



Deposited via The University of York.

White Rose Research Online URL for this paper:

<https://eprints.whiterose.ac.uk/id/eprint/241627/>

Version: Published Version

---

**Article:**

Lidborg, Linda H, Tuncer, David, BURTON, MIKE et al. (2026) Neural correlates of temporal interference between face. *Biological psychology*. 109308. ISSN: 0301-0511

<https://doi.org/10.1016/j.biopsycho.2026.109308>

---

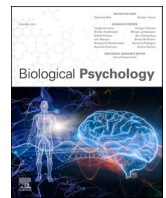
**Reuse**

This article is distributed under the terms of the Creative Commons Attribution (CC BY) licence. This licence allows you to distribute, remix, tweak, and build upon the work, even commercially, as long as you credit the authors for the original work. More information and the full terms of the licence here:

<https://creativecommons.org/licenses/>

**Takedown**

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing [eprints@whiterose.ac.uk](mailto:eprints@whiterose.ac.uk) including the URL of the record and the reason for the withdrawal request.



## Neural correlates of temporal interference between faces

Linda H. Lidborg<sup>a</sup>, Defne Kohen Tuncer<sup>a</sup>, A. Mike Burton<sup>b,c</sup>, Holger Wiese<sup>a,\*</sup> 

<sup>a</sup> Durham University, United Kingdom

<sup>b</sup> University of York, United Kingdom

<sup>c</sup> Bond University, Australia

### ARTICLE INFO

#### Keywords:

Face recognition  
EEG/ERP  
Repetition Priming  
N250r  
Familiarity

### ABSTRACT

Theoretical models of face processing incorporate within-pool inhibition – a mechanism by which representations compete with one another to support recognition. However, direct evidence for these inhibitory mechanisms is sparse in studies of human face perception. Here, we studied immediate repetition priming of faces to investigate this issue, using event-related potentials (ERP). In Experiment 1, we presented two familiar faces (Prime 1 and Prime 2), in sequence, followed by a target. We observed clear priming from Prime 2 (when it showed the same identity as the target) but no effect from Prime 1. In Experiment 2 we manipulated the familiarity of Prime 2, and again found that any effects of Prime 1 were eliminated by subsequent presentation of Prime 2. Experiment 2 also established that the familiarity of Prime 2 did not affect this inhibition – suggesting that it did not occur at the level of familiar face representations. Experiment 3 did find Prime 1 repetition effects with longer stimulus onset asynchronies between primes (500 ms relative to 200 ms in Experiments 1 and 2), suggesting no effective interference from a subsequently presented face once the representation of Prime 1 had become fully activated. These findings show effects of inhibition within the face processing system, but not at the level of abstract representations of familiar people, as had been previously proposed. We discuss the implications of these findings for models of face recognition.

### 1. Introduction

Most people are excellent at familiar face recognition, but the remarkable nature of this ability only becomes evident when the difficulty of the task is considered. Humans typically know thousands of faces (Jenkins, Dowsett, & Burton, 2018), and each of them can look very different depending on changes in viewing conditions (due to variable lighting, viewing angle, etc.) as well as changes in the faces themselves (due to emotional expressions, speech movements, make-up, facial hair, etc.; Bruce et al., 1999; Young & Burton, 2017). Given these challenges to the perceptual system, how can we explain highly reliable familiar face recognition?

Theoretical accounts typically assume that face recognition is a sequential process involving several stages (for a review, see Young & Bruce, 2011). First, once a visual stimulus is classified as being a face rather than a different object (see e.g., Schweinberger & Neumann, 2016), a perceptual representation is generated in a process often referred to as structural encoding. Second, this perceptual representation is compared to the stored long-term representations of known faces. It is assumed that each known face has a stable and image-independent

representation, which contains information about its physical appearance. Such representations (traditionally referred to as Face Recognition Units, FRUs; Bruce & Young, 1986) are established over multiple encounters and are sufficiently abstract to allow for recognition from widely varying instances (Burton, Kramer, Ritchie & Jenkins, 2016; Kramer, Young, & Burton, 2018). If a match is achieved between the perceptual and the long-term representation, the face is recognized as being familiar.

This sequential process of recognition generally produces an accurate result - we are good at recognising the people we know and rarely confuse our friends (say). In computational models of face recognition, competition between representations (i.e., those of similar looking people) tends to be resolved using inhibitory connections within representational levels, for example within the pool of FRUs (Burton, Bruce, & Hancock, 1999; Burton, Bruce, & Johnston, 1990). *Within-pool inhibition* is an attractive feature of many connectionist architectures, because it mitigates problems of hysteresis, in which networks can become inflexible to change. In the case of face recognition models, it also supports “winner-takes-all” decisions, in which a recognised face inhibits responses to other faces, even those with similar appearance.

\* Correspondence to: Department of Psychology, Durham University, South Road, Durham DH1 3LE, United Kingdom.

E-mail address: [holger.wiese@durham.ac.uk](mailto:holger.wiese@durham.ac.uk) (H. Wiese).

<https://doi.org/10.1016/j.biopsycho.2026.109308>

Received 9 December 2025; Received in revised form 28 May 2026; Accepted 28 May 2026

Available online 30 May 2026

0301-0511/© 2026 The Author(s). Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

However, while this inhibition seems to be a key component of working simulations, direct empirical evidence for it is sparse.

One way to test for within-pool inhibition experimentally is to use immediate repetition priming (e.g., [Schweinberger & Neumann, 2016](#)). Repetition priming paradigms first present a familiar face stimulus (the prime) which is followed by a second face (the target) with a fixed stimulus onset asynchrony (SOA; e.g., 1000 ms). If prime and target show the same identity (repetition condition), they should activate the same long-term representation. Accordingly, by the time the target is presented, its representation has already been (pre-)activated by the prime. Because the target's activation level is above baseline in this condition, its processing will be highly efficient. If, however, prime and target show two different facial identities (non-repetition condition), the target's activation level will be "neutral" or at baseline, and processing will be less efficient relative to the repetition condition (see [Burton et al., 1990](#)). This difference between repetition and non-repetition conditions can then be measured as a priming effect both behaviourally (e.g., in response time advantages for repeated faces) and at the neuronal level, as we shall describe below.

Critically, given within-pool inhibition, an intervening face stimulus between prime and target, showing a different known person, should inhibit the prime's representation ([Burton et al., 1990](#)) and should therefore interfere with any potential pre-activation of the target. While this should reduce or even abolish priming, it would also suggest that two different face representations cannot be held active simultaneously, and some previous findings seem to be in line with this proposal ([Bindemann, Burton, & Jenkins, 2005](#); [Boutet & Chaudhuri, 2001](#)). However, as will be discussed below, other results seem to suggest that repetition priming can be observed with intervening face stimuli, which at first sight seems hard to integrate with the theoretical idea of within-pool inhibition.

Here, we used event-related potential (ERP) correlates of immediate repetition priming to test for within-pool inhibition between familiar face representations. ERPs are derived from scalp-recorded EEG and are time-locked to events, such as the presentation of a visual stimulus ([Luck, 2014](#)). They are measured as voltage changes over time and reflect summed post-synaptic potentials ([Jackson & Bolger, 2014](#)). ERPs show characteristic waveforms, consisting of consecutive positive and negative deflections, referred to as components, which are particularly pronounced at occipito-temporal and temporal channels when elicited by face stimuli (for a recent review, see [Wiese, Schweinberger, & Kovacs, 2024](#)).

In immediate repetition priming experiments, ERPs time-locked to a target face are more negative from approximately 200–230 ms until 500 ms in the repetition relative to the non-repetition condition ([Begleiter, Porjesz, & Wang, 1995](#); [Schweinberger, Pfützte, & Sommer, 1995](#)). Here, we will refer to the earlier part of this repetition effect (from approximately 200–300 ms) as the N250r (r for repetition), while labelling subsequent parts as late repetition effects ([Ciocan, Gandlin, Bojdo, Lidborg & Wiese, 2026](#); [Pfützte, Sommer, & Schweinberger, 2002](#)). Given the above interpretation of repetition priming, more negative ERPs in the repetition condition seem to reflect facilitated access to long-term face representations. Traditional studies of ERP face priming tend to use the *same image* of a face as both prime and target ([Dörr, Herzmann, & Sommer, 2011](#); [Schweinberger, Huddy, & Burton, 2004](#); [Schweinberger et al., 1995](#); [Trenner, Schweinberger, Jentsch & Sommer, 2004](#)). However, it is important to note that while both the N250r and LRE are larger when the same image is used as prime and target, repetition effects are still reliably observed when two different images of the same person are presented ([Bindemann, Burton, Leuthold & Schweinberger, 2008](#); [Schweinberger, Pickering, Jentsch, Burton & Kaufmann, 2002](#)). As familiar face representations should be activated similarly by different, highly variable images (e.g., [Burton et al., 2016](#); [Kramer et al., 2018](#)), different-image (or image-independent) ERP repetition effects are arguably theoretically more interesting. However, while more studies investigating image-independent effects have

emerged in recent years ([Quinn, Popova, Green, Talfourd-Cook & Wiese, 2023](#); [Wiese, Ablott, Bojdo & Lidborg, 2025](#); [Wiese, Chan, & Tüittenberg, 2019](#)), relatively little is known about their characteristics as yet.

In the three experiments presented below, we use repetition priming to examine inhibition by introducing an additional familiar face stimulus between prime and target. If an intervening face inhibited activation of the prime face, we would expect no subsequent priming onto the target, as any potential benefit of the prime will have been eliminated, or at least reduced. While in this example inhibition would be backward-facing (as the second stimulus disrupts processing of the first), a forward-facing inhibition effect also appears possible. In this case, a first face would suppress the processing of a following, second prime stimulus, which, in turn, would then not be able to elicit priming as measured during the presentation of the target. Importantly, any potential inhibition effects need to be distinguished from visual masking. In a recent study, we demonstrated that a visual backwards mask, consisting of a phase-randomized image of the prime face, does not eliminate ERP repetition effects ([Wiese, Popova, Lidborg & Burton, 2024](#)). Accordingly, any potential (backwards) interference effects from face stimuli are unlikely to simply reflect the blocking of visual afterimages.

Some experimental reports already suggest an absence of within-pool inhibition. Pfützte and colleagues ([Pfützte et al., 2002](#)) presented famous faces in a continuous stream with image repetitions after two, three, or four intervening items. The authors observed clear ERP repetition effects starting in the N250r. We note, however, that each stimulus was presented for 1500 ms and with a 4000 ms interstimulus interval, which is arguably more than enough time for each face to be fully processed. Inhibition may be less relevant in these conditions, because exhaustive processing time for each individual stimulus should substantially reduce competition for resources between representations. This leaves open the possibility of priming based on strategic expectations, rather than the apparently automatic effects which are typically observed in the very short time-frames typical of perceptual priming. In a further study, Dörr and colleagues ([Dörr et al., 2011](#)) presented a single unfamiliar face between prime and target in a same-image priming experiment and again observed clear ERP priming effects. In this experiment, prime and unfamiliar face were both presented for 500 ms, but the intervening face was unfamiliar – i.e., had no existing representation as a potential source for inhibition.

Finally, both of the two studies demonstrating N250r effects with intervening face stimuli used same-image priming. This is critical because image-level representations can rely on pictorial cues, as well as identity ([Bruce, 1983](#)). As we know, priming is generally larger with same-image repetitions, both behaviourally ([Johnston & Barry, 2001](#)) and in ERP studies of the N250r ([Schweinberger et al., 2002](#)). So, any repetition effect in these experiments may have been based on pictorial rather than more abstract image-independent representations, calling into question their relevance for understanding the nature of FRU within-pool inhibition.

The present experiments were designed to examine whether within-pool inhibition of familiar face representations (not just specific face *pictures*) can be established using ERP repetition priming. In Experiment 1, we used two consecutive familiar face primes followed by a target. If two different, sequentially presented familiar face stimuli inhibit each other, we would expect reduced or absent priming from the first prime to a target showing the same person. However, no such inhibition should occur if the two primes show the same person (as both would activate the same representation). As either the first prime (Prime 1) or second prime (Prime 2) could be the same identity as the target, we further tested whether any potential interference would be forward- (i.e., Prime 1 blocking the processing of Prime 2) or backward-facing (i.e., Prime 2 blocking the processing of Prime 1). In Experiment 2, we then manipulated the familiarity of the primes to test whether any potential inhibition indeed occurred at the level of familiar face representations. Finally, while the first two experiments used relatively fast presentation

times, Experiment 3 introduced longer prime durations to test whether the availability of more processing time would reduce competition between representations.

## 2. Experiment 1: Interference between two consecutive primes

### 2.1. Methods

#### 2.1.1. Participants

A power analysis using G\*Power (Faul, Erdfelder, Lang & Buchner, 2007) based on the effect size for the repetition effect (300–400 ms; 200 ms prime duration) of Experiment 1 of a previous study (Wiese, Popova, et al., 2024) revealed an estimated  $N$  of 17 (two-sided paired-samples  $t$ -test,  $d_z = 0.96$ ,  $\alpha = .05$ ,  $1 - \beta = .95$ ). We aimed to test 30 participants, resulting in a sensitivity of  $d_z = 0.68$  with  $1 - \beta = .95$ , and  $d_z = 0.53$  with  $1 - \beta = .80$ . We note that statistical power in ERP research does not only depend on  $N$  but also on the number of trials per condition (Boudewyn, Luck, Farrens & Kappenman, 2018; Jensen & MacDonald, 2023).

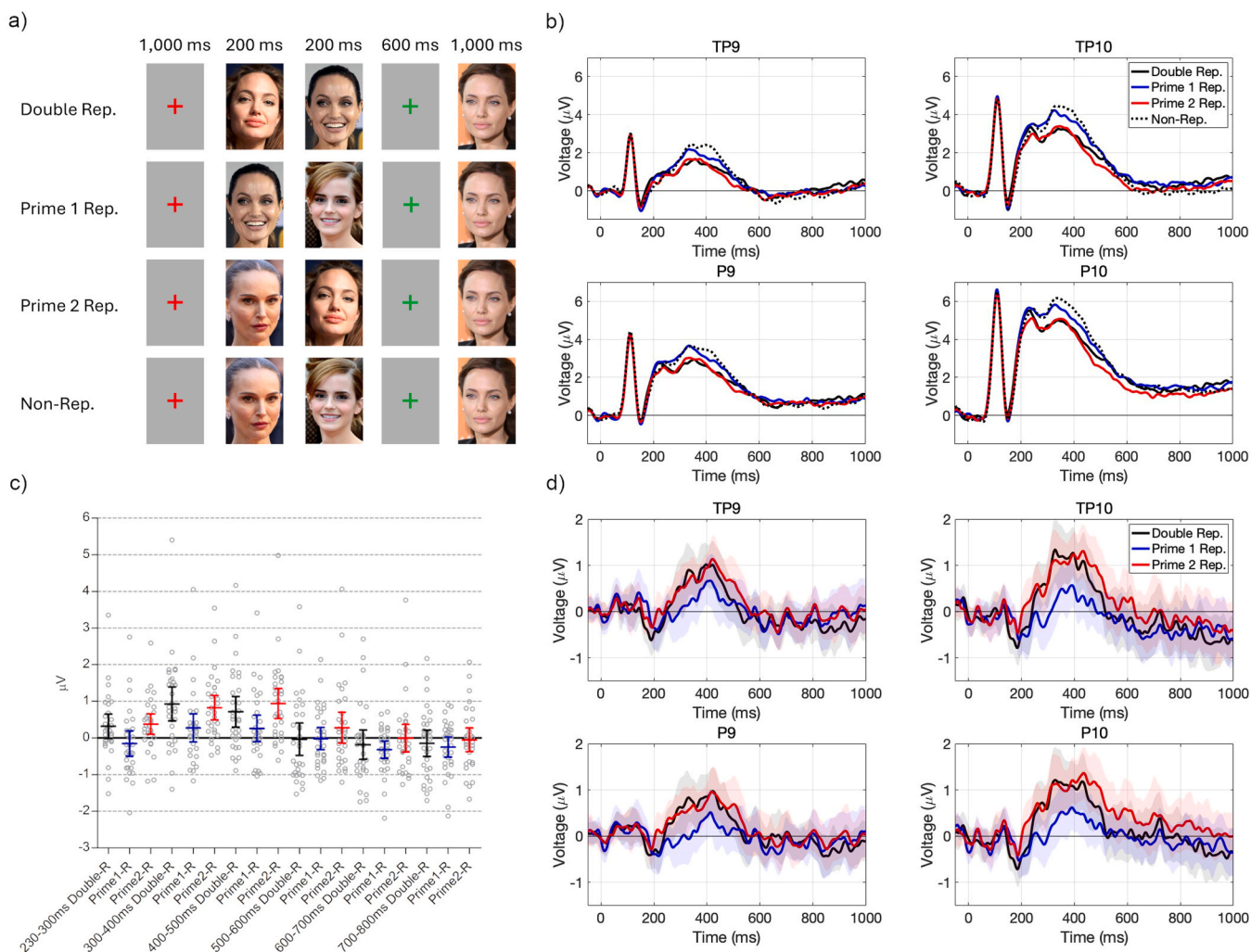
Thirty-two participants were tested, two of whom were subsequently

excluded due to technical issues during the EEG session. The final sample therefore consisted of 30 participants (mean age = 21.5 years,  $SD = 3.7$ ; 24 female, six male; 29 right-, one left-handed). The majority were Durham University students. All participants reported normal or corrected-to-normal vision and none took centrally acting medication. All gave written informed consent and were compensated with course credit or a monetary compensation of £ 8/h. The study was approved by the ethics committee of Durham University’s Psychology Department (PSYCH–2022–03–24T10\_58\_47-nzrk63).

#### 2.1.2. Stimuli

Prior to the EEG session, each participant completed an online survey, in which they were asked to rate how likely they were to recognise the faces of 79 different Western celebrities (actors, musicians, TV personalities, politicians etc.) on a scale from 1 (‘highly unlikely’) to 5 (‘highly likely’). For each individual participant, the 40 celebrities they reported as being most familiar were selected as stimuli. Only participants who reported being ‘somewhat’ or ‘highly’ likely to recognise at least 40 of the celebrities were invited to take part in the EEG session.

Twelve different full-colour images per identity were used during the



**Fig. 1.** a) Experimental conditions, trial structure, and sample stimuli. All images are used under Creative Commons licenses and retrieved from: Angelina Jolie, <https://openverse.org/image/4aaa09d6-62a1-4b03-9ae0-d1b826f40416?q=ANGELINA+JOLIE&p=38>, <https://openverse.org/image/bc88e354-d4b2-4492-bcce-f0510653e6de?q=ANGELINA+JOLIE&p=111>, Emma Watson, [https://upload.wikimedia.org/wikipedia/commons/7/7f/Emma\\_Watson\\_2013.jpg](https://upload.wikimedia.org/wikipedia/commons/7/7f/Emma_Watson_2013.jpg) [https://commons.wikimedia.org/wiki/File:Angelina\\_Jolie\\_2\\_June\\_2014\\_\(cropped\).jpg](https://commons.wikimedia.org/wiki/File:Angelina_Jolie_2_June_2014_(cropped).jpg), Natalie Portman, <https://openverse.org/image/8a442e03-e47e-410c-851b-62aded7bbdc3?q=natalie+portman&p=11>. b) Grand-average event-related potentials in the four experimental conditions at left- (TP9, P9) and right-hemispheric (TP10, P10) occipito-temporal and temporal electrodes. c) Mean and individual repetition effects (Non-Repetition minus Repetition), averaged across TP9/TP10/P9/P10. Error bars depict 95% confidence intervals (CIs). d) Mean (+/- 95% CIs) difference curves.

experiment. “Ambient” images were collected from various internet sources and varied naturally in viewing angle, lighting, emotional expression etc. Faces were cut from the original images (including the immediately-surrounding background; see Fig. 1 for example images) and resized to 200 by 300 pixels.

### 2.1.3. Procedure

Participants were seated in an electromagnetically shielded and sound-attenuated chamber with their heads in a chin rest positioned at a distance of 80 cm from an LCD computer monitor. Stimuli were combined into triplets consisting of a first prime (Prime 1), a second prime (Prime 2), and a target stimulus. In the Double Repetition condition (see Fig. 1a), all three stimuli showed different images of the same person. In the Prime 1 Repetition and Prime 2 Repetition conditions, either Prime 1 or Prime 2, respectively, showed a different image of the same identity as the target, while the other prime stimulus was an image of a different celebrity. In the Non-Repetition condition, all three stimuli showed different identities.

Each trial started with a red fixation cross, presented for 1000 ms, which was followed by Prime 1 and Prime 2, each presented for 200 ms. Primes were followed by a green fixation cross (600 ms), and the target (1000 ms). Each trial ended with a response screen, asking participants to rate the familiarity of the target face (1 = definitely unfamiliar, 2 = probably unfamiliar, 3 = probably familiar, 4 = definitely familiar), presented until a response was made. The experiment consisted of three blocks with 160 trials each and 120 trials per condition overall. Conditions were presented randomly intermixed, such that each identity appeared equally often. Each image was shown three times in total, and no target image was repeated throughout the experiment. A practice block consisting of 16 trials using two or three different images of some of the celebrities preceded the main experiment to familiarise participants with the task.

### 2.1.4. EEG recording and data analysis

During the experiment, 64-channel EEG was recorded from sintered Ag/AgCl electrodes mounted in textile caps using an ANT EEGo amplifier (ANT Neuro, Stevenage, UK). The sampling rate was set to 1024 Hz. AFz served as ground and CPz was used as the recording reference. Blink artefacts were corrected offline using Independent Component Analysis as implemented in BESA 6.3 ([www.besa.de](http://www.besa.de)). Trials were segmented from -50 ms to 1000 ms relative to target onset, with the first 100 ms (-50 to +50 ms) as the baseline (see Eimer, Kiss, & Nicholas, 2010; Wiese et al., 2025; Zimmermann & Eimer, 2013, 2014). This baseline was chosen to reduce the potential impact of prime-elicited ERPs on the target (e.g., Luck, 2014, p.256) and reflects that ERP responses to visual stimuli do not occur earlier than 50 ms after stimulus onset (Jeffreys & Axford, 1972; see also Luck, 2014, p.257). An amplitude criterion of 100  $\mu$ V and a gradient criterion of 75  $\mu$ V were used for artefact rejection. Only trials in which participants indicated that they had definitely recognized the target face (response option 4) were analysed. Remaining trials were filtered from 0.1 to 40 Hz (12 db/Oct, zero phase shift), re-referenced to the common average reference and averaged for each experimental condition separately. From a possible 120, average trial numbers were 108 ( $SD = 12$ ,  $Min = 77$ ) in the Double Repetition, 107 ( $SD = 12$ ,  $Min = 74$ ) in the Prime 1 Repetition, 109 ( $SD = 12$ ,  $Min = 81$ ) in the Prime 2 Repetition, and 107 ( $SD = 13$ ,  $Min = 75$ ) in the Non-Repetition condition.

As in previous studies, repetition effects were analyzed as mean amplitudes between 230 and 300 ms (N250r), and then in consecutive 100 ms time windows until 800 ms post target onset at electrodes P9, P10, TP9, and TP10 (see Wiese et al., 2025). Statistical analyses were carried out using repeated-measures Analyses of Variance (ANOVA), with degrees of freedom corrected using the Huyn-Feldt procedure when appropriate. Pairwise comparisons for repetition effects in all time windows were calculated using repeated-measures *t*-tests and corrected for multiple comparisons using the procedure described by Holm

(1979). In line with a “new statistics” approach (Cumming, 2012), we report confidence intervals and effect size measures throughout. In addition, mass univariate analyses are presented for all three experiments (see below).

### 2.1.5. Transparency and open science

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. Study data and analysis code is available via a publicly accessible repository (<https://osf.io/6mwb8/overview>). The conditions of our ethical approval do not permit the public archiving of the photos of facial identities used in this study and images cannot be shared outside the author team. Images of selected individuals are used as examples in the figures below. The study’s design and its analysis were not pre-registered.

## 3. Results

A repeated-measures ANOVA in the 230–300 ms time window with the within-subject factors site (TP, P), hemisphere (left, right) and prime condition (Double Repetition, Prime 1 Repetition, Prime 2 Repetition, Non-Repetition) revealed a significant main effect of prime condition,  $F(3, 87) = 5.83$ ,  $p = .001$ ,  $\eta_p^2 = .167$ . Paired sample *t*-tests (see Table 1) yielded significantly more negative amplitudes for the Prime 2 Repetition condition relative to both the Non-Repetition and the Prime 1 Repetition conditions.

A corresponding ANOVA in the 300–400 ms time window yielded both a main effect of prime condition,  $F(3, 87) = 14.77$ ,  $p < .001$ ,  $\eta_p^2 = .337$ ,  $\epsilon = .678$ , as well as a significant interaction of Prime Condition by Hemisphere,  $F(3, 87) = 4.73$ ,  $p = .004$ ,  $\eta_p^2 = .140$ , reflecting larger priming effects over the right hemisphere. Following up on the main effect, paired-sample *t*-tests revealed significantly more negative amplitudes for both the Prime 2 and the Double Repetition condition relative to Non-Repetitions, as well as significantly more negative amplitudes for Prime 2 relative to Prime 1 Repetitions.

A repeated-measures ANOVA in the 400–500 ms time range again revealed a significant main effect of prime condition,  $F(3, 87) = 14.10$ ,  $p < .001$ ,  $\eta_p^2 = .327$ ,  $\epsilon = .667$ , as well as an interaction of Hemisphere by Prime Condition,  $F(3, 87) = 2.85$ ,  $p = .042$ ,  $\eta_p^2 = .089$ . Follow-up tests demonstrated the same pattern as in the previous time window, with significantly more negative amplitudes for both Prime 2 and Double Repetition conditions relative to Non-Repetitions, as well as more negative amplitudes for Prime 2 relative to Prime 1 Repetitions.

No significant main effects of prime condition were observed in the 500–600 ms, 600–700 ms, or 700–800 ms time windows, all  $F < 1.96$ , all  $p > .125$ , all  $\eta_p^2 < .064$ .

## 4. Discussion

Using an ERP immediate repetition priming paradigm with two consecutive prime faces, Experiment 1 demonstrated clear and similar late repetition effects in both the Double and Prime 2 Repetition conditions between 300 and 500 ms relative to target onset. By contrast, no priming effect was observed for Prime 1 Repetition, while Prime 1 and 2 Repetition conditions differed significantly from the N250r onwards, between 230 and 500 ms. This pattern suggests that repetition effects in Experiment 1 were largely driven by Prime 2, independent of whether the same or a different person was presented as the first prime.

These results are consistent with the operation of an inhibitory mechanism. When Prime 1 is the same identity as the target, a different identity appearing as Prime 2 seems to eliminate any priming effect. However, other explanations are possible. First, it is possible that Prime 1 cannot influence the target because its activation has decayed by the time of target presentation. Although we consider this possibility unlikely, given previous findings of ERP priming effects with substantially longer SOAs (Pfütze et al., 2002), we will return to this possibility in Experiment 3.

**Table 1**

Pairwise comparisons of repetition effects in Experiment 1. R = Repetition;  $M_{diff}$  = mean difference, CI = confidence interval,  $p(\text{corr.})$  =  $p$ -values after correction for multiple comparisons according to Holm (1979), bold  $p$ -values indicate significant effects.  $d_z$  = Cohen's  $d$  using the standard deviation of the difference as the denominator (Lakens, 2013).

	$M_{diff}$ ( $\mu V$ )	95% CI	$t(29)$	$p$	$p(\text{corr.})$	$d_z$	95% CI
<b>230–300 ms</b>							
Double R. vs. Non-R.	0.320	−0.013, 0.652	1.97	0.059	.767	0.359	−0.013, 0.726
Prime1 R. vs. Non-R.	−0.152	−0.497, 0.193	−0.90	0.376	1.000	−0.164	−0.523, 0.197
Prime2 R. vs. Non-R.	0.377	0.100, 0.655	2.79	0.009	.153	0.509	0.124, 0.885
Prime2 R. vs. Prime1 R.	0.529	0.237, 0.821	3.71	< .001	<b>.017</b>	0.677	0.275, 1.070
<b>300–400 ms</b>							
Double R. vs. Non-R.	0.925	0.460, 1.391	4.07	< 0.001	<b>.007</b>	0.742	0.332, 1.142
Prime1 R. vs. Non-R.	0.271	−0.111, 0.653	1.45	0.157	1.000	0.265	−0.101, 0.627
Prime2 R. vs. Non-R.	0.823	0.489, 1.157	5.04	< 0.001	< <b>.001</b>	0.921	0.486, 1.344
Prime2 R. vs. Prime1 R.	0.552	0.338, 0.767	5.26	< 0.001	< <b>.001</b>	0.960	0.520, 1.389
<b>400–500 ms</b>							
Double R. vs. Non-R.	0.714	0.296, 1.133	3.49	0.002	<b>.028</b>	0.637	0.239, 1.026
Prime1 R. vs. Non-R.	0.259	−0.102, 0.621	1.47	0.153	1.000	0.268	−0.099, 0.630
Prime2 R. vs. Non-R.	0.941	0.529, 1.352	4.67	< 0.001	<b>.001</b>	0.853	0.429, 1.267
Prime2 R. vs. Prime1 R.	0.681	0.418, 0.944	5.30	< 0.001	< <b>.001</b>	0.967	0.526, 1.396
<b>500–600 ms</b>							
Double R. vs. Non-R.	−0.034	−0.475, 0.406	−0.16	0.875	1.000	−0.029	−0.387, 0.329
Prime1 R. vs. Non-R.	−0.018	−0.321, 0.285	−0.12	0.903	1.000	−0.022	−0.380, 0.336
Prime2 R. vs. Non-R.	0.279	−0.145, 0.702	1.35	0.189	1.000	0.245	−0.120, 0.607
Prime2 R. vs. Prime1 R.	0.297	0.045, 0.548	2.41	0.022	.330	0.440	0.062, 0.812
<b>600–700 ms</b>							
Double R. vs. Non-R.	−0.185	−0.584, 0.214	−0.95	0.352	1.000	−0.173	−0.532, 0.189
Prime1 R. vs. Non-R.	−0.321	−0.556, −0.085	−2.78	0.009	.144	−0.508	−0.885, −0.123
Prime2 R. vs. Non-R.	−0.009	−0.387, 0.369	−0.05	0.962	1.000	−0.009	−0.367, 0.349
Prime2 R. vs. Prime1 R.	0.312	−0.007, 0.630	2.00	0.055	.770	0.366	−0.007, 0.732
<b>700–800 ms</b>							
Double R. vs. Non-R.	−0.147	−0.505, 0.211	−0.84	0.407	1.000	−0.154	−0.512, 0.208
Prime1 R. vs. Non-R.	−0.251	−0.523, 0.022	−1.88	0.070	.840	−0.343	−0.709, 0.028
Prime2 R. vs. Non-R.	−0.055	−0.380, 0.270	−0.35	0.731	1.000	−0.063	−0.421, 0.295
Prime2 R. vs. Prime1 R.	0.195	−0.149, 0.540	1.16	0.255	1.000	0.212	−0.152, 0.572

We should also consider the possibility that the absence of Prime 1 priming reflects a visual masking effect. In fact, this is rather unlikely. In a recent study (Wiese, Popova, et al., 2024), we presented prime faces at various durations (33 ms, 100 ms, 200 ms), immediately followed by phase-randomized stimuli as visual masks. We observed reliable ERP repetition effects in all conditions, including the 200 ms prime condition, which had identical timing to the present experiment.

If the pattern of results here genuinely reflects inhibition (of Prime 1 by Prime 2) then certain predictions follow. If, as we hypothesised, inhibition occurs at the level of long-term representations, then the effect should rely critically on the familiarity of the second prime. In particular, if the second (apparently interfering) prime is not known to the viewer, then it has no corresponding representation and so should not exert an interfering effect on Prime 1. In other words, a second *unfamiliar* prime should not disrupt the processing of the first and we should observe a standard repetition effect. This prediction was tested in Experiment 2.

## 5. Experiment 2: The role of prime familiarity

### 5.1. Methods

#### 5.1.1. Participants

Thirty-one participants were tested, one of whom was excluded due to technical problems during the experiment. The remaining sample consisted of 28 female and two male participants (mean age = 20.7 years,  $SD = 2.1$ ), 27 of whom were right-handed, two ambidextrous, and one left-handed. The majority of participants were Durham University students. Inclusion/exclusion criteria as well as reimbursement were identical to Experiment 1, and none of the participants had taken part in Experiment 1. The experiment was approved by the ethics committee of Durham University's Psychology Department.

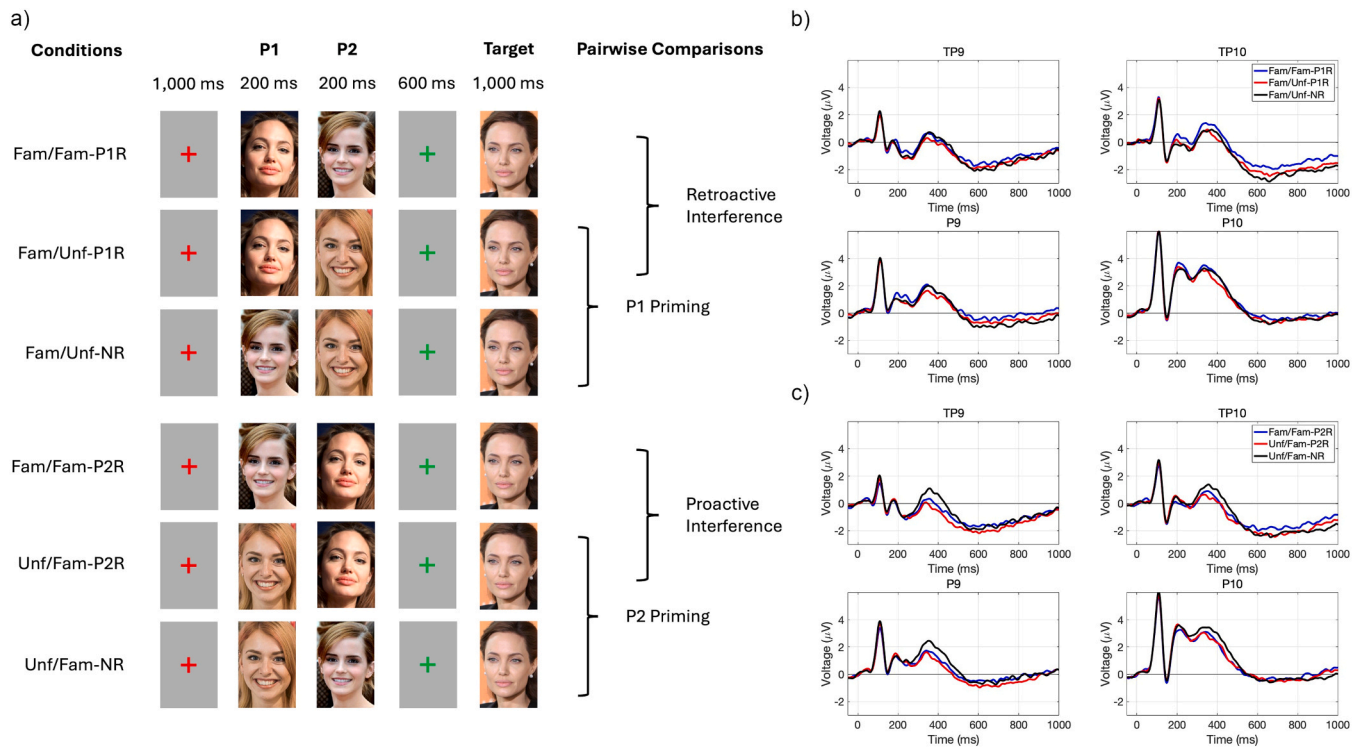
#### Stimuli, procedure, EEG recording and data analysis

Selection of familiar celebrities for each individual participant was

analogous to Experiment 1, and 21 images of each of the 40 best-known celebrities were used. In addition, six images of 40 Swedish celebrities, who were all rated as unfamiliar (except for one participant rating one of the Swedish celebrities as familiar), were used. The set of Swedish celebrities was matched to the international/familiar set with respect to gender, age, and ethnic background.

The experiment had six conditions (see Fig. 2). In the first two, Prime 1 was always familiar and the same identity as the target, while Prime 2 was either a different familiar face (Familiar/Familiar – Prime 1 Repetition; Fam/Fam-P1R) or an unfamiliar face (Familiar/Unfamiliar – Prime 1 Repetition; Fam/Unf-P1R). In the third condition, Prime 1 was familiar but not the same as the target, and Prime 2 was unfamiliar (Familiar/Unfamiliar – Non-Repetition; Fam/Unf-NR). In conditions 4 and 5, Prime 2 was always familiar and the same identity as the target, while Prime 1 was either a different familiar (Fam/Fam-P2R) or unfamiliar identity (Unf/Fam-P2R). Finally, in condition 6, Prime 2 was familiar but a different identity than the target, while Prime 1 was unfamiliar (Unf/Fam-NR). In addition to repetition effects for Prime 1 and Prime 2, this design also allowed to more directly test for retroactive interference (i.e., Prime 2 inhibiting Prime 1; Fam/Fam-P1R vs. Fam/Unf-P1R) and proactive interference (i.e., Prime 1 inhibiting Prime 2; Fam/Fam-P2R vs. Unf/Fam-P2R).

The experiment consisted of six blocks with 120 trials each, and 120 trials per condition were collected. Each image appeared twice throughout the experiment, and never more than once as the target. EEG recording and data analysis were analogous to Experiment 1. Mean number of trials were 106 ( $SD = 12$ ,  $Min = 75$ ) for Fam/Fam-P1R, 106 ( $SD = 13$ ,  $Min = 71$ ) for Fam/Unf-P1R, 103 ( $SD = 14$ ,  $Min = 70$ ) for Fam/Unf-NR, 107 ( $SD = 11$ ,  $Min = 79$ ) for Fam/Fam-P2R, 106 ( $SD = 12$ ,  $Min = 71$ ) for Unf/Fam-P2R, and 104 ( $SD = 13$ ,  $Min = 71$ ) for Unf/Fam-NR.



**Fig. 2.** a) Experimental conditions, trial structure, and sample stimuli. All images are used under Creative Commons licenses, see Fig. 1 legend. Image of Clara Henry retrieved from [https://commons.wikimedia.org/wiki/File:Clara\\_Henry\\_Hedemora\\_bokhandel\\_2015.jpg](https://commons.wikimedia.org/wiki/File:Clara_Henry_Hedemora_bokhandel_2015.jpg). b) Grand-average event-related potentials in the four experimental conditions at left- (TP9, P9) and right-hemispheric (TP10, P10) occipito-temporal and temporal electrodes.

**Table 2**

Pairwise comparisons of repetition and interference effects in Experiment 2. R = Repetition;  $M_{diff}$  = mean difference, CI = confidence interval,  $p(corr.)$  =  $p$ -values after correction for multiple comparisons according to Holm (1979), bold  $p$ -values indicate significant effects.  $d_z$  = Cohen's  $d$  using the standard deviation of the difference as the denominator (Lakens, 2013).

	$M_{diff}$ ( $\mu V$ )	95% CI	$t(29)$	$p$	$p(corr.)$	$d_z$	95% CI
<b>230–300 ms</b>							
Retroactive Interference	0.308	−0.049, 0.665	1.77	.088	1.000	0.323	−0.047, 0.687
P1 Priming	0.038	−0.193, 0.268	0.33	.741	1.000	0.061	−0.298, 0.419
<b>300–400 ms</b>							
Retroactive Interference	0.401	0.025, 0.777	2.18	.037	.814	0.399	0.023, 0.768
P1 Priming	0.258	−0.007, 0.523	1.99	.056	1.000	0.363	−0.009, 0.730
Proactive Interference	0.287	−0.009, 0.582	1.99	.056	.952	0.363	−0.010, 0.729
P2 Priming	0.737	0.423, 1.050	4.80	< .001	.001	0.877	0.449, 1.294
<b>400–500 ms</b>							
Retroactive Interference	0.250	−0.107, 0.608	1.43	.162	1.000	0.262	−0.105, 0.624
P1 Priming	0.222	−0.066, 0.510	1.57	.126	1.000	0.287	−0.080, 0.650
Proactive Interference	0.247	−0.081, 0.574	1.54	.135	1.000	0.281	−0.086, 0.644
P2 Priming	0.701	0.316, 1.085	3.73	< .001	.019	0.681	0.278, 1.074
<b>500–600 ms</b>							
Retroactive Interference	0.266	−0.054, 0.587	1.70	.100	1.000	0.310	−0.059, 0.674
P1 Priming	−0.163	−0.478, 0.152	−1.06	.298	1.000	−0.193	−0.554, 0.169
Proactive Interference	0.247	−0.129, 0.623	1.34	.190	1.000	0.245	−0.120, 0.606
P2 Priming	0.081	−0.249, 0.411	0.50	.619	1.000	0.092	−0.268, 0.450
<b>600–700 ms</b>							
Retroactive Interference	0.282	−0.056, 0.620	1.71	.098	1.000	0.312	−0.058, 0.676
P1 Priming	−0.244	−0.474, −0.014	−2.17	.038	.798	−0.396	−0.765, −0.021
Proactive Interference	0.386	0.018, 0.755	2.14	.041	.820	0.391	0.016, 0.760
P2 Priming	0.070	−0.217, 0.358	0.50	.620	1.000	0.091	−0.268, 0.449
<b>700–800 ms</b>							
Retroactive Interference	0.260	−0.124, 0.645	1.38	.177	1.000	0.253	−0.113, 0.614
P1 Priming	−0.124	−0.434, 0.186	−0.82	.419	1.000	−0.150	−0.508, 0.211
Proactive Interference	0.331	−0.003, 0.666	2.02	.052	.988	0.370	−0.004, 0.717
P2 Priming	0.160	−0.163, 0.483	1.01	.321	1.000	0.185	−0.178, 0.544

**Results**

A repeated-measures ANOVA in the 230–300 ms time window with the within-subject factors site, hemisphere, and condition (Fam/Fam-P1R, Fam/Unf-P1R, Fam/Unf-NR, Fam/Fam-P2R, Unf/Fam-P2R, Unf/Fam-NR; see Fig. 2) revealed no significant effect involving the condition factor, all  $F < 1.98$ , all  $p > .085$ , all  $\eta_p^2 < .065$ . The respective ANOVA in the 300–400 ms time window yielded a significant main effect of condition,  $F(5, 145) = 7.07$ ,  $p < .001$ ,  $\eta_p^2 = .196$ . Paired comparisons (see Table 2) revealed a significant repetition effect for Prime 2, as well as retroactive interference, which, however, did not survive the correction for multiple comparisons.

The ANOVA in the 400–500 ms time window again revealed a significant condition main effect,  $F(5, 145) = 5.57$ ,  $p < .001$ ,  $\eta_p^2 = .161$ . Paired-sample  $t$ -tests yielded a significant repetition effect for the second prime. While the 500–600 ms time window did not show a significant condition effect,  $F(5, 145) = 2.03$ ,  $p = .078$ ,  $\eta_p^2 = .065$ , a significant effect was observed in the subsequent 600–700 ms window,  $F(5, 145) = 4.46$ ,  $p < .001$ ,  $\eta_p^2 = .133$ . Paired-sample  $t$ -tests suggested a (polarity-reversed) repetition effect for Prime 1, as well as a proactive interference effect. However, neither of the two effects survived the correction for multiple comparisons. Finally, while a significant condition effect was similarly observed in the 700–800 ms time window,  $F(5, 145) = 2.44$ ,

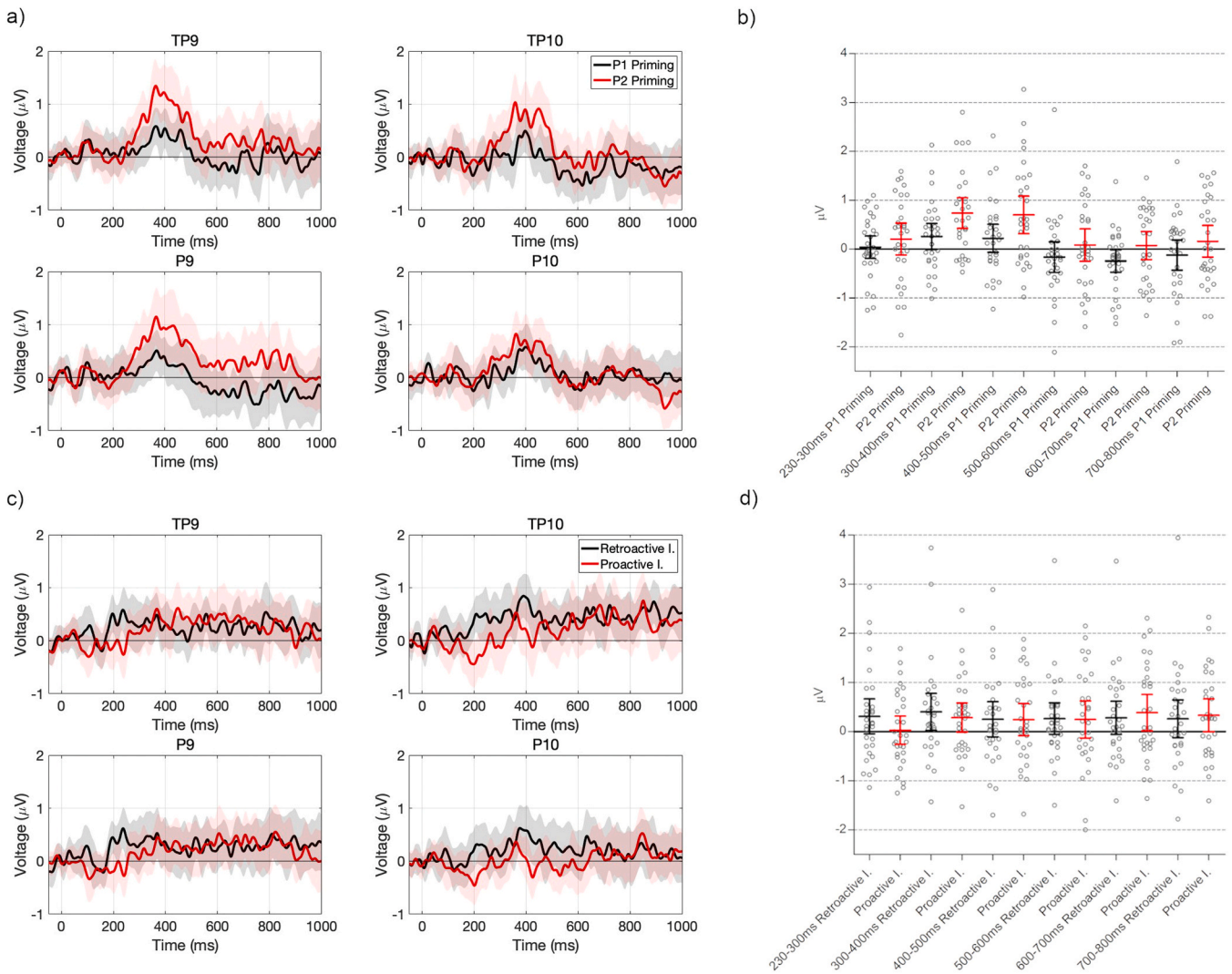
$p = .037$ ,  $\eta_p^2 = .078$ , paired-sample  $t$ -tests yielded no significant effects.

**6. Discussion**

Experiment 2 replicated the main result observed in our first experiment, namely clear and reliable repetition effects for the second prime in the 300–500 ms time range. Importantly, no significant Prime 1 priming was detected even when the second prime was unfamiliar and hence did not have a long-term representation. So, if the explanation for an absence of Prime 1 priming is inhibition, it seems that *any* subsequent face interferes with identity processing of the first face, and, consequently, that inhibition between familiar face representations cannot explain this finding. Instead, interference would have to operate at a processing stage prior to abstract visual representations (FRUs).

While both Experiments 1 and 2 demonstrated late repetition effects elicited by the second but not the first prime, the possibility remains that these effects do not indicate interference at all. Instead, it is possible that Prime 1 faces in these experiments simply have no potential to affect perception of the target, because their associated representations were not sufficiently activated in the first place or their activation decayed during the interstimulus interval.

If Prime 1 activation was blocked by interference from the second face, the effect may become observable with longer presentation times



**Fig. 3.** a) Mean ( $\pm$  95% CIs) difference curves for P1 and P2 priming effects at electrodes TP9/TP10/P9/P10. b) Mean and individual P1 and P2 priming effects averaged across TP9/TP10/P9/P10. Error bars depict 95% confidence intervals (CIs). c) Mean ( $\pm$  95% CIs) difference curves for retro- and proactive interference effects. d) Mean and individual retro- and pro-active interference effects averaged across TP9/TP10/P9/P10. Error bars depict 95% confidence intervals (CIs).

(see Dörr et al., 2011; Pfitze et al., 2002). As noted above, there is good evidence that individual representations are activated from approximately 200 ms onwards (Wiese, Schweinberger, et al., 2024). Accordingly, interference at (or earlier than) this time point may disrupt activation. If, however, interference from the second stimulus occurred at a later time, when identity information of the first prime had already been processed, a priming effect for Prime 1 may emerge using longer SOAs. On the other hand, if Prime 1 priming in Experiments 1 and 2 did not occur because its representation was not held active during the interstimulus interval, then we would not expect to observe Prime 1 priming with even longer presentation times. We examine these possibilities in Experiment 3.

### 7. Experiment 3: the role of prime duration

#### 7.1. Methods

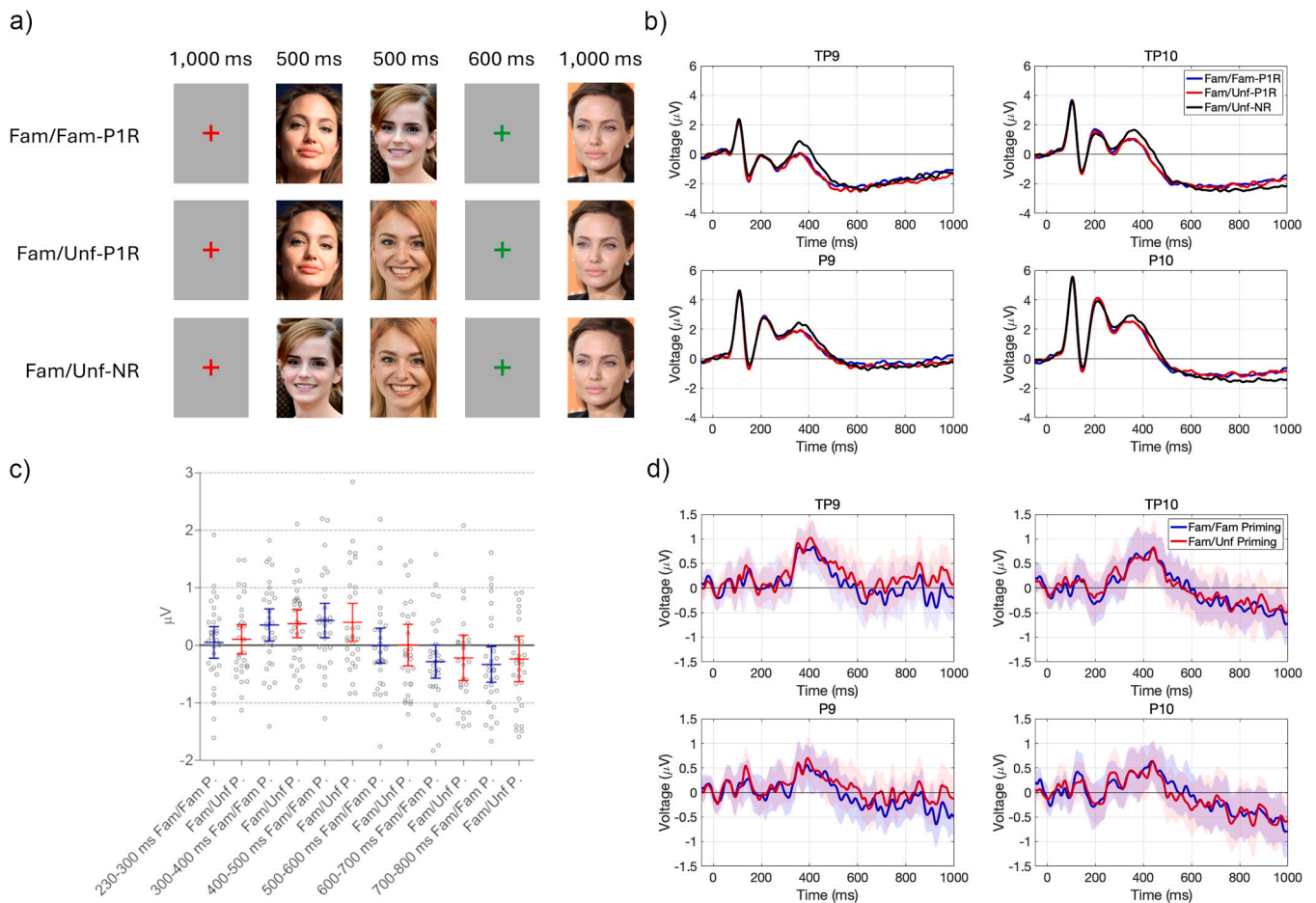
##### 7.1.1. Participants

Thirty-one participants were tested, one of whom was excluded due to being familiar with several of the Swedish celebrities used as unfamiliar stimuli. Of the remaining sample, 22 participants were female and eight male (mean age = 21.1 years, *SD* = 2.7), 27 of whom were right-handed and three left-handed. The sample primarily consisted of Durham University students. Inclusion/exclusion criteria as well as reimbursement were identical to Experiment 1, and the experiment was approved by the ethics committee of Durham University's Psychology Department.

#### 7.1.2. Stimuli, procedure, EEG recording and data analysis

Selection of familiar and unfamiliar celebrities for each individual participant was analogous to Experiment 2. Nine images per familiar identity and three per unfamiliar identity were used. Experimental conditions corresponded to the first three in Experiment 2, namely Familiar/Familiar – Prime 1 Repetition (Fam/Fam-P1R), Familiar/Unfamiliar – Prime 1 Repetition (Fam/Unf-P1R), as well as Familiar/Unfamiliar – Non-Repetition (Fam/Unf-NR; see Fig. 4a). Accordingly, this design allowed testing for Prime 1 Repetition Priming (Fam/Unf-P1R vs. Fam/Unf-NR) as well as retroactive interference (i.e., Fam/Fam-P1R vs. Fam/Unf-P1R). Moreover, Prime 1 Priming was additionally tested using a second familiar face in the repetition condition (Fam/Fam-P1R vs. Fam/Unf-NR). Prime presentation times were longer than in Experiments 1 and 2, and identical to those used in Dörr and colleagues (Dörr et al., 2011). Specifically, Prime 1 and Prime 2 were presented for 500 ms each, followed by a 600 ms interstimulus interval and a 1000 ms target.

The experiment consisted of three blocks with 120 trials each, and 120 trials per condition were collected. Each image appeared two or three times throughout the experiment, but never more than once as the target. EEG recording and data analysis were analogous to the previous experiments. Mean number of trials were 107 (*SD* = 14, Min = 69) for Fam/Fam-P1R, 107 (*SD* = 13, Min = 71) for Fam/Unf-P1R, and 105 (*SD* = 16, Min = 55) for Fam/Unf-NR.



**Fig. 4.** a) Experimental conditions, trial structure, and sample stimuli for Experiment 3. b) Grand-average event-related potentials in the three experimental conditions at left- (TP9, P9) and right-hemispheric (TP10, P10) occipito-temporal and temporal electrodes. c) Mean and individual priming effects (Non-Repetition minus Repetition), averaged across TP9/TP10/P9/P10. Error bars depict 95% confidence intervals (CIs). d) Mean (+/- 95% CIs) difference curves.

## 8. Results

A repeated-measures ANOVA in the 230–300 ms time window with the within-subjects factors site, hemisphere, and condition (Fam/Fam-P1R, Fam/Unf-P1R, Fam/Unf-NR) yielded no significant effect involving the condition factor, all  $F < 0.47$ , all  $p > .63$ , all  $\eta_p^2 < .017$ . A corresponding analysis in the 300–400 ms time range revealed a significant main effect of condition,  $F(2, 58) = 5.19$ ,  $p = .008$ ,  $\eta_p^2 = .152$ , as well as a significant interaction of Site by Condition,  $F(2, 58) = 5.91$ ,  $p = .005$ ,  $\eta_p^2 = .169$ , reflecting larger priming effects at TP relative to P sites. Pairwise comparisons (see Table 3) showed significant repetition priming for Fam/Fam and Fam/Unf prime combinations, while Fam/Fam-P1R and Fam/Unf-P1R conditions were not significantly different. Of note, none of the effects survived a correction for multiple comparisons.

The same pattern was observed in the subsequent 400–500 ms time window, which again showed a significant condition main effect,  $F(2, 58) = 4.60$ ,  $p = .014$ ,  $\eta_p^2 = .137$ , as well as a significant Site by Condition interaction,  $F(2, 58) = 5.35$ ,  $p = .007$ ,  $\eta_p^2 = .156$ . Pairwise comparisons again yielded significant priming for both Fam/Fam and Fam/Unf prime conditions, but no significant difference between Fam/Fam-P1R and Fam/Unf-P1R conditions. None of the later time windows demonstrated any significant effects involving the condition factor, all  $F < 2.98$ , all  $p > .081$ , all  $\eta_p^2 < .094$ . Of note, pairwise comparisons revealed a significant (reversed) priming effect for Fam/Fam-P1R primes in the 700–800 ms time window (see Table 3).

Finally, following a reviewer suggestion, we additionally used Bayesian statistics to examine the evidence for the presence or absence of Prime 1 repetition effects in Experiment 3. A Bayesian paired-sample  $t$ -test for Fam./Unf. Priming in the 300–400 ms time window revealed strong evidence for the H1,  $BF_{10} = 10.37$ , error % < 0.001. A test for Fam./Fam. Priming in the same time window yielded moderate evidence for the H1,  $BF_{10} = 3.11$ , error % < 0.001.

## 9. Discussion

Experiment 3 was designed to test whether the absence of Prime 1 priming and interference as observed in the two previous experiments depended on timing. Consistent with earlier research (Dörr et al., 2011), we observed ERP repetition effects for Prime 1 with prime presentation

times of 500 ms. This effect was observed independent of the familiarity of the second stimulus, and no retroactive interference effect was evident here. It therefore appears that the lack of Prime 1 priming, as observed in the first two experiments, was caused by interference from Prime 2, occurring in a critical window following Prime 1. This is discussed in more detail in the General Discussion.

## 10. Exploratory mass univariate analyses

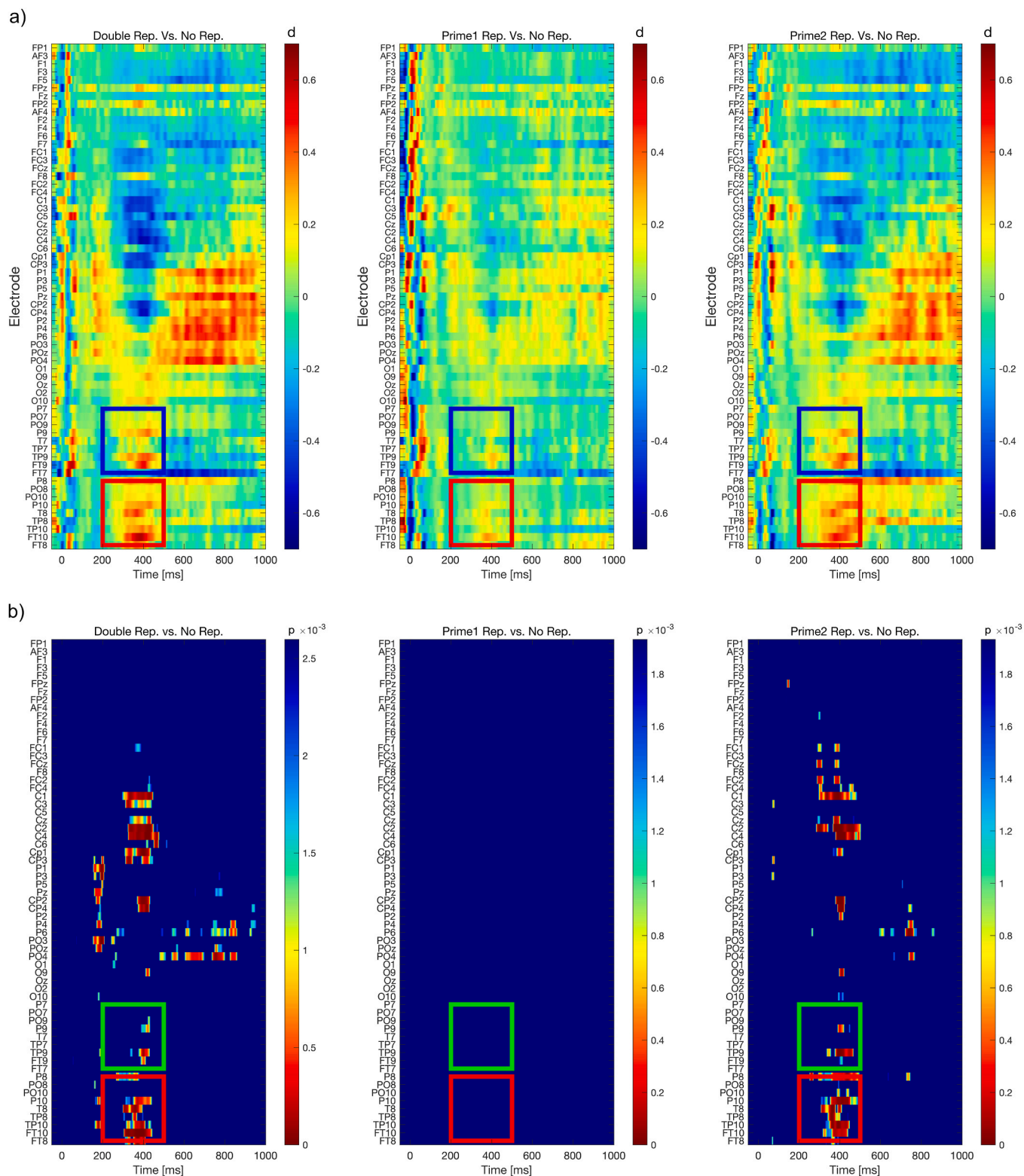
To complement the planned analyses reported above, we additionally conducted exploratory mass univariate analyses for all three experiments. Rather than relying on a priori defined time windows and electrode positions, statistical comparisons are carried out for all time points and electrodes. We report such data-driven analyses for critical comparisons, i.e., repetition effects, in Experiments 1–3. Specifically, we calculated Cohen's  $d$  (see Figs. 5a, 6a, and 6c) as well as paired-sample  $t$ -tests (see Figs. 5b, 6b, and 6d) for Prime 1 and Prime 2 repetition effects in all experiments for each electrode and time point separately.  $p$ -values were corrected for multiple comparisons using the procedure described by Holm (1979). Analysis scripts are available at a publicly accessible repository (<https://osf.io/6mwb8/overview>).

Results are largely in line with planned analyses reported above. As expected for average reference EEG, repetition effects at ventral, occipito-temporal sites were accompanied by polarity-reversed effects at dorsal electrodes. In both Experiments 1 and 2, clear repetition effects were detected for Prime 2 but not for Prime 1 repetitions (see boxes in Figs. 5b and 6b). At the same time, evidence for Prime 1 repetition effects was observed in Experiment 3 (see boxes in Fig. 6d). Similar to previous studies (Ciocan et al., 2026; Li, Sommer, Tian & Zhou, 2024; Wiese et al., 2025), we also observed a late parietal repetition effect in Experiment 1, which seems to belong to the P3 family (Polich, 2007, 2012). Previous work using adaptation paradigms has observed similar effects and has interpreted them as reflecting more pronounced context updating for those test faces that least resembled the adaptors (Kloth, Schweinberger, & Kovacs, 2010). Similarly, in the present Experiment 1, non-repetitions, i.e., faces that did not resemble the primes, elicited larger P3 amplitudes. It remains somewhat unclear, however, why this effect only occurred in Experiment 1. One potential explanation could be that the double prime condition particularly encouraged participants to predict the target identity, which would arguably necessitate context

**Table 3**

Pairwise comparisons of repetition effects in Experiment 3. R = Repetition;  $M_{diff}$  = mean difference, CI = confidence interval,  $p(\text{corr.})$  =  $p$ -values after correction for multiple comparisons according to Holm (1979).  $d_z$  = Cohen's  $d$  using the standard deviation of the difference as the denominator (Lakens, 2013).

	$M_{diff}$ ( $\mu V$ )	95% CI	$t(29)$	$p$	$p(\text{corr.})$	$d_z$	95% CI
<b>230–300 ms</b>							
Fam/Fam-R vs. Fam/Unf-NR	0.048	−0.227, 0.323	0.36	.724	1.000	0.065	−0.294, 0.423
Fam/Unf-R vs. Fam/Unf-NR	0.103	−0.151, 0.357	0.83	.415	1.000	0.151	−0.210, 0.510
Fam/Fam-R vs. Fam/Unf-R	0.055	−0.169, 0.278	0.50	.620	1.000	0.091	−0.268, 0.449
<b>300–400 ms</b>							
Fam/Fam-R vs. Fam/Unf-NR	0.353	0.072, 0.634	2.57	.016	.256	0.469	0.088, 0.843
Fam/Unf-R vs. Fam/Unf-NR	0.377	0.132, 0.622	3.15	.004	.072	0.575	0.184, 0.958
Fam/Fam-R vs. Fam/Unf-R	0.024	−0.253, 0.301	0.18	.860	1.000	0.032	−0.326, 0.390
<b>400–500 ms</b>							
Fam/Fam-R vs. Fam/Unf-NR	0.429	0.131, 0.727	2.95	.006	.102	0.538	0.151, 0.918
Fam/Unf-R vs. Fam/Unf-NR	0.398	0.069, 0.727	2.48	.019	.285	0.452	0.073, 0.825
Fam/Fam-R vs. Fam/Unf-R	−0.031	−0.372, 0.310	−0.19	.854	1.000	−0.034	−0.392, 0.324
<b>500–600 ms</b>							
Fam/Fam-R vs. Fam/Unf-NR	−0.005	−0.309, 0.298	−0.04	.971	1.000	−0.007	−0.364, 0.351
Fam/Unf-R vs. Fam/Unf-NR	0.004	−0.356, 0.363	0.02	.983	.983	0.004	−0.354, 0.362
Fam/Fam-R vs. Fam/Unf-R	0.009	−0.352, 0.370	0.05	.959	1.000	0.010	−0.348, 0.367
<b>600–700 ms</b>							
Fam/Fam-R vs. Fam/Unf-NR	−0.286	−0.574, 0.003	−2.03	.052	.676	−0.370	−0.737, 0.003
Fam/Unf-R vs. Fam/Unf-NR	−0.218	−0.613, 0.176	−1.13	.267	1.000	−0.207	−0.567, 0.157
Fam/Fam-R vs. Fam/Unf-R	0.067	−0.230, 0.364	0.46	.648	1.000	0.084	−0.275, 0.442
<b>700–800 ms</b>							
Fam/Fam-R vs. Fam/Unf-NR	−0.332	−0.641, −0.023	−2.20	.036	.504	−0.401	−0.770, −0.026
Fam/Unf-R vs. Fam/Unf-NR	−0.237	−0.631, 0.158	−1.23	.230	1.000	−0.224	−0.584, 0.141
Fam/Fam-R vs. Fam/Unf-R	0.096	−0.216, 0.407	0.63	.535	1.000	0.115	−0.245, 0.473

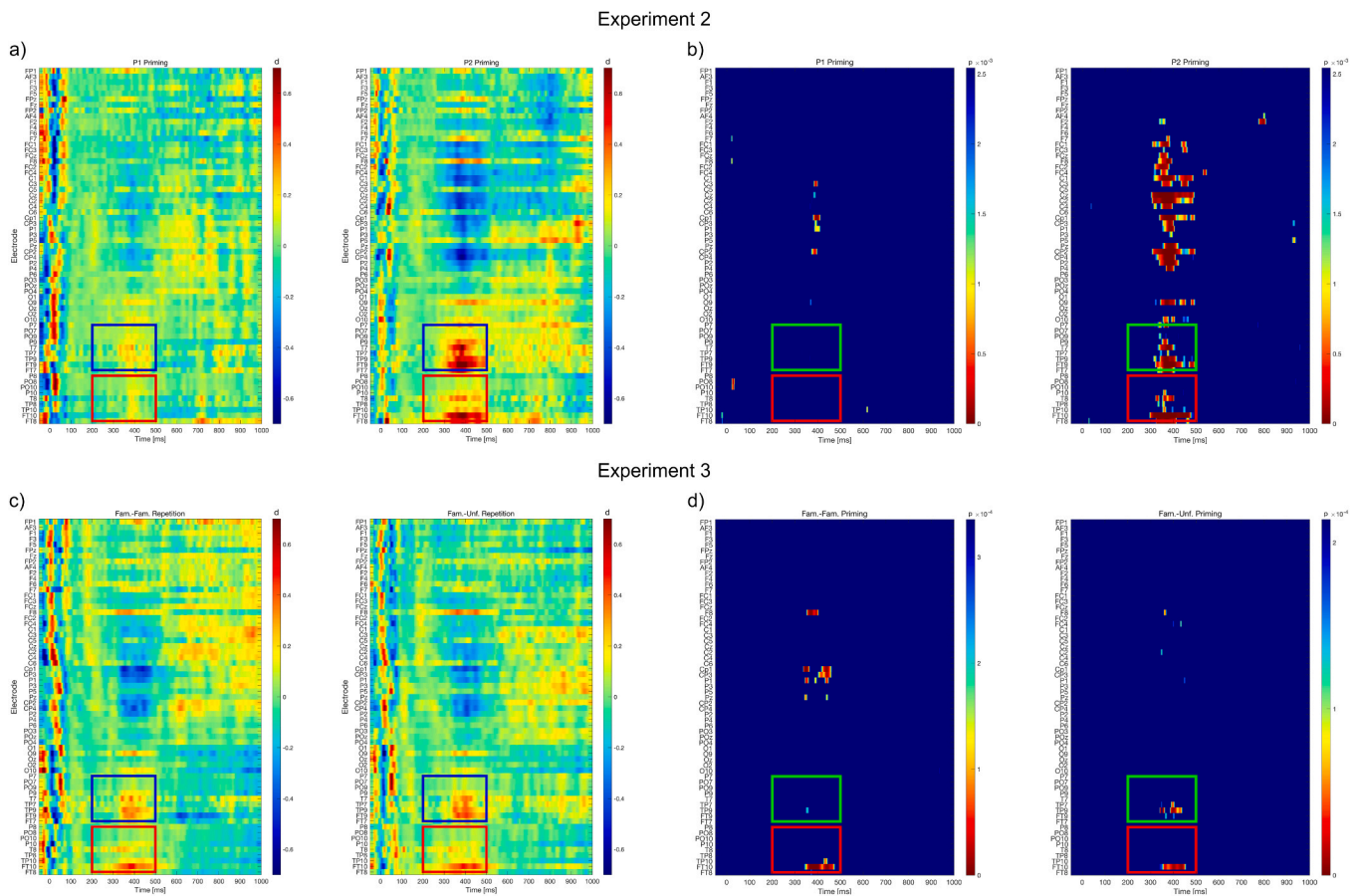


**Fig. 5.** Cohen's *d* (a) and *p*-values of mass-univariate repeated-measures *t*-tests (b) for each time point (horizontal axis) and electrode (vertical axis) in Experiment 1. Red and blue/green boxes highlight right and left occipito-temporal and temporal channels. Deviations from the blue background in (b) denote significant effects ( $p < .05$ , corrected for multiple comparisons) for each repetition effect separately.

updating in the case of non-repetitions. Moreover, participants may have only been able to use the second prime for this prediction (as no P3 effect was observed for Prime 1 repetition), potentially because only this identity was represented at target onset.

### 11. General Discussion

This series of experiments suggests inhibitory effects within the face recognition system, but casts doubt on the claim that this inhibition operates at the level of familiar face representations. We observed face



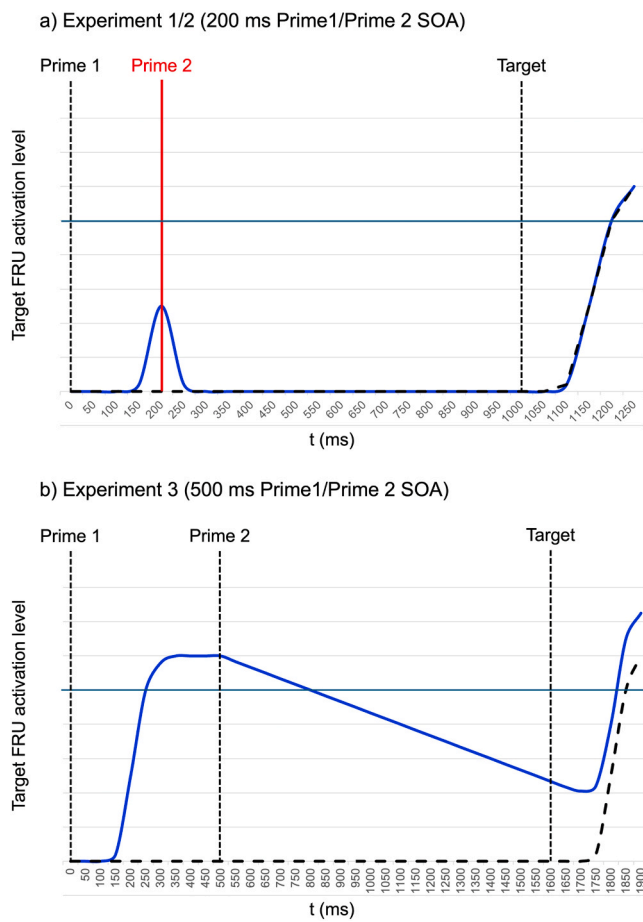
**Fig. 6.** Cohen's  $d$  (a, c) and  $p$ -values of mass-univariate repeated-measures  $t$ -tests (b, d) for each time point (horizontal axis) and electrode (vertical axis) in Experiments 2 and 3. Red and blue/green boxes highlight right and left occipito-temporal and temporal channels. Deviations from the blue background in (b) and (d) denote significant effects ( $p < .05$ , corrected for multiple comparisons) for each repetition effect separately.

priming at two different intervals, i.e., from Prime 2 to target in Experiments 1 and 2 (Prime 1 - Prime 2 SOA = 200 ms) and from Prime 1 to target in Experiment 3 (Prime 1 - Prime 2 SOA = 500 ms). However, we did not observe priming from Prime 1 in Experiments 1 and 2, with a short Prime 1 - Prime 2 SOA. At these latencies, and with brief prime presentation times, a face intervening between prime and target seems to eliminate priming. However, and critically, Experiment 2 shows that this interfering face need not be familiar in order to exert its effect. This suggests that the inhibition we are observing – conceptualised as within-pool competition in theoretical models of face recognition (Burton et al., 1990, 1999) – is not operating at the level of abstract representations of familiar faces.

Priming in these experiments appears sensitive to display times. Using short presentations in Experiments 1 and 2 (200 ms), we observed that a second face prime effectively inhibited a preceding one, while clear repetition effects were observed for the second prime stimulus. This suggests that processing was focused on the more recent, and therefore arguably more salient stimulus. As we have established in earlier work, this finding is unlikely to reflect a simple visual backward masking effect (Wiese, Popova, et al., 2024). Interestingly, Experiment 3 did find evidence for Prime 1 repetition effects with longer prime presentation times (500 ms). Previous work suggests that the brain distinguishes between familiar and unfamiliar faces from approximately 200 ms after stimulus onset (Bojdo, Zakriev, Schipper, Ciocan, Lidborg & Wiese, 2025; Gosling & Eimer, 2011; Tanaka, Curran, Porterfield & Collins, 2006; Wiese et al., 2022; Wiese, Tüttenberg, et al., 2019). Assuming that familiarity signals are based on the activation of individual face representations (for a recent discussion, see Wiese, Schweinberger, et al., 2024), it seems that processing was disrupted

before a face had been (fully) recognized as an individual familiar identity in Experiment 1 and 2 (with a 200 ms Prime 1/Prime 2 SOA). As the corresponding representation was not (sufficiently) activated, no priming effect was observed. In Experiment 3 (with a 500 ms Prime 1/Prime 2 SOA), however, the time between the onset of the two primes was long enough to fully activate the first face's representation, allowing for a corresponding priming effect (see Fig. 7). This is in line with those previous reports that found ERP repetition priming with long SOAs and additional face stimuli between prime and target (Dörner et al., 2011; Pfützte et al., 2002). We note, however, that the argument for a timing-related cause of P1 priming exclusively in Experiment 3 should be regarded as provisionally supported and as a testable hypothesis rather than a settled conclusion. Specifically, a direct within-subjects comparison of shorter and longer SOAs in the same experiment should help to fully clarify the question. While it would be possible to conduct cross-experimental comparisons using data from the present study, the experiments reported here were not designed, and therefore lack appropriate statistical power, for between-subjects comparisons.

If the argument is correct, it leads to an interesting prediction: Different-image priming with prime/target SOAs of 200 ms or below should not result in ERP priming effects – even when the experiments are run using the standard priming technique, with no intervening stimuli between prime and target. This prediction seems to follow as, with such short SOAs, the target should interfere with processing before the prime's familiar face representation can be fully activated. To the best of our knowledge, all previous ERP experiments with such short SOAs have used same-image repetition (Martens, Schweinberger, Kiefer & Burton, 2006; Trenner et al., 2004; Wiese, Komes, Tüttenberg, Leidinger & Schweinberger, 2017), and it therefore remains unclear to what extent



**Fig. 7.** Temporal interference in Experiments 1 and 2 but not in Experiment 3. The y-axis depicts Target FRU activation level, blue lines show activation in the Prime 1 Repetition, black dotted lines in the Non-Repetition conditions over time. Visual recognition of the identity is established when activation passes a threshold (horizontal line). In Prime 1 Repetition, (i.e., Prime 1 is the same ID as the Target), target FRU activation increases from app. 150 ms after Prime 1 onset, subsequent to early perceptual processing and initial structural encoding (blue lines). In the Non-Repetition condition (Prime 1 is different from the Target), target FRU activation remains at baseline after Prime 1 presentation. a) In Experiments 1 and 2, Prime 2 is presented *before* the threshold is reached, resulting in interference (red vertical line) and a return of target FRU activation to baseline. By the time the target is presented, Prime 1 Repetition and Non-Repetition conditions have identical activation levels, resulting in an absence of priming. b) In Experiment 3, Prime 2 is presented *after* the threshold is reached and visual recognition of the identity is established. No interference occurs, but target FRU activation slowly decays towards the baseline following Prime 1 offset. By the time the target is presented, FRU activation level is still above baseline, and higher than in the Non-Repetition condition, and a priming effect, with higher activation levels (and earlier passing of the threshold) is observed.

the observed effects reflect pictorial rather than facial identity priming.

Of note, the results of Experiment 3 also largely rule out the possibility that trace decay rather than interference was responsible for the absence of Prime 1 priming in the first two experiments. As the first prime, per definition, was always presented with a longer time lag relative to the target, it may have in principle been possible that Prime 1 but not Prime 2 activations had returned to baseline by the time the target was presented, reflecting decay rather than interference as the explanation for absent priming. An explanation based on decay, however, is not in line with Prime 1 priming in Experiment 3, particularly because the Prime 1/target SOA was longer relative to the one used in the first two experiments.

The present experiments were designed to test the idea of within-

pool inhibition in the familiar face recognition system. As we noted above, inhibitory mechanisms are common in connectionist models, largely because they counter the problem of hysteresis, inherent in network architectures. They also support mechanical accounts of target identification, in which similar representations compete for activation within models. While we have observed clear evidence of interference, these effects apparently operate prior to face identification – in that *any* face can interfere with another, whether or not the interfering face is familiar. We note that this latter finding not only aligns with inhibition but also with attentional and capacity-based explanations. More specifically, on the basis of the present experiments, it is not possible to differentiate between active suppression (inhibition), passive displacement, or competition for processing resources as explanations for the observed effects.

The absence of Prime 1 repetition effects in the first two experiments also raises another important question – is interference face-specific, or would any stimulus, face or not, interfere with a prior face presentation? In previous work, we have shown (Wiese, Popova, et al., 2024) that a face, but not a phase-randomized stimulus, interferes with the processing of an earlier face, and this interpretation is in line with previous suggestions that we are observing the effect of face-selective attentional resources (e.g., Neumann & Schweinberger, 2009). However, this previous result is insufficient to establish face selectivity, and it is possible that object stimuli (such as images of houses, cars etc.) would produce similar interference effects. If non-face objects can also abolish face priming at short SOAs, the theoretical implications for face recognition models would change by moving the constraint into non-selective processing stages. Future studies should therefore directly compare the effectiveness of different stimulus categories to block Prime 1 repetition effects.

Given the reliance of classical models of face recognition on within-pool inhibition at the level of familiar faces, can they still be brought in line with the present results? First, we note that the specific experimental scenario used here differs from previous behavioural studies of face priming (e.g., Ellis, Young, Flude & Hay, 1987; Johnston & Barry, 2001), because behavioural studies typically measure priming as response time effects, and participants are not required to make speeded familiarity decisions here. Accordingly, it will be interesting to observe, in future experiments, whether there is a direct correspondence between behavioural and psychophysiological effects of priming.

A further approach would be to consider alternatives to network models that incorporate within-pool inhibition. One such alternative may be seen in a “coarse-to-fine” mechanism that refines a perceptual representation over time until only a single known identity remains as a possible match for a stored long-term representation (Wiese, Schweinberger, et al., 2024). This process may not require active inhibition of other representations, as the activation of the long-term representation may occur at a stage at which unambiguous information is available. This basically serial interpretation of the face recognition process is in line with classic and more recent ERP research (Bojdo et al., 2025; Itz, Schweinberger, & Kaufmann, 2016; Schweinberger & Neumann, 2016), demonstrating category-selective, perceptual processing of face stimuli from approximately 120–130 ms onwards (Ciocan et al., 2026; Rossion & Jacques, 2008), which is followed by more fine-grained perceptual processing independent of familiarity (Itz, Schweinberger, Schulz & Kaufmann, 2014; Wuttke & Schweinberger, 2019), i.e., prior to the activation of a long-term representation.

In conclusion, the present experiments found convincing evidence for temporal interference within the face processing system, but not for inhibition at the level of familiar face representations. This conclusion is based on the finding of backward-facing interference from a later towards an earlier face, which – critically – does not depend on familiarity. The present results provide novel information about conditions and limitations under which the processing of facial identity is possible or not. While the results are difficult to explain in terms of classic network models of face recognition, they are consistent with the basic

assumptions of a serial model of face recognition.

### CRedit authorship contribution statement

**Holger Wiese:** Writing – review & editing, Writing – original draft, Visualization, Resources, Methodology, Funding acquisition, Formal analysis, Conceptualization. **A. Mike Burton:** Writing – review & editing, Writing – original draft, Funding acquisition, Conceptualization. **Linda H. Lidborg:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Investigation, Data curation, Conceptualization. **Defne Kohen Tuncer:** Investigation.

### Declaration of Generative AI and AI-assisted technologies in the writing process

The authors did not use generative AI technologies for preparation of this work. The authors declare that no generative AI tools or AI-based technologies have been used during the preparation of this work

### Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Holger Wiese reports financial support was provided by UK Research and Innovation Economic and Social Research Council. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Acknowledgements

The work presented in this manuscript was supported by the Economic and Social Research Council (ESRC; grant number ES/X002063/1) to HW and AMB. The authors gratefully acknowledge help during data collection by Seba Abu Khamsin, Hang Yin Chan, Bobbi Chidley, Therese Dai, Glencora Frith-Fletcher, Lisa Gandlin, Anna Yue Gao, Holly Gilbert, Emila Gordiy, Riana Gulam, Isabella Hosking, Tylis Krzyzek, Rachel Li, Inês Lourenço Cabaço, Caitlin Morrissey, Kaia Sachs, Rui Su, Kiera Tanner, and Wirayut Wongsa.

### Data Availability

Data is available at a publicly accessible repository (osf.io, see manuscript)

### References

- Begleiter, H., Porjesz, B., & Wang, W. (1995). Event-related brain potentials differentiate priming and recognition to familiar and unfamiliar faces. *Electroencephalogr Clin Neurophysiol*, *94*(1), 41–49. [https://doi.org/10.1016/0013-4694\(94\)00240-1](https://doi.org/10.1016/0013-4694(94)00240-1)
- Bindemann, M., Burton, A. M., & Jenkins, R. (2005). Capacity limits for face processing. *Cognition*, *98*(2), 177–197. <https://doi.org/10.1016/j.cognition.2004.11.004>
- Bindemann, M., Burton, A. M., Leuthold, H., & Schweinberger, S. R. (2008). Brain potential correlates of face recognition: geometric distortions and the N250r brain response to stimulus repetitions. *Psychophysiology*, *45*(4), 535–544. <https://doi.org/10.1111/j.1469-8986.2008.00663.x>
- Bojdo, M. M., Zakriev, D., Schipper, M., Ciocan, M., Lidborg, L. H., & Wiese, H. (2025). Neural correlates of familiar face recognition: Evidence in support of a serial model. *Biological Psychology*, *200*, Article 109102. <https://doi.org/10.1016/j.biopsycho.2025.109102>
- Boudewyn, M. A., Luck, S. J., Farrens, J. L., & Kappenman, E. S. (2018). How many trials does it take to get a significant ERP effect? It depends. *Psychophysiology*, *55*(6), Article e13049. <https://doi.org/10.1111/psyp.13049>
- Boutet, I., & Chaudhuri, A. (2001). Multistability of overlapped face stimuli is dependent upon orientation. *Perception*, *30*(6), 743–753. <https://doi.org/10.1068/p3183>
- Bruce, V. (1983). Recognizing faces. *Philos Trans R Soc Lond B Biol Sci*, *302*(1110), 423–436. <https://doi.org/10.1098/rstb.1983.0065>
- Bruce, V., Henderson, Z., Greenwood, K., Hancock, P. J. B., Burton, A. M., & Miller, P. (1999). Verification of face identities from images captured on video. *Journal of Experimental Psychology-Applied*, *5*(4), 339–360. <https://doi.org/10.1037/1076-898x.5.4.339>

- Bruce, V., & Young, A. (1986). Understanding face recognition. *Br J Psychol*, *77*(Pt 3), 305–327. <https://doi.org/10.1111/j.2044-8295.1986.tb02199.x>
- Burton, A. M., Bruce, V., & Hancock, P. J. B. (1999). From pixels to people: A model of familiar face recognition. *Cognitive Science*, *23*(1), 1–31. [https://doi.org/10.1016/S0364-0213\(99\)80050-0c](https://doi.org/10.1016/S0364-0213(99)80050-0c)
- Burton, A. M., Bruce, V., & Johnston, R. A. (1990). Understanding face recognition with an interactive activation model. *Br J Psychol*, *81*(Pt 3), 361–380. <https://doi.org/10.1111/j.2044-8295.1990.tb02367.x>
- Burton, A. M., Kramer, R. S., Ritchie, K. L., & Jenkins, R. (2016). Identity From Variation: Representations of Faces Derived From Multiple Instances. *Cogn Sci*, *40*(1), 202–223. <https://doi.org/10.1111/cogs.12231>
- Ciocan, M., Gandlin, L., Bojdo, M. M., Lidborg, L. H., & Wiese, H. (2026). Event-Related Brain Potential Correlates of Face Processing: A High-Precision Replication and Individual Differences Study. *Psychophysiology*, *63*(1), Article e70242. <https://doi.org/10.1111/psyp.70242>
- Cumming, G. (2012). *Understanding the New Statistics*. New York: Routledge.
- Dörr, P., Herzmann, G., & Sommer, W. (2011). Multiple contributions to priming effects for familiar faces: analyses with backward masking and event-related potentials. *Br J Psychol*, *102*(4), 765–782. <https://doi.org/10.1111/j.2044-8295.2011.02028.x>
- Eimer, M., Kiss, M., & Nicholas, S. (2010). Response profile of the face-sensitive N170 component: a rapid adaptation study. *Cereb Cortex*, *20*(10), 2442–2452. <https://doi.org/10.1093/cercor/bhp312>
- Ellis, A. W., Young, A. W., Flude, B. M., & Hay, D. C. (1987). Repetition priming of face recognition. *Quarterly J Exp Psychol A*, *39*(2), 193–210. <https://doi.org/10.1080/14640748708401784>
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G\*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*, *39*(2), 175–191. <https://doi.org/10.3758/bf03193146>
- Gosling, A., & Eimer, M. (2011). An event-related brain potential study of explicit face recognition. *Neuropsychologia*, *49*(9), 2736–2745. <https://doi.org/10.1016/j.neuropsychologia.2011.05.025>
- Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics*, *6*, 65–70. Retrieved from (<https://www.jstor.org/stable/4615733>).
- Itz, M. L., Schweinberger, S. R., & Kaufmann, J. M. (2016). Effects of Caricaturing in Shape or Color on Familiarity Decisions for Familiar and Unfamiliar Faces. *PLoS One*, *11*(2), Article e0149796. <https://doi.org/10.1371/journal.pone.0149796>
- Itz, M. L., Schweinberger, S. R., Schulz, C., & Kaufmann, J. M. (2014). Neural correlates of facilitations in face learning by selective caricaturing of facial shape or reflectance. *Neuroimage*, *102*(Pt 2), 736–747. <https://doi.org/10.1016/j.neuroimage.2014.08.042>
- Jackson, A. F., & Bolger, D. J. (2014). The neurophysiological bases of EEG and EEG measurement: a review for the rest of us. *Psychophysiology*, *51*(11), 1061–1071. <https://doi.org/10.1111/psyp.12283>
- Jeffreys, D. A., & Axford, J. G. (1972). Source locations of pattern-specific components of human visual evoked potentials. I. Component of striate cortical origin. *Exp Brain Res*, *16*(1), 1–21. <https://doi.org/10.1007/BF00233371>
- Jenkins, R., Dowsett, A. J., & Burton, A. M. (2018). How many faces do people know? *Proc Biol Sci*, *285*(1888). <https://doi.org/10.1098/rspb.2018.1319>
- Jensen, K. M., & MacDonald, J. A. (2023). Towards thoughtful planning of ERP studies: How participants, trials, and effect magnitude interact to influence statistical power across seven ERP components. *Psychophysiology*, *60*(7), Article e14245. <https://doi.org/10.1111/psyp.14245>
- Johnston, R. A., & Barry, C. (2001). Best face forward: similarity effects in repetition priming of face recognition. *Quarterly J Exp Psychol A*, *54*(2), 383–396. <https://doi.org/10.1080/713755976>
- Kloth, N., Schweinberger, S. R., & Kovacs, G. (2010). Neural correlates of generic versus gender-specific face adaptation. *J Cogn Neurosci*, *22*(10), 2345–2356. <https://doi.org/10.1162/jocn.2009.21329>
- Kramer, R. S. S., Young, A. W., & Burton, A. M. (2018). Understanding face familiarity. *Cognition*, *172*, 46–58. <https://doi.org/10.1016/j.cognition.2017.12.005>
- Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Front Psychol*, *4*, 863. <https://doi.org/10.3389/fpsyg.2013.00863>
- Li, Y., Sommer, W., Tian, L., & Zhou, C. (2024). Assessing the influence of latency variability on EEG classifiers - a case study of face repetition priming. *Cogn Neurodynamics*, *18*(6), 4055–4069. <https://doi.org/10.1007/s11571-024-10181-2>
- Luck, S. J. (2014). *An Introduction to the Event-Related Potential Technique*. Cambridge: MIT Press.
- Martens, U., Schweinberger, S. R., Kiefer, M., & Burton, A. M. (2006). Masked and unmasked electrophysiological repetition effects of famous faces. *Brain Res*, *1109*(1), 146–157. <https://doi.org/10.1016/j.brainres.2006.06.066>
- Neumann, M. F., & Schweinberger, S. R. (2009). N250r ERP repetition effects from distractor faces when attending to another face under load: Evidence for a face attention resource. *Brain Res*, *1270*, 64–77. <https://doi.org/10.1016/j.brainres.2009.03.018>
- Pfütze, E. M., Sommer, W., & Schweinberger, S. R. (2002). Age-related slowing in face and name recognition: evidence from event-related brain potentials. *Psychol Aging*, *17*(1), 140–160. <https://doi.org/10.1037/0882-7974.17.1.140>
- Polich, J. (2007). Updating P300: an integrative theory of P3a and P3b. *Clin Neurophysiol*, *118*(10), 2128–2148. <https://doi.org/10.1016/j.clinph.2007.04.019>
- Polich, J. (2012). Neurophysiology of P300. In In. S. J. Luck, & E. S. Kappenman (Eds.), *The Oxford Handbook of Event-Related Potential Components* (pp. 159–188). Oxford: Oxford University Press.
- Quinn, B. P., Popova, T., Green, P. C. E., Talfourd-Cook, R., & Wiese, H. (2023). The role of the eye region for neural correlates of familiar face recognition: The N250r reveals

- no evidence for eye-centred face representations. *Visual Cognition*, 31(7), 501–519. <https://doi.org/10.1080/13506285.2024.2315787>
- Rossion, B., & Jacques, C. (2008). Does physical interstimulus variance account for early electrophysiological face sensitive responses in the human brain? Ten lessons on the N170. *Neuroimage*, 39(4), 1959–1979. <https://doi.org/10.1016/j.neuroimage.2007.10.011>
- Schweinberger, S. R., Huddy, V., & Burton, A. M. (2004). N250r: a face-selective brain response to stimulus repetitions. *Neuroreport*, 15(9), 1501–1505. <https://doi.org/10.1097/01.wnr.0000131675.00319.42>
- Schweinberger, S. R., & Neumann, M. F. (2016). Repetition effects in human ERPs to faces. *Cortex*, 80, 141–153. <https://doi.org/10.1016/j.cortex.2015.11.001>
- Schweinberger, S. R., Pfützte, E. M., & Sommer, W. (1995). Repetition and associative priming of face recognition - Evidence from event-related potentials. *Journal of Experimental Psychology-Learning Memory and Cognition*, 21(3), 722–736. <https://doi.org/10.1037/0278-7393.21.3.722>
- Schweinberger, S. R., Pickering, E. C., Jentsch, I., Burton, A. M., & Kaufmann, J. M. (2002). Event-related brain potential evidence for a response of inferior temporal cortex to familiar face repetitions. *Brain Res Cogn Brain Res*, 14(3), 398–409. [https://doi.org/10.1016/s0926-6410\(02\)00142-8](https://doi.org/10.1016/s0926-6410(02)00142-8)
- Tanaka, J. W., Curran, T., Porterfield, A. L., & Collins, D. (2006). Activation of preexisting and acquired face representations: the N250 event-related potential as an index of face familiarity. *J Cogn Neurosci*, 18(9), 1488–1497. <https://doi.org/10.1162/jocn.2006.18.9.1488>
- Trenner, M. U., Schweinberger, S. R., Jentsch, I., & Sommer, W. (2004). Face repetition effects in direct and indirect tasks: an event-related brain potentials study. *Brain Res Cogn Brain Res*, 21(3), 388–400. <https://doi.org/10.1016/j.cogbrainres.2004.06.017>
- Wiese, H., Ablott, E., Bojdo, M. M., & Lidborg, L. H. (2025). Colour is irrelevant for familiar face recognition: Evidence from event-related brain potentials. *Cortex*, 191, 120–139. <https://doi.org/10.1016/j.cortex.2025.07.013>
- Wiese, H., Chan, C. Y. X., & Tüttenberg, S. C. (2019). Properties of familiar face representations: Only contrast positive faces contain all information necessary for efficient recognition. *J Exp Psychol Learn Mem Cogn*, 45(9), 1583–1598. <https://doi.org/10.1037/xlm0000665>
- Wiese, H., Hobden, G., Siilbek, E., Martignac, V., Flack, T. R., Ritchie, K. L., & Burton, A. M. (2022). Familiarity is familiarity is familiarity: Event-related brain potentials reveal qualitatively similar representations of personally familiar and famous faces. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 48(8), 1144–1164. <https://doi.org/10.1037/xlm0001063>
- Wiese, H., Komes, J., Tüttenberg, S., Leidinger, J., & Schweinberger, S. R. (2017). Age-related differences in face recognition: Neural correlates of repetition and semantic priming in young and older adults. *J Exp Psychol Learn Mem Cogn*, 43(8), 1254–1273. <https://doi.org/10.1037/xlm0000380>
- Wiese, H., Popova, T., Lidborg, L. H., & Burton, A. M. (2024). The temporal dynamics of familiar face recognition: Event-related brain potentials reveal the efficient activation of facial identity representations. *Int J Psychophysiology*, 204, Article 112423. <https://doi.org/10.1016/j.ijpsycho.2024.112423>
- Wiese, H., Schweinberger, S. R., & Kovacs, G. (2024). The neural dynamics of familiar face recognition. *Neurosci Biobehav Rev*, 167, Article 105943. <https://doi.org/10.1016/j.neubiorev.2024.105943>
- Wiese, H., Tüttenberg, S. C., Ingram, B. T., Chan, C. Y. X., Gurbuz, Z., Burton, A. M., & Young, A. W. (2019). A Robust Neural Index of High Face Familiarity. *Psychological Science*, 30(2), 261–272. <https://doi.org/10.1177/0956797618813572>
- Wuttke, S. J., & Schweinberger, S. R. (2019). The P200 predominantly reflects distance-to-norm in face space whereas the N250 reflects activation of identity-specific representations of known faces. *Biol Psychol*, 140, 86–95. <https://doi.org/10.1016/j.biopsycho.2018.11.011>
- Young, A. W., & Bruce, V. (2011). Understanding person perception. *British Journal of Psychology*, 102, 959–974. <https://doi.org/10.1111/j.2044-8295.2011.02045.x>
- Young, A. W., & Burton, A. M. (2017). Recognizing Faces. *Current Directions in Psychological Science*, 26(3), 212–217. <https://doi.org/10.1177/0963721416688114>
- Zimmermann, F. G., & Eimer, M. (2013). Face learning and the emergence of view-independent face recognition: an event-related brain potential study. *Neuropsychologia*, 51(7), 1320–1329. <https://doi.org/10.1016/j.neuropsychologia.2013.03.028>
- Zimmermann, F. G., & Eimer, M. (2014). The activation of visual memory for facial identity is task-dependent: evidence from human electrophysiology. *Cortex*, 54, 124–134. <https://doi.org/10.1016/j.cortex.2014.02.008>