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The neural substrates of the self-prioritisation effect: the role of familiarity and emotionality

PhD thesis
Completed in the Laboratory of Language Neurobiology
of the Nencki Institute of Experimental Biology
Polish Academy of Sciences

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Warsaw, 2023

This research was funded by the National Science Centre Poland (Grant No. 2018/31/B/HS6/00461 awarded to Prof Anna Nowicka).

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Abbreviations

CLARA – Classical LORETA Recursively Applied

EEG – electroencephalography

ERP – event-related potential

fMRI – functional magnetic resonance imaging

FRU - face recognition unit

IPA – implicit positive association

LPP – late positive potential

PIN - person identity node

SAN – self attentional network

SPE – self-prioritisation effect

SIU - semantic information unit

Streszczenie

Ilość informacji napływających z otaczającego świata jest ogromna i przytłaczająca. Niemniej jednak, ludzie nie doświadczają stale konsekwencji ich ogromnego napływu. Jest to przede wszystkim wynik zachodzenia selekcji informacji, która nie zawsze jest zależna od świadomych decyzji. Jednym z możliwych kryteriów w selekcjonowaniu informacji jest odniesienie jej do własnej osoby i wydajniejsze jej przetwarzanie. Efekt ten nazywany jest efektem priorytetyzacji informacji związanych z JA (ang. *self-prioritisation effect*, SPE). Chociaż SPE obserwuje się w wielu różnych kontekstach, czynniki odpowiedzialne za to zjawisko są wciąż dyskutowane. W dotychczasowej literaturze postulowane były dwa czynniki, znaność/znajomość (ang. *familiarity*) i emocjonalność (ang. *emotionality*), lecz większość badań skupiała się głównie na pierwszym z nich. W pracy doktorskiej, wykorzystując metody elektrofizjologiczne, zamierzałam niezależnie zbadać rolę każdego z tych dwóch czynników.

Pierwsze dwa badania poświęcone były czynnikowi emocjonalności. Ponieważ emocje mogą być postrzegane obiektywnie lub subiektywnie, rozróżnienie to przeniosłam na badany przeze mnie czynnik emocjonalności. W pierwszym doświadczeniu skupiłam się na wpływie obiektywnej emocjonalności, porównując przetwarzanie własnej twarzy i nieznanych twarzy emocjonalnych. Analiza potencjałów wywołanych (skupiona na P3 i LPP) oraz testy permutacyjne oparte na klastrach aktywności mózgowej wykazały, że przetwarzanie twarzy własnej jest unikatowe i nie przypomina przetwarzania obiektywnie emocjonalnych twarzy. W kolejnym badaniu w centrum uwagi znalazła się subiektywna emocjonalność. Aby ocenić jej wpływ na SPE, do badania dodano twarz bliskiej osoby. Taka osoba prezentuje podobną kombinację czynników znaności i emocjonalności, jaką posiada JA, dlatego twarz bliskiej osoby wydaje się najlepszym porównaniem do własnej twarzy. Co więcej, ponieważ pandemia COVID-19 znacząco wpłynęła na życie ludzi w ciągu ostatnich kilku lat, cele tego badania zostały rozszerzone i przetestowano, czy SPE wystąpi również w przypadku, gdy jest niepełny dostęp do informacji o twarzach. Analiza źródeł pokazała, że przetwarzanie twarzy częściowo zakrytych angażuje typowy dla przetwarzania twarzy region mózgu, zakręt wrzecionowaty. Amplitudy wczesnych (P1) i późnych (P3, LPP) komponentów ERP spójnie wskazywały, że wszystkie zakryte twarze wymagały do przetworzenia większej uwagi, a maski chirurgiczne nie osłabiły SPE, gdyż twarz własna w obu warunkach (tzn. twarze z maseczkami lub bez) wywołała znacznie wyższe amplitudy P3 i LPP. Ponadto wystąpiła

istotna różnica pomiędzy przetwarzaniem twarzy własnej i twarzy bliskiej osoby. Ten układ wyników podważa potencjalną rolę subiektywnej emocjonalności, a w połączeniu z ustaleniami z pierwszego badania, ogólnie minimalizuje rolę emocjonalności.

Ostatnie badanie poświęcone było czynnikowi znaności. Aby rozdzielić wzajemne oddziaływanie obu badanych czynników, wyrównano poziom znaności prezentowanych bodźców. Oprócz wysoce znanych bodźców, jakimi są twarz własna i osoby bliskiej, wykorzystałam nieznane, abstrakcyjne kształty, które zostały arbitralnie przypisane uczestnikowi oraz osobie bliskiej (dowolnie przez niego wybranej). Analiza zgromadzonych danych nie wykazała różnic w przetwarzaniu nowo nabytej informacji pomiędzy warunkami JA i osoba bliska (amplitudy P3 i LPP nie różniły się istotnie). Ponieważ wzorzec wyników dla przetwarzania twarzy okazał się typowy (większe amplitudy P3 i LPP w warunku JA), brak różnic w przetwarzaniu pomiędzy kształtem przypisanym do JA a kształtem przypisanym bliskiej osobie może być interpretowany jako kolejny istotny argument na rzecz znaności jako czynnika warunkującego wystąpienie SPE.

Wyniki przedstawione w tej rozprawie wskazują, że znaność jest kluczowym czynnikiem w występowaniu zjawiska priorytetyzacji informacji związanych z JA. Wykorzystując różne paradygmaty i różnorodne techniki analiz wykazałam, że wysoka znaność informacji dotyczących JA jest kluczowa dla SPE. Badając wzajemne oddziaływanie między znanością a emocjonalnością, moja praca przyczynia się do głębszego zrozumienia, w jaki sposób ludzie przetwarzają informacje i podejmują decyzje w oparciu o SPE.

Abstract

The volume of information flowing in from the world is enormous and, in fact, overwhelming. Yet, individuals may not be constantly aware of this, as they do not permanently experience the consequences of this immense influx of information. This is primarily attributed to the selection process, which is not always contingent on conscious choices. One possible criterion for the selection of information is its association with the self, leading to more efficient processing. This effect is called the self-prioritisation effect (SPE). Although SPE is observed in many different contexts, the factors driving this phenomenon are still ambiguous. Scientists propound two factors, familiarity and emotionality, focusing mainly on the former. In this thesis, using electrophysiological techniques, I aimed to investigate the role of these two factors independently.

The first two studies were devoted to the emotionality factor. As emotions might be perceived objectively or subjectively, this distinction was transferred to the emotionality factor. In the first study, a plausible role of objective emotionality was investigated by comparing the processing of one's own face and emotional unknown faces. ERPs analysis (with P3 and LPP in the focus of attention) and cluster-based permutation tests revealed that the processing of the self-face is unique and does not resemble the processing of the objectively emotional faces. In the follow-up study, subjective emotionality was in the spotlight. To assess its impact on the SPE, a face of a close person was introduced into the study. Such a person presents a similar combination of familiarity and emotionality factors as is possessed by the self; thus, the face of a close-other seems to be the best comparison to the self-face. Moreover, as the COVID-19 pandemic significantly impacted human lives in the last few years, the study's goals were expanded, and the SPE was tested for partial facial information. Source analysis indicated that the processing of partially covered faces is associated with the brain area typically linked to the face processing, fusiform gyrus. Amplitudes of early (P1) and late (P3, LPP) ERP components consistently indicated that all covered faces require more attentional resources to be processed, and SPE is not impoverished by the surgical-like masks, as the self-face in both conditions (with and without mask) evoked significantly higher P3 and LPP amplitudes. Furthermore, a significant difference between the processing of the self-face and the close-other's face was depicted. This pattern of results undermines the plausible role of subjective emotionality, and in combination with findings from the first study, it deflates the role of emotionality in general.

The last study was dedicated to the familiarity factor. The familiarity of the presented stimuli was equalised to disentangle the mutual impact of both factors. Apart from the highly familiar stimuli as one's own and close-other's faces, we used unknown abstract shapes assigned to the participant and freely chosen close-other. Our findings revealed no differences in the processing of newly acquired information (as evidenced by similar P3 and LPP amplitudes in both cases). As the typical pattern of face processing was manifested (larger P3 and LPP for the self-face), the lack of differences between the self-assigned shape and the shape assigned to the close-other might be interpreted as a further substantial argument in favour of familiarity as a driving factor of self-prioritisation.

The findings presented in this thesis indicate that familiarity is a driving factor in the self-prioritisation effect. Through various paradigms and diverse analytical techniques, we have demonstrated that high familiarity of self-related information is crucial for the self-prioritisation effect. By shedding light on the intricate interplay between familiarity and emotionality, my work contributes to a deeper understanding of how individuals process information and make decisions based on SPE.

1. Introduction

The self is a colourful concept (Hommel, 2019). It captivates the interest of many different fields and becomes the backbone of multiple disputes. Descartes put 'self' in the role of agent in his hunt of proving human existence, corporate lobbies treat it as a target to win over, and personal development and coaching as a forever unattainable developmental goal in life (Hommel, 2019). However, despite the presence in so many different areas, it seems to be still an inscrutable concept. Ergo - what is the self?

Multiple researchers from diverse fields, like philosophy, psychology, psychiatry and neurobiology, have endeavoured to define 'self'. Neisser (1995) postulates a multifaceted perspective, suggesting that each individual possesses five different kinds of self-knowledge which are broadened during a lifetime: (1) the ecological self, (2) the interpersonal self, (3) the temporally extended self, (4) the private self, and (5) the conceptual self. According to that perspective, the self is not a fixed, rigid part of a person or mind but rather a whole person considered in the context in which the individual is situated. This spin of the self redirects attention from an inward-looking view based on private experience to an outward-looking view of the self within ecological and social contexts (Neisser, 1993).

Dennett (1991) offers an alternative approach, linking the concept of the self to language and describing it as the core of 'narrative gravity'. From this perspective, humans direct perception and construction of the world from the position of self-narration. Dennett's idea of the self as the centre of narrative gravity parallels a centre of gravity in the physical sense – a simplified, single point of origin (Dennett, 1991).

Sprung from Dennett's perspective, Gallagher (2000) introduced the concept of 'the minimal self' and 'the narrative self'. 'The minimal self' pertains to the self as perceived in the present moment, devoid of connections to other points on one's life timeline. In contrast, 'the narrative self' complements 'the minimal self' by encompassing the individual's identity and continuity across time.

Yet another perspective on the self emerges from Jeannerod (2003), who emphasises the role of recognising oneself as the owner and the agent of one's own body. This recognition stems from congruent proprioceptive and exteroceptive feedback. Jeannerod contends that the self of agency enables the establishment of a stable identity that remains independent from the external world.

A differentiation proposed by Gillihan and Farah (2005), in turn, pertains to the distinction between the physical and psychological dimensions of self. The physical aspects are typically investigated in studies focusing on self-face recognition, agency, and perspective-taking, while the psychological facets are usually measured through studies examining autobiographical memory and self-knowledge in terms of personality traits. This conceptual separation is supported by neuroimaging research, which indicates that processes related to the physical or embodied self and those linked to the psychological or evaluative self rely on distinct large-scale brain networks (Lieberman, 2007; Uddin et al., 2007).

Although presented definitions show different approaches to the self, they view it as a flexible, developing, and changing construct without sharp boundaries. These diverse perspectives on the self paint a nuanced picture, demonstrating this fundamental concept's complexity and multifaceted nature in human psychology.

The significance of the self in human life is profound. A fundamental feature of human experience is a sense of one's self as a unique unit, distinctive from others (James 1959/1890). The self encompasses a singular sense of identity, autobiographical memories of the past, and expectations and beliefs about the future (Macrae et al., 2004). Thus, disturbance of self is viewed as a core of some mental or personality disorders. Schizophrenia is translated as 'splitting of the mind' from Ancient Greek words (σχίζειν, *schizein*, 'to split' and φρήν, *phrēn*, 'mind'). Despite this name being misinterpreted, it captures the essence of this mental disorder. A person with schizophrenia is often unsure of being the owner of one's own thoughts (Scharfetter, 2003; Fletcher and Frith, 2009) or the agent of one's own actions (Scharfetter, 2003). Moreover, individuals with schizophrenia experience adversity in recognising their own face (Kircher and David, 2003; Zhou et al., 2020), parts of their body (Ferri et al., 2012), their own reflection in the mirror (Parnas, 2003; Szczotka and Majchrowicz, 2018) and differentiating it from themselves, i.e. indicating where a real person and reflection are (Blanke and Metzinger, 2009). Rubber hand illusion research showed that individuals with schizophrenia adapt faster than healthy controls (Thakkar et al., 2011), and their EEG signal remains unchanged before and during the experiment (Peled et al., 2003).

Difficulties in self perception are also observed in anorexia nervosa. Studies demonstrated that people with anorexia nervosa encounter obstacles in the proper evaluation of face expression - they more often confound neutral self-face as sad than healthy controls (Phillipou et al., 2015).

Other mental disturbances affecting the representation of the self are presented in Internet gaming addiction. Leménager and colleagues (2016) showed that pathological Internet gamers generally demonstrates higher self-concept deficits. Moreover, analysis of fMRI data revealed hyperactivation of the left angular gyrus during avatar reflection, a region linked to identification processing and feeling of empathy. This hyperactivation was correlated with symptom severity (Leménager et al., 2016). Therefore, stable self-representation is a core of mental health.

Moreover, the self is crucial in our everyday cognitive functioning. We live in a world where we obtain more information than we need and more than we can process. Therefore, we must sieve through a wealth of information to pinpoint the crucial. The self may constitute ‘an information filter’ as a key to select incoming input for further processing. An excellent and universal example is the cocktail party effect (Moray, 1959), which shows that people can pick up one’s own name in the meaningless noise. This facilitation is not confined to names (Tacikowski and Nowicka, 2010; Tacikowski et al., 2013), as it exerts its influence on faces (Tacikowski and Nowicka, 2010; Tong and Nakayama, 1999; Keenan et al., 1999), other parts of the body (Ferri et al., 2012), self-reflection (Moran et al., 2006), and even handwriting (Chen et al., 2008). This phenomenon is known as a self-preference or self-prioritisation effect (SPE). Multiple research shows that due to the reference with the self, such information is more quickly and accurately detected, easier remembered (Magno and Allan, 2007; Nowicka et al., 2018) and recalled (Rogers et al., 1977). However, cognitive and social neuroscience ventures beyond behavioural studies, seeking to bolster the SPE with physiological techniques and find its neural substrates. Functional magnetic resonance imaging (fMRI) studies demonstrates the self-face increases activity of the medial prefrontal cortex, anterior cingulate cortex, and posterior cingulate cortex in comparison to other faces (e.g. Macrae et al., 2004; Philippi et al. 2012; Tacikowski et al., 2013). Moreover, Yankouskaya and Sui (2022) discovered that the interaction between the default mode network, frontoparietal network, and insular salience network is crucial for SPE occurring (Yankouskaya and Sui, 2022). A noteworthy contribution was also made by Tacikowski and colleagues (2013), who demonstrated that SPE appears for self-name presented visually and auditorily. SPE is related with increased activity in the medial prefrontal cortex for both modalities and bilateral inferior frontal gyri for auditorily presented stimuli (Tacikowski et al., 2013).

As fMRI studies indicate critical brain regions for self-awareness and processing of information related to the self, electroencephalography (EEG) is more suitable for following temporal dynamics of brain responses to these stimuli. EEG research indicates a few components important for SPE. P3 (or P300) potential is reported in most studies concerning the processing of self-related stimuli. Multitude studies demonstrates significantly amplified P3 amplitude for one's own name or face than for names or faces related to other people, respectively (Perrin et al., 2005; Zhao et al., 2009; Tacikowski and Nowicka, 2010; Tacikowski et al., 2011; Fan et al., 2013; Cygan et al., 2014; Tacikowski et al., 2014). Moreover, such an increase of P3 amplitude is also observed for other self-related information like hometown, school, etc. (Gray et al., 2004). Similarly, research reports the enhancement of the P2 (or P200) potential, comparing self-name with other names (Fan et al., 2013) or autobiographical and nonsignificant information (Hu et al., 2011). Analogous findings are obtained for the comparison of personality trait words describing an individual and other-relevant people (Mu and Han, 2010; Liu et al., 2013).

Summing up, studies show that self-related information not only leads to stronger brain responses when compared to information linked to unknown people but also to celebrities, family members, and friends (Kotlewska and Nowicka, 2016; Kotlewska et al., 2023; Zhou et al., 2020).

There is considerably less agreement, however, about the nature of self-prioritisation. In this thesis, I will focus on the two most possible factors that may drive this phenomenon.

2. Description of the project: the general aim

A vast body of research has been dedicated to investigating the self-prioritisation effect, showing its substantial and widespread impact on everyday life (e.g. Moray, 1959). However, even though research indicates two major factors driving this phenomenon, it appears they have been not equally often investigated. The majority of studies has focused on the familiarity factor (e.g. Kotlewska and Nowicka, 2016), while the contribution of emotionality to the SPE is heretofore narrowly examined (e.g. Sui et al., 2012). This unequal interest has resulted in misrepresentation and an illusive understanding of this process. Therefore, one of the aims of this project was to suss and assess separately the role of these factors.

In order to answer the question mentioned above, a series of ERP experiments was conducted with experimental conditions differing mainly in respect to their emotional loads or familiarity levels.

Emotionality is not a one-dimensional concept. Definitions of emotion emphasise the individual and intrinsic perspective of every being (e.g. Frijda, 1986; Dolan, 2002), resulting in a subjective perception of every event in the world. Rainy day may be objectively assessed as heart-sickening while simultaneously recapturing pleasant memories in some people. Similarly, a smiling or fearful unknown face may be objectively perceived as emotional but not necessarily subjectively so. Therefore, to fully assess the role and possible impact of emotionality, it is crucial to consider not only objectively explicit emotional stimuli (e.g., happy faces) but also personally relevant ones (e.g., a partner's face). This issue might be addressed by introducing a freely chosen close-other person who presents a mixture of high familiarity and high subjective emotionality, as is the case for the self. This would reveal whether emotionality partakes in SPE and, if so, whether its character is objective or subjective.

Moreover, COVID-19 had an essential and unexpected input on this project. One of the crucial changes that the pandemic brought about was using surgical-like protective masks to cover our noses and mouths. This introduced a series of questions concerning processing human faces when they are partially concealed. Due to these new conditions, the project's scope was expanded to address additional questions - how faces (self, close-other, unknown) with masks are processed and whether the SPE would remain for covered self-face.

However, the self-face differs from the close-other's, emotional and neutral unknown faces not only in emotionality dimensions but also on familiarity level. Even though the majority of the studies is devoted to familiarity, they do not analyse it solely, as a face or a name makes up a combination of both aforementioned factors. Therefore, the third study aimed to investigate the familiarity in separation from emotionality. It was achieved by making presented stimuli equally familiar.

3. Description of research: background and results

3.1. Emotionality

3.1.1. Objective Emotionality

As it was aforementioned, emotionality is a complex and multilayered factor. The moment of our emotional development starts on the day of our birth or in the early months of life as the neural substrates become functional for some basic-emotion expressions (e.g. joy) (Izard et al., 1995), while for others within the first two years (Camras et al., 2002). Emotions are the significant information carrier and the impairment of their perception, understanding, and expression may lead to socialisation problems as it may be viewed in autism spectrum disorder (e.g. Kinnaird et al., 2019; Gaigg et al., 2018; Samson et al., 2015), patients with cerebellum tumour (e.g. Hoche et al., 2016; Beuriat et al., 2022; Schmahmann, 2010; Sokolov, 2018), or juvenile offenders (e.g. Hubble et al., 2015; Pincham et al., 2015; Shelton, 2001). Moreover, deficits in self-conscious emotions (a specific type of emotions developing when one encounters to identity-relevant events) may also lead to a diversity of psychopathological outcomes (Muris and Meesters, 2014).

Emotions may be defined as a distinctive, episodic outcome of evaluating an event through personal goals that modifies action readiness (Frijda, 1986). In other words, positive emotions may be evoked if an event furthers the personal objectives or negative if an event is perceived as an impediment. However, the role and function of emotion in life have sparked off a debate among the social scientists. Hard-line opinions propound emotions' uselessness, minimising their impact and even suggesting they negatively affect everyday functioning (e.g. Skinner, 1948; Mandler, 1984). Nevertheless, most scientists indicate that emotions play a part in the prioritisation and organisation of behaviour to enhance an individual's adjustment to the environment's physical and social demands (Ekman, 1992; Lazarus, 1991). The functional aspect of emotions might be best seen through 'basic emotions' such as happiness, fear, and anger. They are distinctive, acquired in the early period of life, and seem to appear to serve specific purposes (Izard, 2007). For instance, happiness is evoked in response to pleasant events, encouraging to repeat them in the future. In contrast, fear is generated when a person perceives an event as a threat or danger, leading to an F3 response (freeze, fight, or flight).

The first study, presented in this thesis, aimed to explore the objective emotionality in self-prioritisation. ERP responses to self-face were compared to objective emotional faces as they may capture, hold and bias attention and avoid involving awareness, similarly to the self-face (Wójcik et al., 2019; Zotto and Pegna, 2015). As they activate the same areas in the brain, they might be expected to be processed similarly. Therefore, based on the self-positivity bias (Greenwald, 1980; Watson et al., 2007) and the theory of implicit positive association (IPA) with the self (Ma and Han, 2010), one may presume that self-face might be processed as an emotionally positive face (e.g. smiling face), as both can evoke positive feelings. Another crucial aspect of the self is saliency, a mutual feature with the fearful face. A neutral face was added as a control stimulus. It is also noteworthy that self-face differed from other faces in the aspect of familiarity. None of the non-self-face was known to the participants before the study. Participants were tasked with the simple detection of presented faces - they were asked to push the response button (same for each presented stimulus) as quickly as possible.

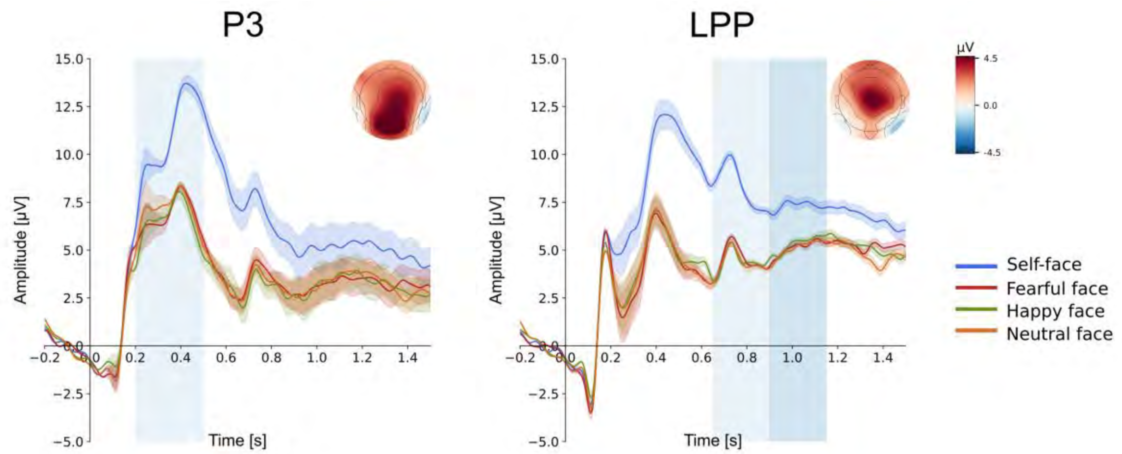

Figure 1. Grand average ERPs for self-face, fearful, happy, and neutral faces are presented. Shaded areas denote standard deviations (*SD*). In the left panel, the P3 component is shown, which is the average of pooled electrodes PZ, CPZ, CP2, and P2, located within the region of maximal activity in the topographical distribution of brain activity. This average is across all experimental conditions, encompassing four types of faces. The right panel displays the LPP, which is the average of pooled electrodes FCZ, FC2, and C2, also within the region of maximal activity in the topographical distribution of brain activity, averaged across all experimental conditions. The analysed time windows are highlighted with light-blue rectangles.

Comparison of the self-face with happy and fearful faces showed that the self-face is processed dissimilar to all other faces. ERP results showed a preference for the processing of one's own face. P3 and LPP components were significantly increased in comparison to emotional and neutral faces (mean amplitudes to the self-face were approximately two times higher, Figure 1). Moreover, cluster-based permutation tests were deployed to this data. This method facilitates unbiased comparisons of EEG signals recorded under various experimental conditions across all sensors and time points. It achieves this by controlling for multiple comparisons and maximising statistical power, utilising the data's cluster structure as its sole test statistic. I applied this approach to assess differences in spatial and temporal distributions among the experimental conditions. Cluster permutation tests demonstrated that self-face processing differs from each emotional (happy or fearful) face (Figure 2).

Together, these results suggest that the driving factor of self-prioritisation is familiarity, as no resemblance was found between the self-face and any of the emotional faces.

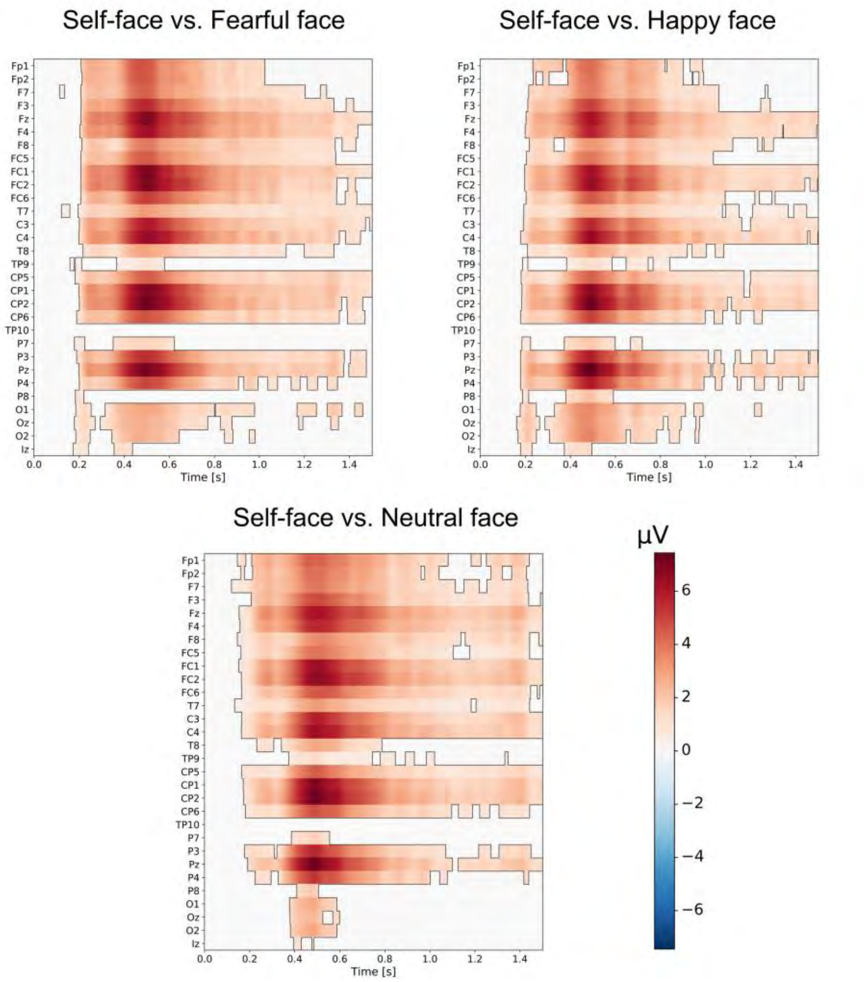

Figure 2. The results of cluster-based permutation tests are presented. Self-face was compared to fearful and happy faces in the top-left and top-right panels, respectively. Additionally, the self-face was compared to the neutral face in the bottom panel. Statistically significant positive differences between the tested experimental conditions are highlighted in red ($p < .05$). For clarity, only 30 electrodes from the total set of 62 are displayed for illustrative purposes.

3.1.2. *Subjective Emotionality*

A quite obvious feature of emotion is its subjectiveness. Whoever defines emotion discerns its intrinsic character (e.g. Frijda, 1986; Dolan, 2002), highlighting the unique and deeply personal nature of emotional responses. This subjectivity in emotional responses reflects the complex diversity of human psychology, influenced by personal history, cultural background, upbringing, and a multitude of other factors. It underscores the idea that emotions are deeply personal, and the emotional evaluation of one person may differ significantly from that of another in response to identical external stimuli or events (Dolan, 2002). Thus, people attach diverse emotional values to things, places, events, and, most notably - to people. For instance, seeing a joyful unknown person with flowers on a train station platform or a crying unknown child with an injured knee on the playground may arouse tenderness for the first and compassion for the latter. However, these emotions are diminished (or even swept off) if we notice our beloved on the platform or our child is injured. Therefore, an objectively emotional stimulus or event may lose its emotional valence if co-presented with a subjectively emotional stimulus or event. This indicates that traversing emotionality through the perspective of objective emotions sheds light only on the part of emotionality as a factor of self-prioritisation.

This shaded part might be investigated by adding a stimulus related to a close-other person who combines familiarity and emotionality on a comparable level to the self. This could help unveil if the distinctions between one's own face and objectively emotional faces are unique to the self or if other highly familiar and subjectively emotional faces undergo similar processing as the self. Consequently, this notion could enrich the ongoing discourse regarding whether the self is a higher-order or fundamental function of the brain.

The second study, presented in this thesis, aimed to determine the plausible role of subjective emotionality in self-prioritisation. As in the previous study, participants were tasked with a simple detection task. However, the current research used self-face, a close-other’s person face, and a neutral face (as a control stimulus). Because of the COVID-19 pandemic, I decided to make research more ecologically valid by adding a surgical-like mask condition (Figure 3). Therefore, each face was presented with and without a mask which enabled me to answer additional questions: (1) how the human brain processes partially covered faces and (2) whether SPE appears for self-face hidden behind the surgical-like mask.

Figure 3. Here are examples of faces, with and without surgical-like masks, featuring two study co-authors.

The main concern of this study was the potential role of subjective emotionality. Analysis of P3 and LPP amplitudes unveiled that they were significantly enlarged for the self-face in comparison to other faces, including the close-other's face (Figure 5). Nevertheless, P3 amplitude also increased substantially more to the close-other's face than to the unknown. Furthermore, SPE for the self-face persisted, irrespective of the surgical-like mask's presence. Analysis of P1, P3, and LPP amplitudes revealed a general enhancement for faces covered with masks (Figure 4 and Figure 5). In addition, source analysis revealed that for both types of faces, brain activity was located in fusiform gyri (Figure 6).

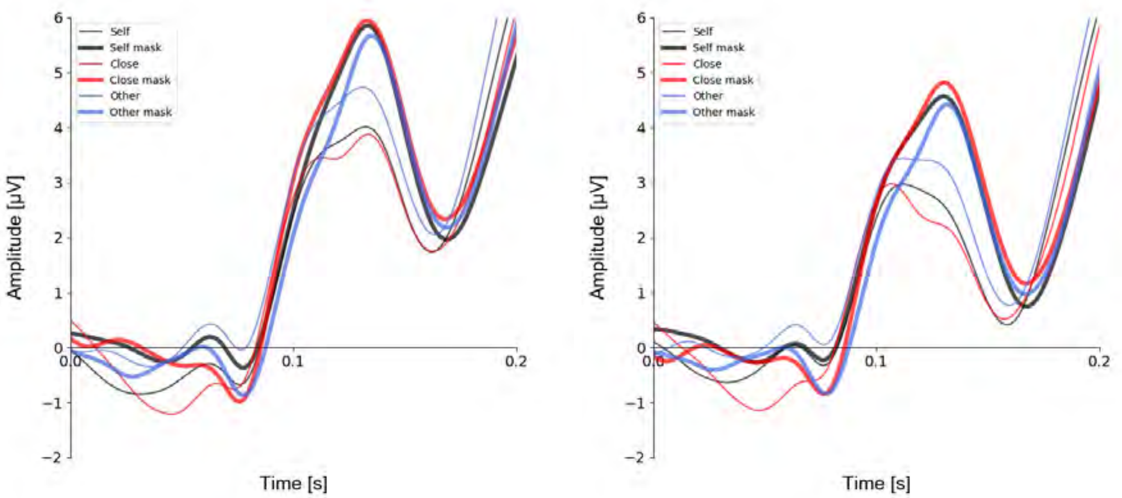

Figure 4. Here is the grand average of P1 ERP for self-face, close-other's face, and unknown face, both with and without a surgical-like mask. The P1 potential is computed from the combined data of electrodes O2 and PO4 in the right occipital-parietal region (right panel) and corresponding electrodes in the left occipital-parietal region, O1 and PO3 (left panel).

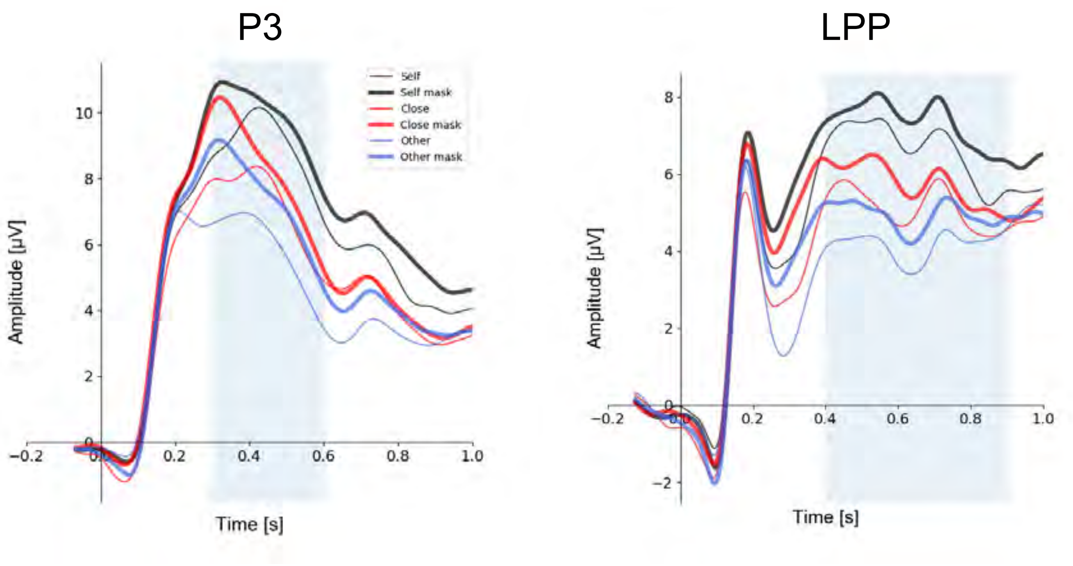

Figure 5. Late ERP components, P3 and LPP. In the left panel, we observe the P3 component, calculated from pooled electrodes Pz, CPz, CP2, and P2. In the right panel, we present the LPP derived from pooled electrodes FCz, Fz, FC2, and C2. The selected electrodes for both potentials were located within the region of maximal activity in the topographical distribution of brain activity. The analysed time light-blue rectangles indicate windows.

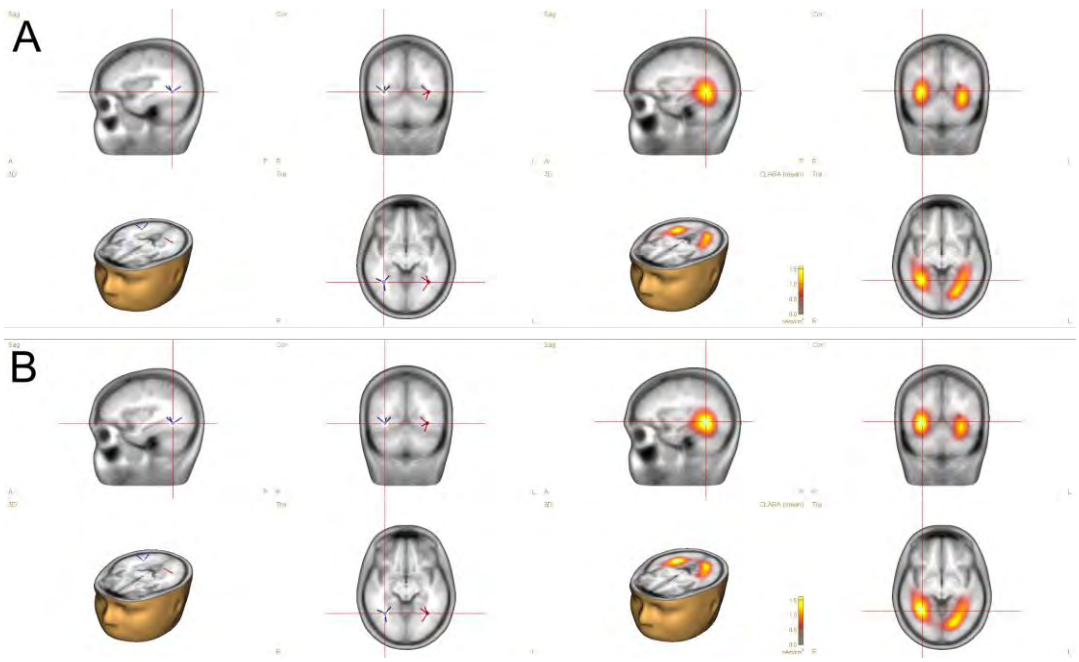

Figure 6. Source analysis of ERP responses was conducted (in a typical time window for N170) using distributed source imaging with CLARA (Classical LORETA Analysis Recursively Applied). The results indicate that the fusiform gyrus is the primary signal source elicited by presenting masked faces (Panel A) and unmasked faces (Panel B). Two dipoles fitted within the fusiform gyrus explain nearly 98% of the data.

Considering these results, it might be assumed that subjective emotionality plays a role in SPE as the processing of close-other's and unknown faces was disparate. However, the dissociation in the processing of close-other's and one's own faces also manifested; one may assume that self-face is more imbued with subjective emotionality, or it is better known to an individual, suggesting the more crucial role of the familiarity factor. Additionally, it seems that the recognition of human faces is not severely disturbed by the COVID-19 restrictions and even partial information about the self-face leads to the emergence of SPE.

3.2. Familiarity

Despite the fact that numerous studies were devoted to the familiarity factor, they are based on similar methodologies. Scrutinising the familiarity factor, studies typically compared reactions to the self-related stimuli and stimuli related to the other person/people (celebrities: Zhou et al., 2020; family or friends: Cygan et al., 2014; Cygan et al., 2022). As stimuli, most often were used faces (Cygan et al., 2022) and sometimes names (Perrin et al., 2005) or parts of the body (Ferri et al., 2012). The research findings consistently show the presence of SPE, which is interpreted in favour of familiarity. However, it seems to be overlooked that not only familiarity differentiates those stimuli but also emotionality, as they cannot be defined only by one of these factors. Therefore, such a choice of stimuli disenables disentangle and analyse the source of self-prioritisation.

Sui and colleagues (2012) essayed to split the wreath of these two factors by proposing a novel approach. Instead of looking for stimuli presenting different levels of familiarity, they obliterated it in all employed stimuli. In their experimental paradigm, participants were told to make associations between unknown, neutral stimuli (three geometric shapes) and personally significant labels (you, friend, stranger). In this manner, stimuli with the same level of familiarity were filled with different emotional intensity. Participants were tasked with answering whether the displayed shape-label pair matched the learned assignment. The findings of this study showed that participants were faster and more accurate in the detection of congruent self-shape-label pairs than any other combination. It suggests that SPE extends the frames of familiarity and may be driven by emotionality. This effect was replicated in numerous studies (e.g. Sui et al., 2014), however, all of them were based on behavioural measures (RTs accuracy), obtained in perceptual matching task. Nonetheless, some scientists imply the overlooked presence and plausible impact of simultaneously displayed labels (Woźniak and Knoblich, 2019). It sowed doubt whether the SPE was a result of the association of the unknown stimuli with the self or was again an effect of high familiarity and emotionality factors combination hidden in the verbal labels.

The aim of the third study, presented in this thesis, was to investigate the role of familiarity factor. In pursuit of detailed assessment, stimuli were set on the two extremes of the familiarity spectrum. As the highly familiar stimuli were used faces of the self and a close-other, and as the newly acquired ones - unknown abstract shapes that were just newly assigned to one's own person and the freely chosen close-other. As the control conditions to the self and close-other's conditions, unknown neutral stimuli were used (unknown faces and unknown shapes, respectively). The task was as follows: participants were told to indicate whether the presented stimuli were familiar or unfamiliar (Figure 7). Familiar stimuli incorporated (1) the faces of a participant and a chosen close-other and (2) the shapes assigned to them just before the study.

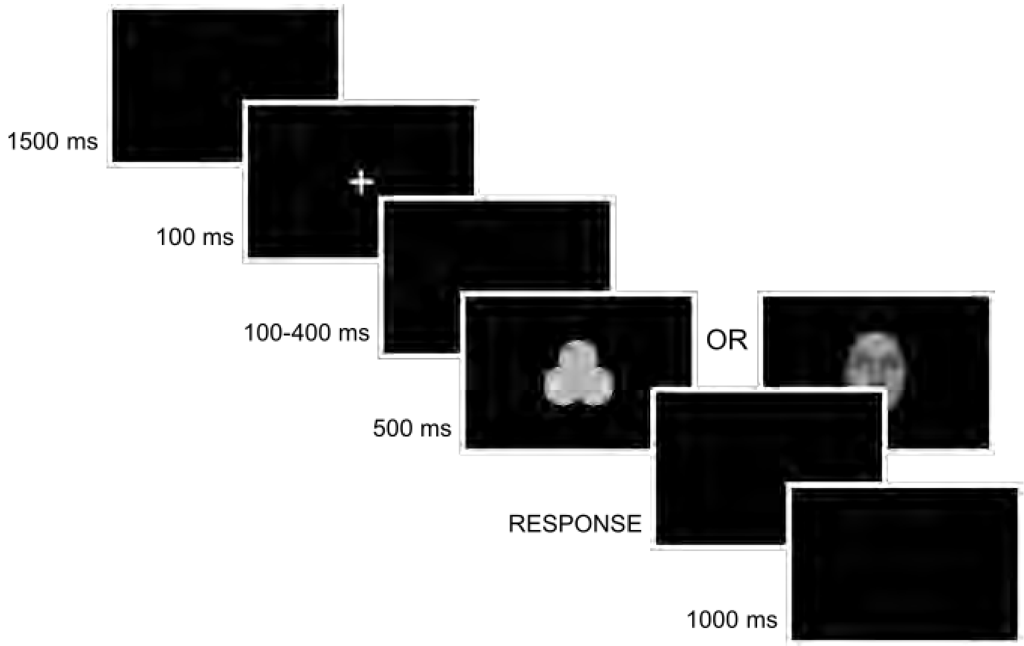

Figure 7. Schematic presentation of the experimental procedure: Three categories of faces (self, close-other's, unknown) and three categories of shapes (self-assigned, assigned to the close-other, unknown) were intermixed and presented in a pseudo-random order. Participants were instructed to determine whether each stimulus was familiar or not.

For faces, a typical pattern was observed. Self-face evoked significantly enhanced P3 amplitude than all other faces (i.e., close-other's and unknown faces) (Figure 8). P3 amplitude was significantly smaller for unknown faces than for both familiar faces. Responses to close-other's face were located in between, significantly different from self-face and unknown faces. Moreover, self- and close-other's faces presented a distinct processing pattern, as the cluster-based permutation test revealed differences between those and unknown faces, widely distributed in space and time (Figure 9).

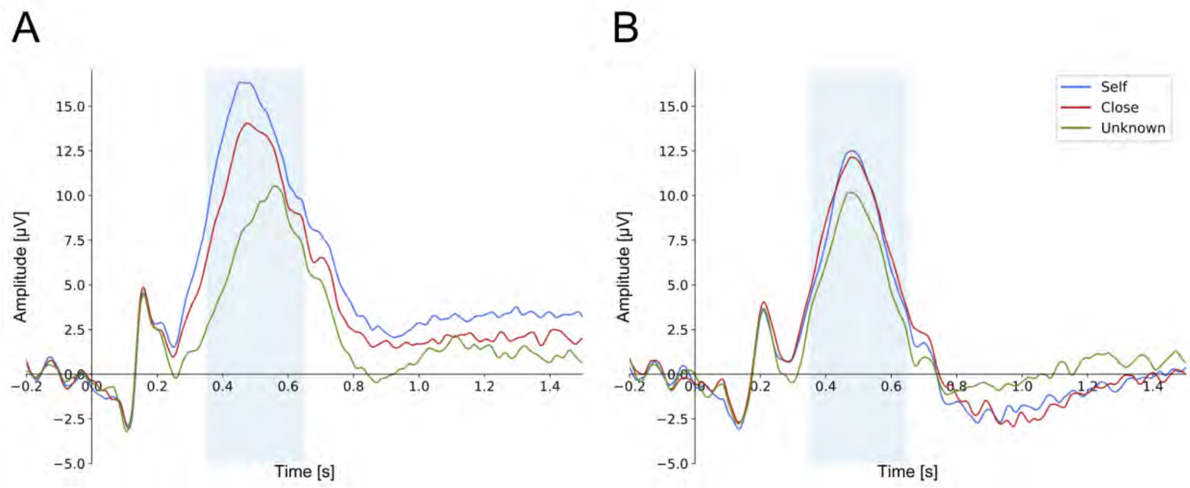

Figure 8. Grand-average ERPs for (A) faces and (B) shapes, combined from four electrodes: CP1, CPz, CP2, and Pz. The analysed time window of P3 is highlighted with light-blue rectangles.

Crucially, P3 amplitudes to shapes assigned to the self and close-other were likewise elevated (the differences between them were non-significant), however, in both cases, they were larger than to the unknown shapes (Figure 8). This was reinforced by the cluster-based permutation tests: self-assigned shape and shape assigned to the close-other were processed in a similar manner as no cluster was detected in the whole analysed time window. The processing of both shapes differed significantly from the processing of unknown shapes (Figure 10).

Last but not least, shapes were compared with faces. Substantially heightened P3 amplitudes were observed for self-face and close-other's face than for shapes assigned to the self and close-other, respectively. For unknown faces and shapes, no differences in P3 amplitudes were unveiled.

The findings of this study underlines the significance of familiarity. As the familiarity of presented stimuli was equalised, the SPE vanished.

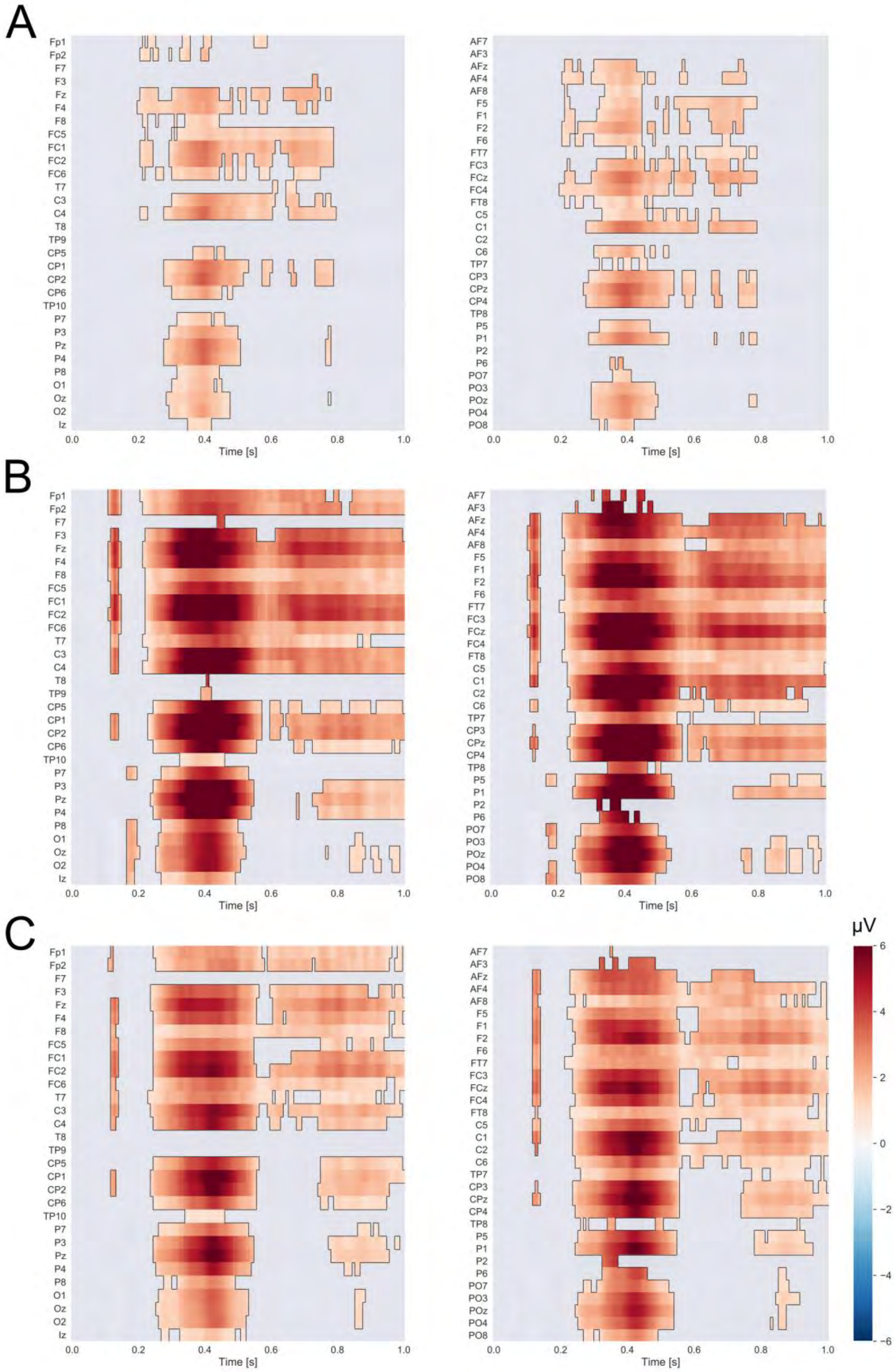

Figure 9. The outcomes of cluster-based permutation tests conducted on faces: Comparisons include the self-face versus (A) the close-other and (B) unknown faces, as well as (C) the face of the close-other versus unknown. Any statistically significant positive distinctions between these conditions are highlighted in red ($p < .05$).

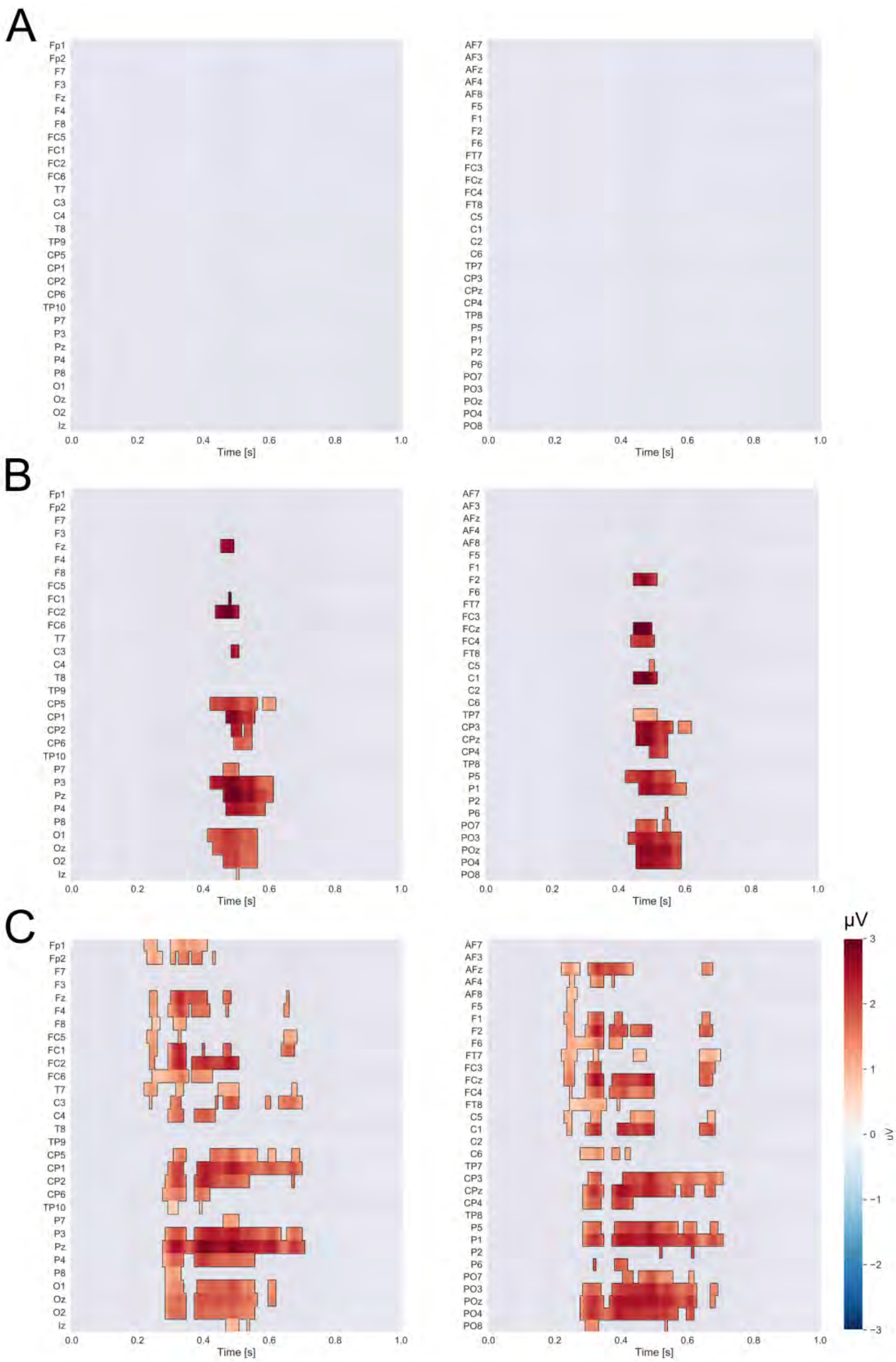

Figure 10. The outcomes of cluster-based permutation tests conducted on shape data: Comparisons include the self-assigned shape versus the shape assigned to (A) the close-other and (B) unknown shapes, as well as (C) the shape assigned to the close-other versus unknown shapes. Any statistically significant positive distinctions between these conditions are highlighted in red ($p < .05$).

4. Discussion

As humans, we are quite inquiring beings. Some are dedicated to exploring the intricacies of the world, while others are deeply engrossed in the matters of the inner self and consciousness. Nonetheless, despite the profound interest of many distinct disciplines in exploring the self, some answers are still unearthed. Therefore, this thesis focused on the factors leading to self-prioritisation as they remain ambiguous. Pursuing to unveil the significance of familiarity and emotionality, a human face was chosen as the main stimulus in my research. Although self-prioritisation is observed for other self-related stimuli (for instance, a name) (e.g. Cygan et al., 2014), a face cannot be shared with other people, thus, it is clearly related only to the self and is even seen as its emblem (McNeill, 1998).

In general, the SPE was clearly evidenced in the case of one's own face. Specifically, P3 and LPP amplitudes were significantly more enhanced for the self-face than for all other (close-other's, unknown emotional, and neutral) faces. These findings are in line with the previous studies, reporting the SPE for one's own face (Wójcik et al., 2018; Kotlewska et al., 2017), even when compared with faces of personally familiar people (Cygan et al., 2014; Kotlewska and Nowicka, 2015; Kotlewska and Nowicka, 2016). However, it is worth stressing that only one earlier ERP study investigated the processing of self-face and emotionally negative faces, all presented as deviant stimuli in an odd-ball procedure (Zhu et al., 2016). Despite different experimental procedures, an analogous pattern of findings was reported: amplitudes of P3 to the self-face were much higher than to (unknown) emotional and neutral faces. In addition, results presented in this thesis showed that P3 amplitude was also significantly increased for the close-other's face compared to the unknown neutral faces. This pattern of P3 results may be driven by the familiarity of faces. Moreover, it may be interpreted with respect to the classical models of face recognition (Bruce and Young, 1986; Burton et al., 1990).

Classical models of face recognition suggest four stages: (1) structural encoding, (2) FRUs - face recognition units, (3) PINs - person identity nodes, and (4) SIUs - semantic information units. After the structural encoding of the crucial face features, a structural representation of the face is triggered (FRU) if it is perceived as known. The next step initiates a multimodal representation of the seen person (PIN), leading to full identification. This enables activation of the last phase - the retrieval of the possessed biographical knowledge about the recognised individual (SIUs). According to this concept, some studies have linked different ERP components with enumerated stages, viewing late ERP components as a reflection of PINs' and SIUs' phases (Paller et al., 2000; Tacikowski et al., 2011). Therefore, significantly higher amplitudes of P3 for the self-face, when compared to all other (i.e., close-other's, unknown emotional and neutral) faces, may arise from hugely rich semantic information for the self. Analogously, substantially higher P3 amplitude for the close-other's face in comparison to the unknown neutral faces may also result from available semantic information for the close-other in contrast to the unknown person. Building upon this interpretation, the lack of differences between emotional and neutral faces does not stun, as no semantic knowledge is accessible. Thus, more familiar faces evoke higher P3 amplitudes.

Nevertheless, we can broaden the angle of interpretation and look at self-prioritisation and these results, for instance, through the lens of attentional processes. Automatic capture and prioritised allocation of attention to the self-referential stimuli are plausible mechanisms that actuate or trigger the self-prioritisation process (Humphreys and Sui, 2016; Sui and Rotshtein, 2019). Humphreys and Sui (2016) provided a framework primarily situated within the attentional domain that aimed at explaining the prioritised processing of self-referential information (the Self Attention Network – SAN). Specifically, the SAN states that self-related attentional processing is in some way special. The SAN framework is based on the notion that an individual's self-representation is continuously activated and is thus rapidly triggered by the presence of a self-representational stimulus. Therefore, the prioritised processing of self-referential information could be explained by the rapid engagement of bottom-up orienting processes stemming from a chronically activated self-schema. In light of the latter, it is worth noting that P3 is often related to the attentional processes (e.g. Polich, 2007). Thus, this interpretation seems to be cogent as numerous studies demonstrated that one's own face captivated attention automatically (Tong and Nakayama, 1999; Brédart et al., 2006; Alzueta et al., 2020) and similarly evoked a significant increase in P3 amplitude (Knyazev, 2013). Therefore, the significant P3 growth in response to the self-face (and later, in the order of increase, to the close-other's face) may indicate the preferential attention engagement, shifting the tipping point from the later attentional facilitation as a consequence of rich semantic information.

Another concept that could shed light on the obtained results is the size of the saliency of presented stimuli in all three studies. Comparison of the self-face with any emotional unknown faces revealed no similarities in any of the shown dimensions - neither in the ERP results nor the cluster-based permutation tests. Processing of the self-face also differed from processing the close-other's face. Thus, despite all these faces seeming salient when compared to the unknown neutral face, they were no more in comparison to the self-face. This pattern of results indicates that the saliency might be contextual. In fact, studies show that P3 (Teixeira et al., 2010), as well as LPP (Martin et al., 2020), are influenced by saliency. While studies comparing unknown emotional vs neutral faces report significant differences between them (Zhu et al., 2016), our findings showed that when the self-face was added to the set of presented stimuli, that difference disappeared. Thus, reported P3 and LPP findings may indicate that the self-face and close-other's face are more salient than objectively emotional faces. Moreover, it is worth paying attention to the position of the close-other's face in the ERPs results hierarchy for a more profound and complex understanding of self-prioritisation. As the close-other's face was between the self-face and unknown neutral face, its P3 amplitude differed significantly from both. In contrast, its LPP amplitude was distinctive only from the self-face, i.e. LPP amplitudes for the close-other and unknown person were similar. Studies associate LPP with emotional arousal as it is enhanced for emotional stimuli in comparison to the neutral stimuli (Foti and Hajcak, 2008; Olofsson et al., 2008; Cuthbert et al., 2000), and the growth of its amplitude is correlated with the growth of arousal (Cuthbert et al., 2000). Some studies compared the self-face with the close-other's face, showing a similar pattern of P3 findings (Kotlewska and Nowicka, 2015; Kotlewska and Nowicka, 2016). As aforementioned, P3 is usually related to attentional processes and might be modulated by the saliency of the stimuli (Teixeira et al., 2010), similar to the LPP, which is typically associated with emotional saliency (Cuthbert et al., 2000). It seems possible that the close-other's face, which presents a mixture of high familiarity and high emotionality, may attract attention, but its emotional load is not high enough to maintain this effect in time. Therefore, this would indicate familiarity as the main factor of self-prioritisation. However, this is a quite venturesome hypothesis and further examination dedicated to this aspect is required.

Moreover, the results of the second study have unveiled the presence of SPE in the extraordinary conditions caused by the COVID-19 pandemic, i.e. for the self-face covered by mask. Other studies focused on the perception of faces covered by the surgical-like mask revealed agreeably difficulties in face-matching performance tasks when compared to fully visible faces (Freud et al., 2020; Carragher and Hancock, 2020; Noyes et al., 2021; Estudillo et al., 2021). Moreover, they discovered that covering faces with a surgical-like mask hits the face-matching performance similarly, regardless of the familiarity of the perceived faces (Carragher and Hancock, 2020; Noyes et al., 2021). Despite the distinctive paradigms and methods of data collection, our results are in line with those from the previous studies. P1, P3, and LPP amplitudes were significantly higher for each face hidden behind the surgical-like mask, i.e. all faces (self-face, close-other's, and unknown faces) were similarly affected, and they attracted attention to a higher extent than uncovered faces. Nevertheless, the pattern of findings observed in our study with covered faces (self-, close-other's, unknown) is analogous to the typical pattern for uncovered faces: presentations of the self-face were associated with increased P3 and LPP amplitude. In other words, the SPE was found in the case of partial information about the self- and other faces. The latter is a novel finding, and it expands our knowledge about the SPE. An interesting insight is also provided by the source analysis, which demonstrated similar structural activation for both stimulus types, i.e. faces covered and uncovered by masks. Such a pattern of findings further supports the notion that faces are similarly processed regardless of available facial information.

In the last study, faces evoked higher ERP responses than shapes, indicating that the former captures attention stronger than the latter. However, the pattern of results for shapes was dissimilar to that of faces. A comparison of collected data revealed that shapes assigned to the participant and chosen close-other did not differ, however, both presented significantly higher P3 amplitudes and were characterised by distinctive activation patterns from unknown shapes. It should be highlighted that the association of the shapes consisted of remembering them, thus, they were equally familiar and more familiar than any other shape used later in the study. Therefore, the observed difference between assigned and unknown shapes, and the lack of such differences between the former ones, is a strong argument for familiarity.

Nonetheless, our results are diverse from those obtained in other studies assigning unknown stimuli to the self and close-other. It may result from methodological differences. Sui and colleagues (2012) used a shape-label matching task in which participants were asked to indicate whether the presented pair was congruent or not. Woźniak et al. (2018) designed a task matching labels and unknown faces, earlier assigned to the self and others. As in both of these studies, well-known labels were used, it is possible that reported SPE was a consequence of labels instead of transferred emotionality on those stimuli. Moreover, the main question was significantly different - in the aforementioned experiments, participants were tasked to focus on the stimuli' congruency, whereas in this study, it was on familiarity.

5. Summary and Conclusions

Results of these studies clearly indicated higher amplitudes of late (P3 and LPP) ERP components to self-face vs. subjectively and objectively emotional faces, pointing to the role of familiarity factor in the SPE. Crucially, when the familiarity of processed stimuli is equalised (abstract shapes), the SPE disappears.

Thus, the key conclusion drawn from this thesis is that familiarity plays a crucial role in driving the self-prioritisation effect. Through a comprehensive exploration, we consistently demonstrate the pivotal role of high familiarity of self-related information for the appearance of the self-prioritisation effect. This work further advances our scientific understanding by spotlighting the intricate interplay between familiarity and emotionality in shaping how individuals process information and make decisions influenced by the self-prioritisation effect.

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