbott & Hogg, 2000). The SBD method could be added to provide greater insight on such training programs. Fifth, our findings also suggest the importance of early development of interpersonal skills. In the past, it has been proposed that such skills should be included in the tourism education at the teritary level (e.g., DiMicelli, 1998; Oktadiana & Chon, 2017; Rimmington, 1999).

There is a growing use of artificial intelligence (AI) to detect facial expressions. As with the London taxi drivers who were tested on their navigation abilities from memory (Griesbauer et al., 2022), FLEs must pick up the emotional signals from a customer's facial expression in a split second without any AI assistance or other technologies, despite these being available for more than a decade (Esau et al., 2007). AI technology is now emerging in hospitality and tourism—for example, a KFC outlet in Beijing detects customers' moods in order to make recommendations at POS terminals (Wu & Cheng, 2018). In humans, the reaction to others' emotions is an automatic and unconscious process, and as we have described above, it is supported by an extensive brain network. Facial expression mimicry will come more naturally than a response based on an outcome of technology-enhanced identification, which is similar to an appraisal account of emotional response. Even with technologies like Google Glass that may help inform employees about the real-time emotions of customers, the conscious and "educated" reactions by FLEs are different and difficult to replace, as genuine reactions are biologically endowed.

Limitations

This study advances the field of neurotourism, the intersection of neuroscience and tourism studies. However, there are a few cautionary notes, as in other studies using different methodologies. First, the finding of a lack of moderation by experience comes from a cross-sectional comparison. We were unable to confirm whether the more developed neural system for facial expression recognition in FoH executives was a direct consequence of their employment and training, or external sources such as family and social interactions. As our study did not exclude the possibility of external influences such as education on the development of grey matter volume, future research could include assessing the impact of training and education interventions. Given the important implications for human resources planning, a longitudinal study tracking the brain structural changes of FoH employees is suggested. This could also be tested with specific training courses to explore whether these resulted in actual neurological responses. Second, FoH and BoH employees are not necessarily homogeneous groups. Those in frontline roles such as front office and housekeeping may have different attitudes, motivations, and experiences in their jobs (Robinson et al., 2016). Research on EI has recommended considering hospitality roles, whether BoH or FoH, staff, manager, or executive (Miao et al., 2021). As a first step, we studied the differences between BoH and FoH. Future studies could isolate those engaged in specific frontline roles such as immigration officers, retail sales staff, flight attendants, or ticketing staff, to determine whether the cognitive processes of the individuals were consistent or differed with those in other sectors. BoH and FoH analysis could be applied in different hotel environments, be it luxury hotels or those with limited facilities, to established hotel brands compared to local ownership. The findings would provide practical insights on providing directed service training to enhance the FLE to visitor interaction. We recommend expanding the research to include more roles and levels. Third, we do not know how the neural mechanism interacts with culture. We did not ask for country of origin from the executives, yet we noted there was a mix of Asians and Westerners in our sample. This may enhance the generalizability of our findings. There may be other factors such as culture and ethnicity that influence the effect of the frontline role on SBDs that cannot be uncovered in the current sample. Given the multicultural nature of those working in tourism, future research may study the intercultural or inter-ethnicity differences. Lastly, the structural brain images were collected after the outbreak of the coronavirus. Although brains are capable of adapting to environmental changes such as a pandemic with resulting structural changes, it is unlikely that such changes interact with the role—that is, whether the employees work in FoH or BoH roles—and drive the results we observe.

Appendix

Region	Size (voxels)	*t*-score	MNI coordinates		
			x	y	z
FoH > BoH					
Occipital Face Area/Fusiform Gyrus	943	5.05*	51	−86	−20
Inferior Temporal Gyrus	32	3.57	51	−36	−18
Fusiform Gyrus	8	3.30	48	−32	−29
BoH > FoH					
dlPFC	149	3.79	−26	39	44
dlPFC	218	3.7	30	36	38
Cingulate Gyrus	149	3.55	−8	−32	33

Note. Results of VBM threshold at cluster size >5 and $p < .001$, uncorrected.
*$p < .05$, FWE-corrected.

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