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Milena Dzhelyova, Christine Schiltz, Bruno Rossion

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The Relationship Between the Benton Face Recognition Test and Electrophysiological Unfamiliar Face Individuation Response as Revealed by Fast Periodic Stimulation

Milena Dzhelyova
Psychological Sciences Research Institute and Institute of Neuroscience, Université Catholique de Louvain, Belgium; Cognitive Science and Assessment Institute, University of Luxembourg, Luxembourg

Christine Schiltz
Cognitive Science and Assessment Institute, University of Luxembourg, Luxembourg

Bruno Rossion
CNRS - Université de Lorraine, CRAN, France; Service de Neurologie, CHRU-Nancy, Université de Lorraine, France

Abstract

A recent approach to implicitly study face recognition skills has been the fast periodic visual stimulation (FPVS) coupled with electroencephalography (EEG). Its relationship with explicit behavioral measures of face individuation remains largely undocumented. We evaluated the relationship of the FPVS–EEG measure of individuation and performance at a computer version of the Benton Face Recognition Test. High-density EEG was recorded in 32 participants presented with an unfamiliar face at a rate of 6 Hz (F) for 60 s. Every five faces, new identities were inserted. The resulting 1.2 Hz (F/5) EEG response and its harmonics objectively indexed rapid individuation of unfamiliar faces. The robust individuation response, observed over occipitotemporal sites, was significantly correlated with speed, but not accuracy rate of the computer version of the Benton Face Recognition Test. This effect was driven by a few individuals who were particularly slow at the behavioral test and also showed the lowest face individuation response. These results

Corresponding author:
Bruno Rossion, CNRS - Université de Lorraine, CRAN, UMR 7039, Pavillon Krug (1er étage - entrée CC-1), Hôpital Central, CHRU Nancy - University Hospital of Nancy, 29 Avenue du Maréchal de Lattre de Tassigny, 54000 Nancy, France.
Email: bruno.rossion@univ-lorraine.fr

highlight the importance of considering the time taken to recognize a face, as a complementary to accuracy rate variable, providing valuable information about one's recognition skills. Overall, these observations strengthen the diagnostic value of FPVS–EEG as an objective and rapid flag for specific difficulties at individual face recognition in the human population.

Keywords
unfamiliar face recognition, FPVS, Benton Face Recognition Test

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Introduction

Compared with other animal species such as macaque monkeys, humans have an astonishingly good ability to individuate novel (i.e., unfamiliar) facial identities (Rossion & Taubert, 2019). This ability—which undergoes a long development (e.g., Hills & Lewis, 2018)—is particularly important in our species for three reasons at least. First, in humans, identity recognition is based primarily on the face, which is clearly visible during most interactions and shows elevated phenotypic and genetic interindividual variability compared with other body parts (Sheehan & Nachman, 2014). Second, most human societies are characterized by the presence of numerous individuals and fission–fusion dynamics, that is, a tendency to change the number of experienced individuals over time. Third, learning to identify new people from their faces requires first and foremost being able to pick up the idiosyncratic features of these faces.

Behavioral studies generally show that neurotypical human adults are highly accurate and fast at discriminating segmented images of different individual faces and matching the same individual faces across changes of size, position, or even head orientation (e.g., Bowles et al., 2009; Bruce et al., 1999; Bruce, Henderson, Newman, & Burton, 2001; Busigny & Rossion, 2010; Estudillo & Bindemann, 2014; Herzmann, Danthiir, Schacht, Sommer, & Wilhelm, 2008; Megreya & Burton, 2006; Rossion & Michel, 2018; Sergent, 1984). However, there is also a substantial amount of interindividual variability in unfamiliar face individuation abilities, this variability having been increasingly used in recent years to study interindividual differences and inform about the origin and nature of the human face recognition function (e.g., Wilmer et al., 2010).

While behavioral measures aim at closely reflecting an individual's ability at face individuation in natural circumstances, they are limited due to the use of explicit tasks, which include many processes contributing to a given performance level. Moreover, performance is reflected by different outcome variables (i.e., accuracy rates and response times). A potential alternative way to measure individual differences in face individuation is to use global (i.e., system-level) neurophysiological indexes. Specifically, by coupling fast periodic visual stimulation (FPVS) with human electroencephalography (EEG), one can obtain measures of unfamiliar face individuation that are sensitive, taking only a few minutes of data collection (Alonso-Prieto, Van Belle, Liu-Shuang, Norcia, & Rossion, 2013; Dzhelyova & Rossion, 2014a, 2014b; Liu-Shuang, Norcia, & Rossion, 2014; Rossion & Boremanse, 2011; Rossion, Prieto, Boremanse, Kuefner, & Van Belle, 2012; Xu, Liu-Shuang, Rossion, & Tanaka, 2017), and highly reliable (Dzhelyova et al., 2019; Stacchi, Liu-Shuang, Ramon, & Caldara, 2019). Compared with behavioral measures, this electrophysiological approach has several important advantages. First, it measures face individuation *implicitly* so that

there is no need for explicit instructions, which could account for some of the variations observed in individual performance in behavioral experiments. In addition, the visual recognition system may be constrained to perform this function at a single glance (i.e., 200 ms stimulus onset asynchrony), preventing unnatural and slow feature-by-feature facial analyses. Third, responses are identified and quantified objectively in the frequency domain at the individual level, allowing the investigation of interindividual variation of face recognition skills.

An influential paradigm to studying face individuation relies on the repeated presentation of an unfamiliar face identity for about 1 min at a periodic rate, usually 6 Hz (i.e., 6 images/s), allowing only a single fixation on each face image. Different unfamiliar face identities are introduced at a lower periodic rate (e.g., one change of identity every five faces, or 1.2 Hz). While EEG responses recorded at 6 Hz (and harmonics, i.e., 12 Hz, etc.) reflect common visual processing of all visual stimuli, responses at 6 Hz/5 and its specific harmonics (1.2 Hz, 2.4 Hz, etc.) can be taken as an index of rapid (i.e., single-glanced) individuation of faces (Dzhelyova & Rossion, 2014a, 2014b; Dzhelyova et al., 2019; Liu-Shuang et al., 2014; Liu-Shuang, Torfs, & Rossion, 2016; Stacchi et al., 2019; Xu et al., 2017).

While this electrophysiological index can be selectively affected in patients with prosopagnosia following brain damage (Liu-Shuang et al., 2016), showing its functional relevance (see also Jonas et al., 2018), its relationship with explicit behavioral measures of face individuation remains largely undocumented. A recent study using a low-density sampling of EEG (32 channels, 3 relevant channels over occipitotemporal regions) found only a weak correlation of EEG amplitude in this paradigm with performance at a widely used explicit individual face learning test—the Cambridge Face Memory Test (CFMT; Duchaine & Nakayama, 2006; Xu et al., 2017). A weak correlation could partly result from the two tasks measuring different aspects of individuation of faces: While the CFMT requires explicit short-term memory encoding of individual unfamiliar faces, FPVS–EEG measures rapid individuation of unfamiliar faces implicitly. Moreover, individual differences in the speed of face individuation are not considered in the CFMT, despite the fact that it is an important aspect of individual differences in this function (Rossion & Michel, 2018; Wilhelm et al., 2010). To this end, the present short study evaluates the relationship of the FPVS–EEG measure of individuation with an oddball-like paradigm to another widely used behavioral test—the Benton Face Recognition Test (BFRT; Benton & Van Allen, 1968). In the BFRT, participants are simultaneously presented with a target face and six test faces and must choose either one test face for 6 trials or the three test faces that match the target face for the remaining 16 trials. Most recently, an electronic version of the BFRT has been validated in a large cohort of participants (computer version of BFRT [BFRT-c]; Rossion & Michel, 2018), adding response time measures to accuracy rates, thus providing a reliable and critical complementary measure of performance at individual unfamiliar face matching. Here, we tested 32 participants both with the FPVS–EEG measure of face individuation described earlier and the BFRT, testing for correlations between the two measures.

Methods

Participants

Thirty-two participants (17 females; mean ± SD age at first recording session = 22.12 ± 2.62) took part in the study. They were all right-handed, free of neurological or psychiatric problems, and had normal or corrected-to-normal vision. All participants provided signed

and informed consent and were paid an amount according to their testing time. The study was approved by the Biomedical Ethical Committee of the University of Louvain.

Stimuli

Facial stimuli were 25 female and 25 male photographs from the Face Categorization lab database. A detailed description of the images is available in previous studies investigating unfamiliar face individuation (Laguesse, Dormal, Biervoye, Kuefner, & Rossion, 2012; with FPVS: Dzhelyova & Rossion, 2014a; Liu-Shuang et al., 2014). All faces were unknown to the participants tested. They were presented in a frontal view with forward eye gaze, with masked external features such as ears and hair and placed against a gray background (Figure 1). Images were resized to 250 pixels height (width = 186 ± 11 pixels), corresponding to 8.57 deg × 3.97 deg at an 80 cm distance from the monitor.

Procedure

Upon arrival, participants completed the computer version of the BFRT (BFRT-c, Rossion & Michel, 2018). They were then seated comfortably in a dimly lit room 80 cm away from the monitor. They performed only four stimulation sequences of about 1 min, which is sufficient to provide robust face individuation measures in single individuals (e.g., Liu-Shuang et al., 2014, 2016; Xu et al., 2017). In each stimulation sequence, a randomly chosen face identity (either male, for two sequences, or female, for two sequences) was presented repeatedly at a fast rate of 6 Hz. Stimuli were presented through sinusoidal contrast modulation as in most previous studies with this paradigm. They varied randomly in size (80%–120% of original size) at each cycle, as also performed in previous studies (e.g., Liu-Shuang et al., 2014; Rossion & Boremanse, 2011) to minimize low-level cue repetition effects (see Dzhelyova & Rossion, 2014a for quantification of size change effects on the EEG response). Within a given sequence, different same-sex faces picked randomly among the pool of the remaining 24 faces, appeared as every 5th stimulus (i.e., change of identity frequency 6 Hz/5 = 1.2 Hz, Figure 1(b)). Each sequence started with a fixation cross presented for a random period of a 2 to 5 s, followed by a 2-s fade-in interval during which

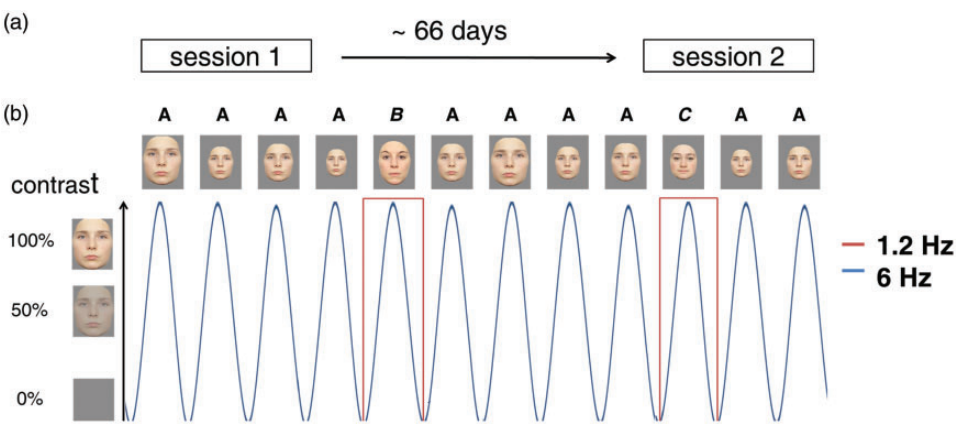

Figure 1. Experimental design: (a) an illustration of a fast periodic visual stimulation sequence where images of Identity A are presented through sinusoidal contrast modulation at 6 Hz and every 5th image is a different identity (B, C, etc.). Thus, unfamiliar face identity change occurs at 1.2 Hz (6 Hz/5). Image size varies for each cycle and (b) length of an experimental sequence. (See online for a colour version of this figure)

image contrast gradually increased, a 60-s stimulation sequence, and a 2-s fade-out. The fade-in and fade-out were included to avoid abrupt eye movements at stimulation onset and offset. Participants' task was to respond to brief (300 ms) changes in the color of the fixation cross, and they received no information as to the goal of the study. Participants performed the orthogonal task at ceiling, with no difference in ($ps > .40$) accuracy ($M \pm SEM = 0.96 \pm 0.031$) or response times ($M \pm SEM$: 433 ± 17).

EEG Acquisition

EEG was recorded via a BIOSEMI Active two amplifier system (Biosemi, Amsterdam, Netherlands) with 128 Ag/AgCl electrodes inserted in an electrode cap and sampled at 512 Hz. Electrodes' scalp location is similar to the standard 10 to 20 system locations and additional intermediate positions. Eye movements were monitored with four electrodes, one placed at the outer canthi of each eye (horizontal electrooculogram), and one placed above and one below the right eye (vertical electooculogram).

EEG Preprocessing and Frequency Domain Analysis

All EEG preprocessing steps were carried out with Letswave 6 (https://github.com/NOCIONS/letswave6) running on MATLAB (R2012b) and followed procedures described in detail in previous publications with this approach (see, e.g., Liu-Shuang et al., 2016). EEG data were first digitally band-pass filtered at 0.10 to 100 Hz with a Butterworth filter (fourth order) and downsampled to 256 Hz to reduce computation load. Then, it was segmented to include 2 s before and after each sequence (i.e., before the fade-in and after the fade-out of the stimulation), resulting in 68 s segments (–2 to 66 s). Data from 3 participants who blinked more than 10 times in at least 2 sequences (mean number of blinks across participants = 3.5, $SD = 4.59$) were corrected by means of ICA using the runica algorithm (Bell & Sejnowski, 1995; Makeig, Bell, Jung, & Sejnowski, 1996), as implemented in EEGLAB. This algorithm outputs a square mixing matrix in which the number of components corresponds to the number of channels. For each of these participants, only one component representing vertical eye movements was removed. Channels with extreme voltage offset ($\pm 100\,\mu V$ identified by visual examination) were replaced using linear interpolation of the three neighboring channels. Less than 5% of the channels were interpolated per participant, only = 1.1 $\pm$ 1.58 ($M \pm SEM$) channels. After that, a common average reference computation was applied to all channels for each participant.

Preprocessed data segments were cropped to an integer number of 1.2 Hz cycles, beginning 2 s after the onset of the sequence until approximately 62 s ($\sim$60 s, 15,149 time samples in total). The first 2 s of each segment (i.e., fade-in) were excluded to avoid any contamination by the initial transient responses. The four resulting 60 s segments were averaged in the time domain to increase the signal-to-noise ratio. A fast Fourier transform was then applied to these averaged segments, and normalized amplitude spectra were extracted for all channels (square root of the sum of squares of the real and imaginary parts divided by the number of data points). Thanks to the long time window, frequency analysis yielded spectra with a high frequency resolution of 0.0166 Hz (1/60), thus increasing signal-to-noise ratio (Regan, 1989) and allowing unambiguous identification of the response at the frequency of the change in face identity (1.2 Hz).

The amplitude spectra across participants were grandaveraged. The resulting EEG spectrum was averaged across all 128 channels. To identify the presence of statistically significant responses at the frequencies of interest and its harmonics, the grandaveraged

amplitude spectrum was converted to Z scores by computing the difference between the amplitude at the frequency of interest and the mean amplitude of the 20 surrounding frequency bins divided by the standard deviation of the 20 surrounding bins (see, e.g., Liu-Shuang et al., 2016). Harmonics with significant responses (Z score > 3.14, $p < .001$ one-tailed, i.e., signal > noise) were considered for analysis. Based on this criterion, six harmonics (i.e., 1.2, 2.4, 3.6, 4.8, 7.2, and 8.4 Hz) were significant and thus included to quantify the face individuation response, while eight harmonics up to 48 Hz were included for the quantification of the base rate response.

To quantify the face individuation response, the baseline-corrected amplitudes were calculated on individual subjects' spectra by subtracting the mean amplitude of the surrounding bins (until the 10th on each side, excluding the immediately adjacent bin and the bins containing the highest and lowest amplitudes) and summed for the six significant harmonics, excluding the fifth harmonic corresponding to the 6 Hz response. The response was quantified over two regions of interest (ROIs): in the left occipitotemporal (LOT: electrodes PO7, PO9, PO11, P7, P9) and right occipitotemporal (ROT: PO8, PO10, PO12, P8, P10) sites. These ROIs were defined based on previous studies (Dzhelyova & Rossion, 2014a, 2014b; Liu-Shuang et al., 2014, 2016) and visualization of the present data. The 6 Hz response was quantified as the baseline-corrected amplitudes of the summed eight (up to 48 Hz) significant 6 Hz harmonics over the middle occipital (MO) site: POz, POOz, Oz, Oiz, Iz. The summed baseline-corrected amplitudes were averaged across the five electrodes for each ROI. To assess if the response is significant at a group level, we tested the baseline-corrected amplitudes against 0 with inferential (spss v.19) and Bayesian (Jasp software) statistics. In addition, for the face individuation response, we compared the response over the LOT and the ROT region. We expected significant face individuation responses, larger over the right hemisphere, and a significant general visual response over the MO site.

Relationship to Explicit Behavioral Measures of Face Individuation

To examine the relationship between FPVS–EEG and the behavioral measure of face individuation, the EEG discrimination response averaged over the LOT and the ROT ROIs (the mean baseline-corrected amplitudes across the five electrodes in left and right hemisphere respectively) was correlated with the BFRT-c score of the participants. In addition to the accuracy score, to account for interindividual variation, we also examined RTs as well as inverse efficiency scores (IES; RTs/accuracy). We tested the overall BFRT score obtained as well as the score excluding the first six items (i.e., only the items including variations in pose and lighting) because these items require only strict image-based matching (Rossion & Michel, 2018). To evaluate the specificity of the relation between the individuation response and the performance on the BFRT-c, we also evaluated the correlations with the summed significant harmonics of the general visual response recorded over MO sites.

Results

General Visual Response

The general visual response was distributed over MO sites, spreading to ROT sites for the first harmonic at 6 Hz but focusing over the MO sites for higher harmonics (Figure 2(a)). The summed baseline-corrected response for the significant eight harmonics peaked over

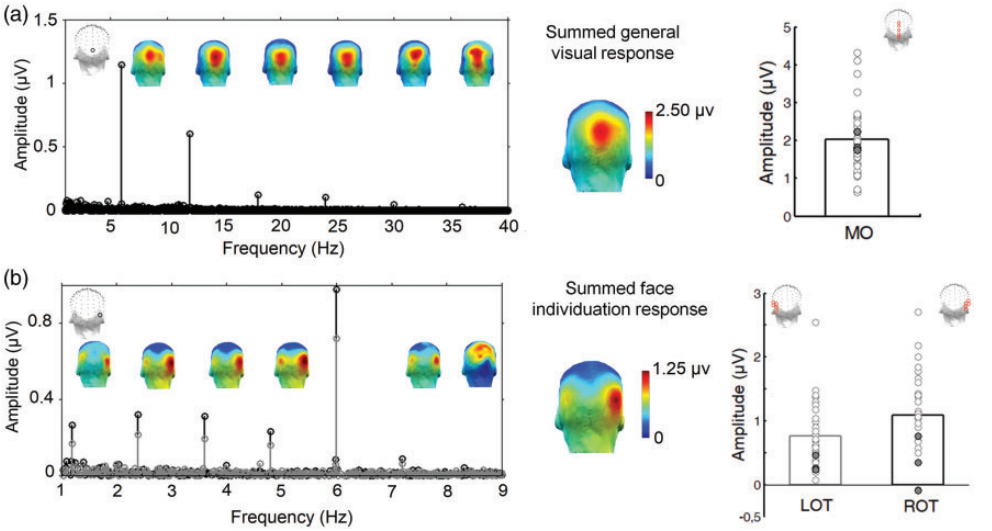

Figure 2. Responses obtained with the fast periodic visual stimulation paradigm. (a) General visual response. Left panel: Baseline-corrected amplitude spectrum at middle occipital electrode Oz (black) highlighted with a black circle on the blank headplot. Topographical maps show the baseline-corrected amplitudes for each harmonic displayed at their maximal activation. Middle panel: Topographical distribution of the summed baseline-corrected amplitudes for the significant harmonics of the general visual response (until 48 Hz). Right panel: Summed baseline-corrected amplitudes for the general visual response over middle occipital region of interest (channels are circled in red on the blank headplot) and individual general visual responses are displayed. Filled markers correspond to the response of the three participants with the slowest reaction times at the computer version of the Benton Face Recognition Test. (b) Face individuation response. Left panel: Baseline-corrected amplitude spectra at right occipitotemporal electrode PO10 (black) and left occipitotemporal electrode PO11 (gray) highlighted with a black and a gray circle, respectively, on the blank headplot. Topographical maps show the baseline-corrected amplitudes for each harmonic displayed at the maximal activation for each harmonic. Middle panel: Topographical distribution of the summed baseline-corrected amplitudes for the significant harmonics of the face individuation response (until 8.4 Hz). Right panel: Summed baseline-corrected amplitudes for the face individuation response over left and right occipitotemporal region of interest (channels are circled in red on the blank headplot). Filled markers correspond to the response of the three participants with the slowest reaction times at the computer version of the Benton Face Recognition Test.
MO = middle occipital; LOT = left occipitotemporal; ROT = right occipitotemporal. (See online for a colour version of this figure).

channel Oz = 2.56; $z = 218.28$. This response was highly significant, $t(31) = 12.61$, $p < .0001$, $BF_{10} = 1.507e^{+11}$.

Face Individuation Response

At a group level, the face individuation response was clearly visible in the frequency spectrum (Figure 2(b)). It was centered over the occipitotemporal sites, particularly over the right hemisphere at a group level, replicating previous studies with this paradigm (Dzhelyova & Rossion, 2014a, 2014b; Liu-Shuang et al., 2014; Xu et al., 2017: 32 channels). The response peak was found over the low occipitotemporal channel PO10 = 1.26 μV, $z = 28.83$. The face individuation response over both hemispheres was significantly different from 0—right OT: $t(31) = 10.01$, $p < .0001$, $BF_{10} = 6.119e^{+8}$; left OT: $t(31) = 8.73$, $p < .0001$, $BF = 2.999e^{+7}$. In

addition, there was a larger response over the right ($M \pm SEM = 1.08 \pm 0.11$) than the left ($M \pm SEM = 0.75 \pm 0.08$) hemisphere, $t(31)=7.21$, $p < .0001$; $BF_{10} = 69.39$.

At an individual level, most participants (22) had a larger response in the right hemisphere (Figure 2(b)). Right lateralization was determined as a larger face individuation response over the right than the left OT ROI. The sum of the 1.2 Hz harmonics provides a quantification of the face individuation response and was significant in all participants on at least four electrodes at a conservative statistical threshold of $z > 3.1$, $p < .001$.

Relation With BFRT-c

All participants scored above 37 (a score considered as indicating impairment of face recognition skills at the BFRT, Benton & Van Allen, 1968) out of 54 (accuracy $M \pm SEM = 44.8 \pm 0.67$, $SD = 3.77$ range 38/54–52/54), but below ceiling. Four participants scored in the range of 39 to 40, indicating a borderline score, and only one participant scored 38, considered to indicate a moderate impairment. These latter five participants would have scored under the 5th percentile (<39–40) on the normative scores for BFRT-c (Rossion & Michel, 2018). The performance of only two of them was slower than average (more than 1 SD above the mean), while the time taken to complete the BFRT-c by the other two was similar or faster than the average time required to complete the test ($M \pm SEM = 7.31 \pm 0.55$, $SD = 3.08$). Performance excluding the first six trials, which require only to match identical images of faces, was also highly accurate ($M \pm SEM = 39/48 \pm 0.67$) and completed in $M \pm SEM = 9.23 \pm 0.70$ min, with similar values as reported in Rossion and Michel (2018).

Despite a positive trend, the face individuation response averaged over the LOT and the ROT channels was not significantly correlated with BFRT-c accuracy (all trials: $N = 32$, $r = .27$, $p = .14$; excluding the first six items, $N = 32$, $r = .24$, $p = .18$; Figure 3(a)). However, there was a significant negative correlation with correct RTs ($N = 32$, $r = -.39$, $p = .026$; without the first six items: $r = -.39$, $p = .029$): Participants who were the slowest at the BFRT-c tended to have the lowest face individuation EEG response amplitude (Figure 3 (b)). The correlation increased slightly when considering IES (all trials: $N = 32$, $r = -.43$, $p = .013$ Figure 3(c); excluding the first six trials: $N = 32$, $r = -.42$, $p = .017$). Interestingly, the three individuals showing the lowest individual discrimination response, despite having a general visual response well within the normal range (black markers filled with gray at Figure 3(b) and (c)), were among the four lowest performers (among 32) at the BFRT-c. Removing these three participants reduced the correlations to nonsignificant values: all items, RT ($N = 29$, $r = -0.13$, $p = .52$); IES ($N = 29$, $r = -.18$, $p = .34$); excluding the first six items, RT ($N = 29$, $r = -.18$, $p = .35$); IES ($N = 29$, $r = -.17$, $p = .38$).

In contrast, the general visual response over the MO site was not correlated with the BFRT-c indices—all ps $> .14$; all items: accuracy ($N = 32$, $r = -.122$, $p = .50$), RT ($N = 32$, $r = .25$, $p = .16$), and IES ($N = 32$, $r = .25$, $p = .16$); excluding the first six items: accuracy ($N = 32$, $r = -.13$, $p = .48$), RT ($N = 32$, $r = .27$, $p = .14$), and IES ($N = 32$, $r = .26$, $p = .15$).

Discussion

Replicating previous studies using the same paradigm (Dzhelyova & Rossion, 2014a, 2014b; Liu-Shuang et al., 2014; Xu et al., 2017), we found an implicit robust unfamiliar face individuation response over occipitotemporal sites observed at an individual level within only 4 min of recordings. More important, we observed moderate correlations between the face individuation response and the response times needed to complete the computerized version of the BFRT-c (Rossion & Michel, 2018). This relation was specific to the face individuation

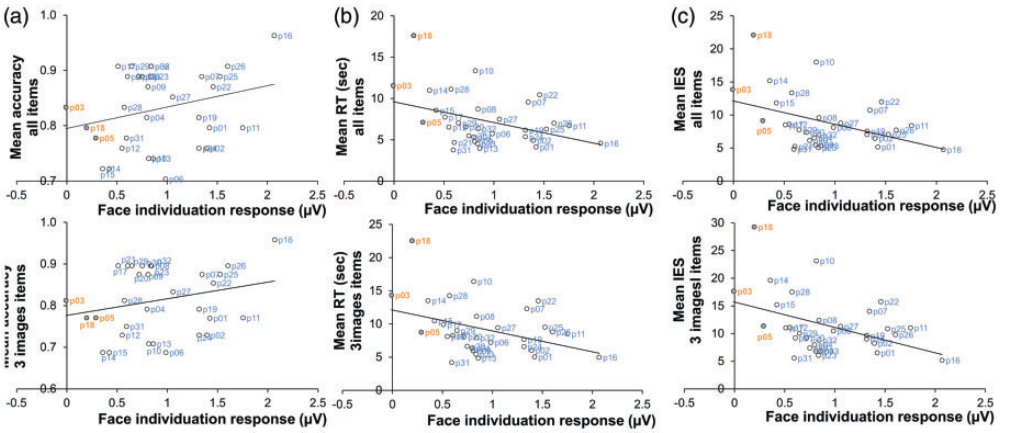

Figure 3. The relationship between the behavioral response at the BFRT-c and the face individuation response averaged over the channels in the left and right occipitotemporal ROIs. (a) Weak positive correlations between the mean accuracy and the face individuation response obtained with FPVS for all trials (upper panel) and for the trials with three items to be selected (matching individuals from different viewing angle and lighting, lower panel). (b) Moderate negative correlations between the mean response time necessary to complete the whole BFRT-c and the face individuation response obtained with FPVS for all trials (upper panel) and for the trials with three items to be selected (matching individuals from different viewing angle and lighting, lower panel). (c) Moderate negative correlations between the averaged IES (RTs/accuracy) and the face individuation response obtained with FPVS for all trials (upper panel) and for the trials with three items to be selected (matching individuals from different viewing angle and lighting, lower panel). RT = response time; IES = inverse efficiency scores.

response and was not found when examining the relationship between the performance on the BFRT-c and the general visual response.

In a previous study, there was only a modest ($r = .30$) correlation between the accuracy rate at individuation of unfamiliar faces (CFMT) and the electrophysiological index of face individuation (Xu et al., 2017). Here, we used a fourfold higher density sampling on the scalp (i.e., 128 electrodes compared with 32), with a higher density of channels over the occipitotemporal cortex to capture the face individuation response. The denser coverage of the scalps allows better capturing individual variations in EEG response because not all participants would have the same channel showing the maximal response. Furthermore, it increases reliability of the data when relevant channels are considered (Dzhelyova et al., 2019; Thigpen, Kappenman, & Keil, 2017). Most important, the correlation was performed with another behavioral test, the BFRT, in principle more closely related to the function assessed in EEG because it does not involve any learning and storage of individual faces in memory. Despite this, the correlation between the two measures remained modest, being nonsignificant for accuracy rates at the BFRT-c, but reaching significance for correct RTs. The highest correlation coefficients ($r = .43$) were obtained when combining the two behavioral variables into IES (Figure 3).

This significant but modest correlation suggests that there is shared variance between the electrophysiological and behavioral measures of face individuation, but that it is limited. This is not surprising because each of these measures reflect also more general processes than face individuation per se (e.g., task understanding, motivation, attention, visual search, and decision processes for the BFRT-c; e.g., skull thickness, orientation of the sources due to cortical folding for the FPVS–EEG measure). The fact that this correlation is driven

primarily by RTs at the BFRT-c could be explained by the higher reliability (e.g., split reliability) of this variable than accuracy scores (Rossion & Michel, 2018), but also because RTs at the behavioral task can be considered as a proxy for processing time, while in FPVS–EEG, the visual system is put under severe time constraints so that face identity needs to be extracted at a single glance. Nevertheless, our data also show that the correlation was driven essentially by a few (nonoutlier) individuals who had extremely low face individuation EEG responses and were also the slowest at the BFRT. This observation suggests that those participants might need more time to process the faces at the individual level. Moreover, an advantage of the FPVS paradigm is that it measures face individuation rapidly, at a single glance. In comparison, most behavioral studies present facial images for very long, or even unlimited, durations (e.g., the CFMT, Duchaine & Nakayama, 2006). One reason for that is that time pressure in *explicit* unfamiliar face discrimination tasks can deteriorate behavioral performance even in healthy adult participants (Bindemann, Fysh, Cross, & Watts, 2016; Fysh & Bindemann, 2017) and could even be more problematic (or impossible to apply) when testing children or clinical populations. Future studies with neurotypical adults could examine if varying the presentation rate of the stimulus could increase the correlation of performance in these conditions with EEG measures of face individuation with FPVS (see, e.g., Retter, Jiang, Webster, & Rossion, 2019 for such an approach used with generic face categorization).

In summary, the observation that the unfamiliar face individuation response was correlated with the response time of the BFRT-c task suggests that similar to its demonstrated relevance in cases of prosopagnosia following brain damage (Liu-Shuang et al., 2016), face palinopsia following electrical stimulation of the right *Fusiform Face Area* (Jonas et al., 2018), and deficits in processing facial identity in boys with autism spectrum disorder (Vettori et al., 2019), the electrophysiological index of face individuation measured with FPVS–EEG could be used as a rapid and implicit index to flag for difficulties at individual face recognition in neurotypical individuals (i.e., prosopdysgnosia; Rossion, 2018).

Declaration of Conflicting Interests

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ORCID iD

Milena Dzhelyova https://orcid.org/0000-0001-5128-3774

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