An Ecological and Objective Neural Marker of Implicit Identity Recognition

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Abstract

We developed a novel paradigm to measure identity recognition implicitly - using Fast Periodic Visual Stimulation (FPVS) with electroencephalography (EEG). Uniquely, we used ecologically valid face images that represent the features characteristic of forensic case material. FPVS EEG data were acquired from a demographically diverse cohort of 16 students and 12 police officers with normal face processing abilities. We measured participants' neural responses to a 1-Hz tagged oddball identity embedded within a 6-Hz stream of base images, using different types of face stimuli varying in image quality. Evidence of implicit recognition was found with high-quality mugshot, but not CCTV-like images. Our study extends previous research by demonstrating that unfamiliar identities can elicit robust neural signatures of recognition through brief, repeated passive exposure. The sensitivity of our method is valuable for applications where objective validation of face processing ability is crucial, including assessment of law enforcement experts (e.g., facial forensic examiners, Super-Recognizers) and eyewitnesses.

Keywords: implicit identity recognition; EEG; fast periodic visual stimulation

Introduction

FPVS with EEG is an established, yet relatively underused approach for objective neural measurement of face identity processes (FIP), including face categorization/detection (Rossion et al., 2015), discrimination (Liu-Shuang, Norcia, & Rossion, 2014; Rossion, Retter, & Liu-Shuang, 2020), and familiar face recognition (Yan, Zimmermann, & Rossion, 2020; Campbell & Tanaka, 2021). Our study introduces a novel FPVS paradigm to probe *implicit unfamiliar identity recognition*, using images of unfamiliar identities designed to mirror mugshots and CCTV images (Surveillance Cameras Face database; Grgic, Delac, & Grgic, 2011).

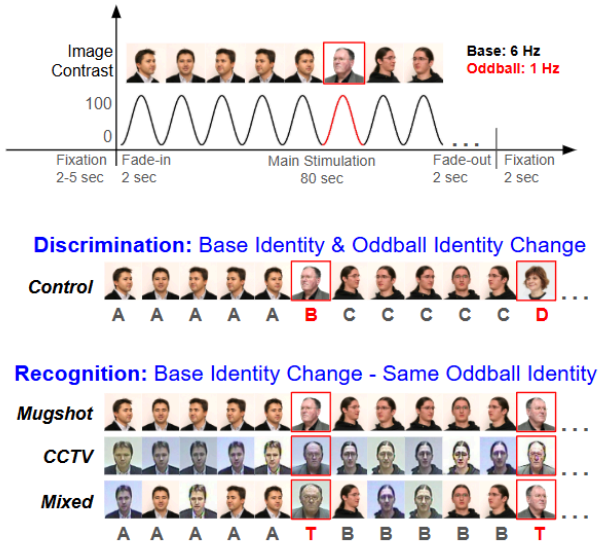

Figure 1. Illustration of the experiment paradigm. Note that only four representative identities are shown to adhere to image copyright agreement.

Our paradigm (Figure 1) involves presenting images flickering at 6-Hz, with each cycle showing five images of one individual (base identity), followed by an oddball image of a different identity. While base identities change across cycles, the oddball identity remains constant (AAAAA T BBBBB T...), allowing measurement of implicit recognition through neural responses at the 1-Hz oddball frequency. We created three variants of this implicit recognition condition: only mugshots, only CCTV images, and a mixed condition involving both. An additional control

condition measures neural identity discrimination (i.e. without recognition) by changing both base *and* oddball identities across cycles (AAAAA B CCCCC D...). We measured implicit neural recognition by comparing EEG responses at oddball frequencies between the *Mugshot* condition and *Control* condition, and determined the effect of stimulus variations on neural recognition responses.

Participants. We tested 16 undergraduate students in a controlled laboratory environment (14 females; Mage = 28±8y) and 12 police officers at their workplace (4 females; Mage = 37±8y), all with typical-range FIP abilities.

Results

Detection of Oddball Responses

Significant oddball responses (z-normalized signal-to-noise ratio (SNR) > 3.1; *p<.001*) were found in all conditions up to the 5th harmonics, predominantly in lateral occipito-temporal regions (see Figure 2).

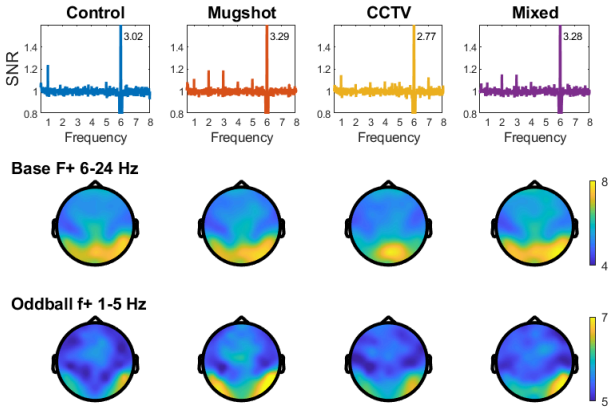

Figure 2. SNR responses and scalp plots.

Base Responses at *F+* 6-24 Hz.

Base frequency SNR did not significantly differ between *Control* and *Mugshot* conditions. Concerning the three *Recognition* conditions, the ANOVA results suggested a higher response in the *Mixed* condition, but this effect was not significant after Bonferroni correction.

Oddball Responses at *f+* 1-5 Hz.

Oddball frequency SNR for the *Mugshot* condition was significantly higher than the *Control* condition (*p=.008,* Cohen's *d=.64*), evidencing implicit recognition (Figure 3). Comparing the three conditions designed to probe implicit recognition (*Mugshot*, *CCTV*, and *Mixed*), we found that responses in the *Mugshot* were significantly higher than both other conditions (*CCTV*, *p=.012*, Cohen's *d=.58*; *Mixed*, *p=.008,* Cohen's *d=.58*) (Figure 3).

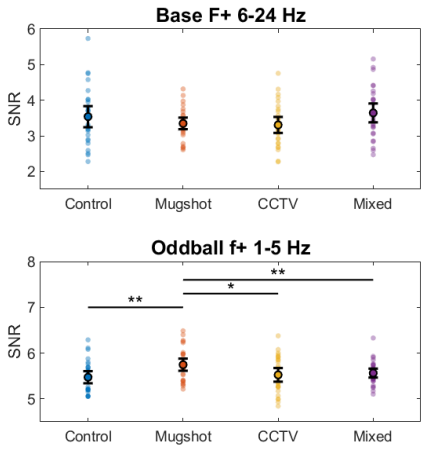

Figure 3. Comparison of SNR across conditions, and separately for base and oddball responses. *(* p<.05; ** p<.01)*

Discussion and Conclusion

We designed a FPVS EEG paradigm to measure implicit recognition using ecologically valid stimulus material: Mugshot and CCTV-like images. For *Mugshot* images, we found reliable neural markers of recognition. This demonstrates FPVS EEG's potential to capture automatic unfamiliar face recognition. Additionally, neural recognition responses were significantly larger for the *Mugshot* versus the *CCTV* and *Mixed* conditions, suggesting optimal image resolution may be necessary to measure implicit recognition among neurotypical observers using FPVS EEG. Our ongoing work addresses two open questions: (1) (How) do neural recognition responses differ across atypical cohorts, e.g. developmental prosopagnosics and Super-Recognizers? (2) Does the magnitude of neural recognition responses relate to individual FIP abilities? The answers will determine the utility of our paradigm over *behavioural* FIP ability assessment methods (Bobak et al., 2023). This is particularly relevant across applied settings, where identity recognition is called upon, e.g. forensic perpetrator recognition via experts (Mayer & Ramon, 2023) and eyewitnesses (Wixted et al., 2021).

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