NeuroImage 331 (2026) 121856

Contents lists available at ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/ynimg

Seeing race, stopping action: neural dynamics of face-based inhibitory control

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ARTICLE INFO

Keywords:
Cognitive control
Inhibitory control
Go/No-Go
Face processing
Face race
ERP

ABSTRACT

The human ability to suppress inappropriate or automatic responses is crucial for flexible and socially adaptive behavior. Inhibitory control is influenced by prominent environmental cues, including visual information gathered from the perception of others. Among the most salient features of people we interact with, face race stands out as a particularly powerful visual signal. Despite considerable research on face race perception and categorization, and recent evidence on cognitive control, the extent to which task-relevant face race influences inhibition remains unclear, yet relevant. To address this issue, we recorded the electrophysiological signals of West European participants while they performed a Go/No-Go task using West European (WE) and East Asian (EA) faces as stimuli targets. At the behavioral level, inhibitory efficiency was modulated by face race, with participants showing enhanced performance when inhibiting EA faces compared to WE ones. At the neural level, results revealed race-related modulation at both perceptual and post-perceptual processing stages. EA faces elicited a stronger P100, and a race effect on the No-Go P3 emerged, with greater amplitudes during its rising phase and anticipated latency for EA stimuli. Notably, the strength of the behavioral race effect correlated with the neural amplitude within time and location consistent with the No-Go P3. These results suggest modulation of the inhibitory cascade by task-relevant face race, spanning early perceptual and later control-related neural responses, and aligned overt effects on behavior.

1. Introduction

Successful human interaction with the environment relies on cognitive control - set of cognitive functions that enable flexible coordination of thoughts and behaviors in response to external demands as well as internally-defined goals (Diamond, 2013). Among these higher-order functions, inhibitory control – the ability to suppress inappropriate responses – undoubtedly stands out as pivotal, serving as a cornerstone of human adaptability and survival (Aron, 2007; Egner, 2017). Within cognitive science, the inhibitory taxonomy commonly distinguishes two broad inhibitory dimensions that sustain cognitive control, (i) *interference inhibition*, in which an irrelevant yet prepotent stimulus dimension competes with the task-relevant one; and (ii) *inhibitory control of actions*, in which a prepotent motor response must be withheld or stopped (Verbruggen and Logan, 2008; Verbruggen et al., 2019; Wessel, 2018). Both components are typically operationalized using established paradigms: while Stroop-type tasks usually index interference inhibition (MacLeod, 1991; Zahedi et al., 2019), motor inhibition is typically explored via the Stop-Signal Task (SST) and the classical Go/No-Go (GNG). In these latter stopping paradigms (SST and GNG), inhibition is typically probed as a keypress suppression driven by external stimuli (Derpsch et al., 2024; Raud et al., 2020; Verbruggen et al., 2019; Verbruggen and Logan, 2008; Wessel, 2018). Both tasks require establishing a strong stimulus-response association via repeated and fast pairing and then require its suppression when a Stop/No-Go signal appears (Verbruggen and Logan, 2008). Within this framework, the present study focuses on inhibitory control of actions. Throughout, we use "inhibitory control" (abbreviated "inhibition") to denote the immediate, online suppression of prepotent responses in service of current goals. This is distinguished from resolve processing that

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https://doi.org/10.1016/j.neuroimage.2026.121856
Received 28 June 2025; Received in revised form 10 March 2026; Accepted 12 March 2026

interprets the present choice as part of a broader class of future choices and commits to that rule (Ainslie, 2021). This inhibitory capacity relies on a broad neural network including subcortical structures, like the basal ganglia, and cortical regions such as the anterior cingulate cortex and frontal gyri (Aron, 2011; Choo et al., 2022; Duann et al., 2009; Gavazzi et al., 2021; Simmonds et al., 2008). Its critical role is also underscored by impairment observed across various clinical conditions, such as ADHD, substance use disorder, and many neurological and psychiatric dimensions (Aron et al., 2003; Bari and Robbins, 2013; Barkley, 1997; Chambers et al., 2009; Enticott et al., 2008).

In our fast-paced society, inhibitory control is crucial for goal-directed action and promotes motivational control. Motivation and control are jointly organized in hierarchies, with higher-level goals and values setting the precision of lower-level actions and gating when and how inhibitory control is engaged (Pezzulo et al., 2018). Beyond internal goals, inhibitory control also supports efficient interaction with the external environment at large, encompassing also face-to-face social contexts. In these settings, external cues can shape inhibitory efficiency via their motivational and contextual relevance, predictive value, and exogenous salience (Duma et al., 2020; Pessoa and Engelmann, 2010; Verbruggen et al., 2014). Such modulators span perceptual and social domains, with the latter especially pertinent to interpersonal exchange (Fazel et al., 2024). Within this domain, salient signals - whether visually striking or motivationally/contextually significant - can bias inhibitory efficiency (Boehler et al., 2011; Happer et al., 2021). Social cues such as perceived status, emotional expressions, and attractiveness can directly modulate inhibitory control (Cohen-Gilbert et al., 2014; Fazel et al., 2024; Lodha and Gupta, 2023; Logemann-Molnár et al., 2022; Mancini et al., 2022; Pessoa, 2009; Pessoa et al., 2012).

Among the social signals that we can rapidly extract from others faces, race is especially salient. It plays a crucial role in face perception, influencing both visual processing and social judgments (Brigham and Barkowitz, 1978; – for a review see Schaller and Caldara, in press). It categorizes individuals based on salient features, such as skin tone or eye shape (Hannaford, 1996). It holds a special and wide-reaching relevance in social interaction, especially with individuals of different races than one's own (Kite et al., 2022). Research on visual processing and social judgment highlights that less familiar race faces are perceived as novel and salient, possibly due to limited exposure and lower contact levels (see Face-Space Model - (Valentine et al., 2016; Valentine and Endo, 1992; Valentine and Ferrara, 1991) Consistent with salience and broad relevance of race cues, a reliable effect is the Other-Race Categorization Advantage (ORCA): for individuals, categorizing other-race faces by race is both easier and faster than categorizing same-race faces. For example, West European observers categorize "Asian vs. European" faces faster when the target is Asian than when it is European. This robust phenomenon has been replicated across many studies (e.g., Blais et al., 2008; Caldara et al., 2004; de Lissa et al., 2021; Levin, 1996; Serafini and Pesciarelli, 2023; Valentine and Endo, 1992), and persists even in face-processing deficits like prosopagnosia (Schaller et al., 2023) and under degraded visual conditions, where other-race faces remain recognizable at lower visual structural-coherence (de Lissa et al., 2021).

The ORCA captures a robust behavioral regularity. However, its neural underpinnings - and, more broadly, the electrophysiological correlates of race processing – have yielded mixed results, likely due to variations in signal intensity, task structure or methodology (Serafini and Pesciarelli, 2023; Tüttenberg and Wiese, 2023). While some studies report early visual processing differences (e.g. P100 component) between same and other-race faces, these effects are inconsistent, showing stronger responses to own-race faces (Giménez-Fernández et al., 2020; He et al., 2009; Wang et al., 2020), opposite results (Anzures and Mildort, 2021a; Fishman et al., 2012; Pesciarelli et al., 2021) or no effect at all (Brebner et al., 2011; Colombatto and McCarthy, 2017). The P100 is associated with early perceptual encoding and rapid attentional gating of visual input (Mangun and Hillyard, 1991; Van Voorhis and Hillyard, 1977). Race-related modulations at this stage have been interpreted as attentional capture by socially distinctive cues and/or a shift toward featural (rather than configural) sampling strategies often reported for other-race faces (Valentine and Endo, 1992; Zhao and Bentin, 2011), a pattern that aligns with P100 increases in some studies (Hahn et al., 2012; Wang et al., 2020). At the same time, the P100 is sensitive to multiple determinants, from low-level image properties (Regan, 1989) to reward/valence associations, and selection history/motivational relevance (Anderson, 2016; Bayer et al., 2017; Hickey et al., 2010; Luck, 2014; Schacht et al., 2012), which may help explain the heterogeneity of findings. Similar inconsistencies are observed for components specifically indexing structural face encoding, such as the N170 component. Some studies report larger amplitudes for other-race faces (Anzures and Mildort, 2021b; Giménez-Fernández et al., 2020; Herzmann et al., 2018), others for own-race (Cassidy et al., 2014; Vizioli et al., 2010b; Wiese, 2013) or often null results (Caldara et al., 2004; Colombatto and McCarthy, 2017). Task demands and goal settings (e.g., race categorization vs. identity recognition) have been shown to modulate or even reverse such patterns, suggesting that N170 race modulation may be contingent on concurrent cognitive requirements and decisional context (e.g., Senholzi and Ito, 2013; Wiese, 2013). Later components (P200, N250) have shown mixed findings as well (Anzures and Mildort, 2021c; Hahn et al., 2012; Wiese and Schweinberger, 2018). The P200 may be linked to attentional processing and categorical evaluation of socially relevant cues, with occasional enhancements for other-race faces (Carretié et al., 2001; Halgren et al., 1994; Kanske et al., 2011; Hahn et al., 2012; Wiese and Schweinberger, 2018). The N250 has been associated with access/update of identity representations and semantic information, and often shows larger amplitudes for other-race faces, consistent with greater individuation/semantic demands for less familiar categories (Schweinberger et al., 2002; Sun et al., 2014; Wiese et al., 2014; Herzmann, 2016; Caldara et al., 2004). A recent study explored neural responses to face race, controlling for signal intensity through visual degradation within categorization demands. This study confirmed race sensitivity up to the P100 component, depending on varying levels of signal intensity, suggesting a complex process at play (de Lissa et al., 2024). However, potentials associated with inhibition are less well characterized in relation to face race. Of interest, it remains unclear whether race modulates later components typically linked to inhibitory control, such as the No-Go P3 - a positive deflection occurring around 300 - 600 ms post inhibitory-stimulus, recorded over fronto-central and centro-parietal electrodes (Huster et al., 2013, 2013; Nguyen et al., 2020, 2016; Raud et al., 2020; Wessel, 2018; Wessel and Aron, 2014).

Despite extensive research on race perception and social evaluation, studies linking facial race information to cognitive control are still relatively few and heterogeneous across constructs and modalities. Existing work has examined cognitive control with respect to face race in face memory encoding (Brown et al., 2017) or in a Go/No-Go with task-irrelevant face race, where race signal was orthogonal to the inhibitory demand (Rubien-Thomas et al., 2021). This study extends prior research employing an inhibitory task in which face race is task-relevant and by using time-resolved evidence to explore when effects emerge along the cognitive processing cascade.

Accordingly, we made race the explicit response rule, leveraging the ORCA effect to integrate inhibition and face-race processing. We thus tested West European individuals in a Go/No-Go (GNG) task with East Asian (i.e., other-race) and West European (i.e., same-race) face images as Go/No-Go targets (Experiment 1). This paradigm ensured that inhibition would directly engage face-race processing. In fact, here to successfully inhibit their response, participants had first to rapidly categorize the face by race (corresponding to No-Go target detection) under task pressure. Given the Other-Race Categorization Advantage (ORCA), we know that other-race faces (Asian for our sample) are usually categorized more easily and more quickly than same-race faces, thereby possibly enhancing rule mapping and subsequent inhibition. Conversely, slower or noisier categorization for same-race faces may delay or weaken the inhibition trigger, failing to stop the build-up of the prepotent Go response and resulting in poorer inhibitory performance. Based on these predictions, we hypothesized that the face race might modulate inhibition within this task, potentially enhancing inhibition efficiency for other-race faces in accordance with the ORCA. Behavioral results alone could not determine the processing stage at which face-race influences inhibition. To further examine the neurocognitive mechanisms underlying this interaction, we recorded high-density EEG during task execution (Experiment 2). This approach allowed us to characterize the temporal dynamics of face-race effects within inhibitory processing, thereby testing whether these effects are evident at both early perceptual and later post-perceptual stages (e.g., the No-Go P3). This interaction may be relevant both theoretically and for everyday social dynamics. Inhibition plays a key role in social exchanges and is influenced by the interlocutor's features, suggesting that face race may shape responses in everyday encounters. The impact of race perception on inhibition seems especially worth considering in high-stake and fast-decision-making contexts, such as clinical interaction with patients of different races in healthcare settings, or law enforcement scenarios in shoot/non-shoot situations where inhibitory control is inherently involved.

2. Experiment 1

2.1. Materials and methods

2.1.1. Participants

Inclusion criteria consisted of normal or corrected-to-normal vision. Each subject was blind to the purpose of the study before the experimental session. Study aims were carefully disclosed and explained after the completion of the evaluation. All participants gave their written informed consent to the procedure and the processing of personal data. The study was performed according to the Declaration of Helsinki and was approved by the Ethical Committee of the University of Fribourg. Fifty West European participants were recruited from the student pool of the University of Fribourg. After dataset exclusion process (see Data Analysis section), forty-five participants (mean age: 22.2 years old ± 2.7 S.D., 37 female, 41 right-handed) datasets were statistically analyzed.

2.1.2. Familiarity questionnaire

Participants completed a short familiarity questionnaire previously used in studies on same- and other-race face perception (Voci and Hewstone, 2003; Walker et al., 2008). The questionnaire assessed social contact with East Asian (EA) and West European (WE) individuals using a 5-point scale (low to high contact).

2.1.3. Visual stimuli

The stimuli consisted of 20 front-view grayscale photographs of West European (WE) and East Asian (EA) faces (Fig. 1A). Five male and five female identities were depicted for WE and EA faces. Each face subtended ∼14° vertically and 10° horizontally, matching a real-life size (∼20 cm high) when viewed from 60–80 cm, simulating natural interaction distance (Blais et al., 2008). Stimuli were neutral-expression portrait photos of Belgian (WE) and Chinese (EA) students aged 18–25. Ears and hair were excluded. Images were spatially equalized using the average amplitude spectrum while preserving the original phase (Oppenheim and Lim, 1981; Rousselet et al., 2008), with constant RMS contrast across faces (Vizioli et al., 2010a). Normalization was performed using the SHINE toolbox (Willenbockel et al., 2010). These same stimuli have been previously used in several studies successfully investigating race perception (de Lissa et al., 2021, 2022, 2024; Michel et al., 2006; Vizioli et al., 2010a, 2010b).

2.1.4. Experimental procedure

The experiment was hosted through the web-based Gorilla Experiment Builder software (www.gorilla.sc, Anwyl-Irvine et al., 2020) and was conducted online on personal desktop/laptop computers of participants. A calibration step ensured a uniform image size across screens.

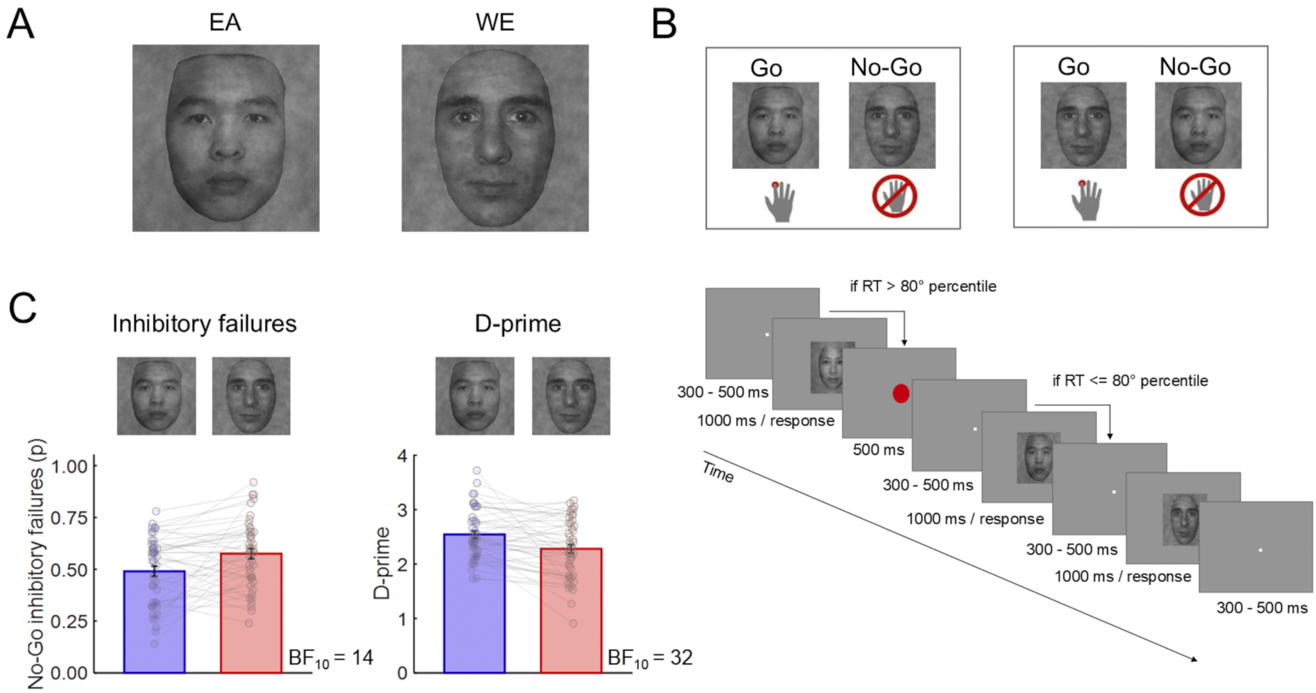

Fig. 1. **(A)** Representative East Asian (EA, left) and West European (WE, right) face stimuli. **(B)** Experimental conditions. Upper panel – left: 'WE No-Go' condition, with EA faces as Go targets and WE faces as No-Go targets. Right: 'EA No-Go' condition, with WE as Go and EA as No-Go targets. Lower panel: Trial structure for the 'WE No-Go' condition, showing three example trials: two Go trials (one above and one below the feedback threshold) and one No-Go trial. **(C)** Mean values for inhibitory failures and d' in the 'EA No-Go' (blue) and 'WE No-Go' (red) conditions. Dots represent individual participants; lines connect repeated measures. Bayes Factors (BF_{10}) are reported.

Participants were instructed to sit ∼60 cm from the screen and completed a Go/No-Go task based on face race categorization. The task was performed twice, corresponding to the two different experimental conditions. The presentation order was balanced across observers. At the end of the experiment, a short familiarity questionnaire about participants' level of contact with East Asian or West European individuals was administered.

2.1.5. Go/No-Go tasks

Participants had to quickly categorize one race by pressing the space bar with their right index (Go stimulus) while inhibiting responses to the other (No-Go stimulus). The experiment consisted of two conditions, in a randomized order:

i) 'EA No-Go' condition: EA faces (i.e., other-race) served as the Go target and WE faces (i.e., same-race) were the No-Go target that had to be inhibited.
ii) 'WE No-Go' condition: the race roles were inverted, with EA corresponding to Go targets and WE as No-Go targets.

By implementing these two conditions, we ensured that each face race would serve as the stimulus to be inhibited (Fig. 1B).

Each condition consisted of 250 trials (200 Go targets, 80 %; 50 No-Go target trials, 20 %), divided into five blocks with 50 trials each one (40 Go target trials, 80 %; 10 No-Go targets trials, 20 %). Trial order was pseudorandomized, with the sole constraint being the avoidance of two consecutive No-Go targets to prevent potential inhibitory-demands biases. Face identities were also randomized. Blocks were divided by breaks. Before each condition, a practice phase of 50 trials was conducted to familiarize participants with instructions and minimize the influence of pre-established associations based on the order of condition execution.

Trial structure. Each trial begins with a white fixation dot displayed on a gray screen for an amount of time drawn from a uniform distribution between 300 - 500 ms (Young et al., 2018), followed by a face stimulus presented for 1000 ms or until the subject's response. If participants responded too slowly in any given trial, visual feedback on response speed was provided (Fig. 1B). Feedback consisted of a red central dot (∼ 2° visual angle) presented for 500 ms when participant's RT was higher than the 80th percentile of the current RTs distribution. The threshold for the first trial was set arbitrarily at 300 ms and then adaptively adjusted. This feedback was designed for a challenging (Benikos et al., 2013) yet feasible task, accounting for individual differences in response speed (Sharp et al., 2010) and potential slowing strategies.

2.1.6. Data analysis

For each participant, behavioral performance was quantified using the following measures: Go mean reaction times ('Go RTs'), proportion (P) of correct responses in the Go condition ('Go accuracy'), and proportion of inhibitory failures in the No-Go condition ('No-Go Inhibitory failures'). Given the online format and the difficulty of reliably measuring participant engagement, datasets with >95 % inhibitory failures were excluded, as such high rates likely indicate non-compliance with task instruction and compromised data quality. For the 'Go RTs' measure, behavioral responses shorter than 100 ms were excluded from datasets (constituting a mean proportion of 0.04 in both conditions among participants). Additionally, d' (d-prime) with the log-linear method (Hautus, 1995) was calculated to assess discriminability between target (go) and non-target (no-go). Each measure was independently calculated and compared between 'EA No-Go' vs. 'WE No-Go' conditions by means of a Bayesian paired-sample analysis (Rouder et al., 2009) with Cauchy prior scale 0.707. Posterior distribution plot (prior vs. posterior), point estimate (median), the 95 % Credible Interval (C.I.) and posterior robustness analyses are reported per each test in the Supplementary materials (S). Data processing and statistical hypothesis testing was performed using MATLAB (version 2020b; The MathWorks Inc., Natik, Mass, Portola Valley, CA, United States) and JASP (Version 0.18.1; JASP Team 2023).

2.2. Results

The mean familiarity questionnaire score in our sample reported a higher value for WE (4.78 ± 0.54 S.D.) compared to EA (1.64 ± 0.55 S.D.) individuals, sustaining the differentiation of WE and EA faces as respectively same-race and other-race stimuli. Descriptives of the behavioral performance in the GNG task are reported in Table 1.

The comparison of 'No-Go inhibitory failures' and '*d*' score' revealed evidence of a difference between conditions. Particularly, No-Go inhibitory failures were less frequent when inhibiting toward EA No-Go targets (0.49 ± 0.17) compared to WE (0.58 ± 0.16), with strong evidence for this effect ($BF_{10} = 14.44$), suggesting an inhibitory advantage toward other-race faces (Fig. 1C, Figure 1SA). This was accompanied by a higher d' when inhibiting EA No-Go targets (2.54 ± 0.46) compared to WE (2.28 ± 0.55), with very strong evidence ($BF_{10} = 31.96$), suggesting enhanced discriminability associated with better performance (Fig. 1C, Figure 1SB). By contrast, 'Go RTs' yielded moderate evidence against a difference ($BF_{10} = 0.16$), consistent with comparable RT between conditions (Figure 1SC). Similarly, 'Go accuracy' showed comparable values ($BF_{10} = 0.16$; Figure 1SD).

2.3. Discussion

Inhibitory efficiency appeared enhanced when participants inhibited responses to EA faces, as indicated by fewer inhibitory failures - a classic behavioral marker of superior inhibitory performance. This effect was accompanied by higher d′ in the 'EA No-Go' condition, pairing improved inhibition with greater discriminability of targets. These results suggest that face race may modulate inhibitory performance. As the task was conducted online on participants' personal laptops, with no attention probes, participant engagement and potential environmental confounds could not be fully controlled; we acknowledge this as a limitation of the online setting. In the subsequent experiment, we employed a laboratory-based EEG variant to examine the dynamics of inhibition to task-relevant face race under controlled conditions.

3. Experiment 2

3.1. Materials and methods

3.1.1. Participants

Eligibility criteria, consent procedures, and ethics approval were identical to Experiment 1. Thirty West European participants were recruited from the student pool of the University of Fribourg. EEG recordings of three subjects were discarded from analysis due to excessive movement artifacts during registration, therefore twenty-seven participants (mean age: 22.3 years old ± 4.4 S.D., 21 female) datasets were statistically analyzed.

3.1.2. Familiarity questionnaire

The same familiarity questionnaire from Experiment 1, section 2.1.2, was used, with an additional question about exposure to EA and WE individuals through media (e.g., TV series, movies).

Table 1
GNG measure (mean ± S.D.) per condition.

	EA No-Go	WE No-Go
GO ACCURACY (P)	0.99 ± 0.01	0.99 ± 0.01
GO RTS (MS)	345 ± 64	344 ± 63
NO-GO INHIBITORY FAILURES (P)	0.49 ± 0.17	0.58 ± 0.16
D-PRIME	2.54 ± 0.46	2.28 ± 0.55

3.1.3. *Visual stimuli*

Visual stimuli corresponded to the 20 front-view grayscale photographs of West European (WE) and East Asian (EA) faces used in experiment 1, section 2.1.3.

3.1.4. *Experimental procedure*

The experiment was conducted in a controlled EEG Faraday room. Stimuli were displayed on a 24-inch VIEWPixx/3D monitor (1920 × 1080 px, 120 Hz) at a 70 cm viewing distance. Participants used a chin rest for stability. Tasks were run on MATLAB (version 2020b; The MathWorks Inc., Natik, Mass, Portola Valley, CA, United States) using the Psychophysics Toolbox (Kleiner et al., 2007).

As in Experiment 1, participants completed two GNG tasks, corresponding to the two experimental conditions, with condition order balanced across the sample. Electrophysiological and electromyographic activity were recorded throughout the task, followed by a short familiarity questionnaire on contact with East Asian and West European individuals.

3.1.5. *Go/No-Go tasks*

As in experiment 1, participants categorized faces by pressing the space bar for one race (Go stimulus) while inhibiting responses to the other (No-Go stimulus). Two conditions were still performed:

i. 'EA No-Go' condition: EA faces as Go targets, WE faces as No-Go targets.
ii. 'WE No-Go' condition: Race roles reversed, with EA as Go targets and WE as No-Go targets.

The paradigm differed slightly from experiment 1 in trial count and timing to adjust for EEG recordings. Trial numbers increased, and inter-trial intervals extended for ERP baseline recovery while ensuring reliable inhibitory control (Wessel, 2018).

Each condition included 500 trials (400 Go, 80 %; 100 No-Go, 20 %), divided into four blocks of 125 trials (100 Go, 80 %; 25 No-Go, 20 %), separated by short breaks. Trials were pseudorandomized, ensuring no consecutive No-Go stimuli to prevent bias. Face identities were also randomized. A 40-trial practice phase preceded each task to familiarize participants and mitigate potential pre-existing associations based on condition execution order.

Each face remained onscreen until the participant's response or for a maximum of 1000 ms. A fixation cross followed for the remaining time in a 1500 ms trial window (e.g., 500 ms for omitted responses, or 1500 *minus* RT ms if responded). This timing was based on Wessel (2018). For slow responses, adaptive feedback was provided as in experiment 1: a red central dot (∼2° visual angle) appeared for 500 ms if RT exceeded the 80th percentile of current RTs. This 500 ms feedback was additive to the 1500 ms trial duration (so feedback trials lasted 2000 ms). The initial threshold was set at 300 ms and adjusted dynamically (Fig. 2A).

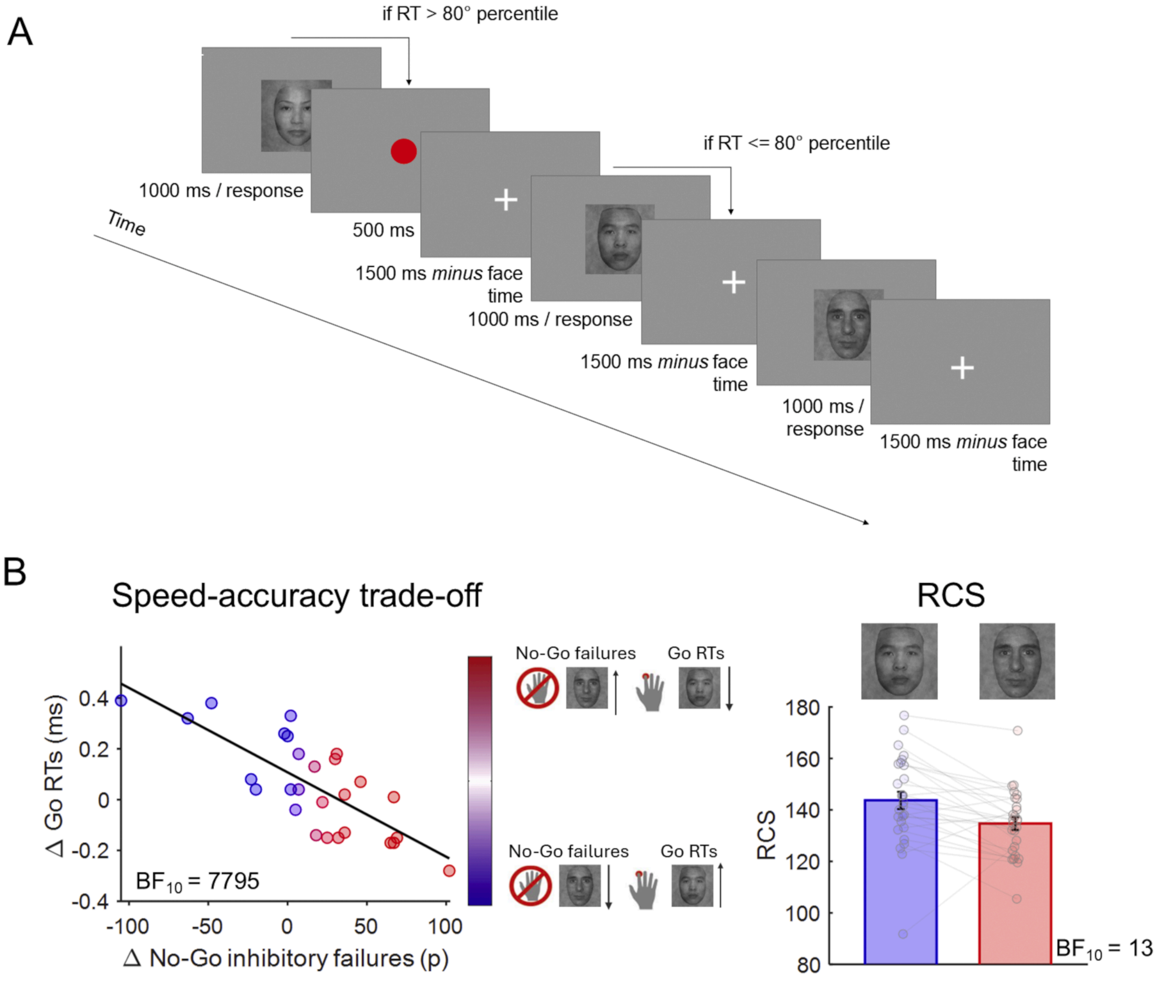

Fig. 2. (A) Trial structure in the 'WE No-Go' condition. Three example trials are shown. **(B)** Left: correlation between race effect magnitude on No-Go inhibitory failures (x-axis) and Go RTs (y-axis). Positive x-values indicate more inhibitory failures for WE No-Go; positive y-values indicate slower responses to EA Go targets in the same condition. Dots represent individual data; black line shows linear trend. Right: RCS scores for the 'EA No-Go' (blue) and 'WE No-Go' (red) conditions. Dots represent individual participants; lines connect repeated measures. BF_{10} values are reported.

3.1.6. EEG recordings

EEG recordings were obtained via a Biosemi Active-Two amplifier system using 128 Ag/AgCl electrodes, sampling at 1024 Hz. Two additional electrodes were placed on the left canthus (on the lateral part of the orbital bone of the left eye) and below the left eye. EEG signal was processed offline using the EEGLAB Toolbox (v2021.1) within MATLAB (version 2020b; The MathWorks Inc., Natik, Mass, Portola Valley, CA, United States). A bandpass (0.1-30 Hz) and notch filter (50 Hz) were applied before epoch segmentation (-500 to 1000 ms). Subsequently, epochs were baseline corrected to the average voltage from - 100 to 0 ms (de Lissa et al., 2024; Maruo, Sommer, and Masaki, 2017). Eye-blink and horizontal-eye movement artifacts were removed through Independent Component Analysis (ICA - Delorme and Makeig, 2004). EEG segments where the signal was obscured by significant noise, such as prominent muscular artifacts, were removed before running ICA. Additionally, channels with poor EEG quality were excluded from the ICA analysis and were subsequently interpolated. The EEG epochs were then re-referenced using a common-average. Epochs with voltages exceeding ±100 µV were rejected. A final visual assessment of the EEG trace was conducted and any remaining epochs with noticeable artifacts were removed. ERP averages were formed separately for condition and face race in order to obtain 4 ERP waves per participant, i.e., 'Go EA', 'No-Go WE', 'Go WE' and 'No-Go EA'. After preprocessing, trials retained by condition (mean ± SD retained) were: 'Go Asian' 320 ± 45, 'Go Caucasian' 329 ± 48, 'No-Go Asian' 90 ± 28, 'No-Go Caucasian' 91 ± 25.

3.1.7. EMG recordings

EMG signals were recorded concurrently with EEG using a bipolar electrode montage. The active electrode was placed over the belly tendon of the right First Dorsal Interosseous (FDI) muscle, responsible for the response effector, while the reference electrode was positioned on the bony area of the wrist. A bandpass filter (20–500 Hz) and a notch filter (50 Hz) were applied before signal rectification and Root Mean Square (RMS) smoothing. Epochs were then segmented (-200 to 1000 ms) (Raud et al., 2020, 2022).

3.1.8. Data analysis

Behavioral data. Per each participant, behavioral performance was quantified by the following measures: Go mean reaction times ('Go RTs'), proportion (P) of correct responses in the Go condition ('Go accuracy') and the proportion of inhibitory failures in the No-Go condition ('No-Go Inhibitory failures'). Behavioral responses shorter than 100 ms were excluded from the datasets (0.01 and 0.00 mean proportion in EA No-Go' and a 'WE No-Go' condition respectively). Speed-accuracy tradeoff effects between conditions (Standage et al., 2014) were examined to determine whether face race influenced inhibitory performance differently across individuals. To assess this, a correlation was conducted between the race effect magnitude for 'No-Go inhibitory failures' and 'Go RTs'. The race effect magnitude for 'No-Go inhibitory failures' was computed as the difference (Δ) between conditions: 'Δ No-Go inhibitory failures' = 'No-Go inhibitory failures' for 'WE No-Go' *minus* 'No-Go inhibitory failures' for 'EA No-Go'. A positive value indicates more inhibitory failures for WE faces, while a negative value reflects the opposite trend. Similarly, the race effect magnitude for 'Go RTs' was calculated as: Δ Go RTs = Go RTs for 'WE No-Go' *minus* Go RTs for 'EA No-Go'. A positive score indicates slower Go responses when WE faces served as the inhibitory target, whereas a negative score suggests slower responses when inhibiting EA faces. Correlations were conducted on these measures with the hypothesis that inhibiting responses to WE faces (i.e., other-race) might be more challenging. This could potentially prompt individuals with high cognitive control capacity to proactively slow down their responses as a strategy to enhance accuracy. Therefore, the correlation provides information on the presence of a speed-accuracy trend associated with face race inhibitory demands.

To quantify the overall cognitive cost of inhibiting responses toward WE or EA faces, speed and accuracy were integrated into a single measure. The Rate Correct Score (RCS), also known as the Throughput score, was computed following the Thorne formulation (Liesefeld and Janczyk, 2019; R. Thorne, 2006; Vandierendonck, 2021). Specifically, we computed RCS as (% of correct responses / mean RT in s) × 0.6, where 0.6 is the time-scaling constant. % of correct responses was defined as (Go hits + No-Go correct inhibitions) / 500 per condition (400 Go + 100 No-Go). Mean RT was computed over all trials that elicited a response (Go responses and No-Go commission errors), excluding anticipations <100 ms and no-response trials. A high RCS score indicates a superior balance between accuracy and speed, reflecting more accurate responses within a given time frame. As a result, a higher RCS value indicates enhanced inhibitory performance.

Each measure was computed separately and compared between 'EA No-Go' and 'WE No-Go' conditions using a Bayesian paired-sample analysis (Cauchy prior scale 0.707). Posterior distribution plot, point estimate, the 95 % C.I. and posterior robustness analyses are reported in the Supplementary materials. For completeness and transparency, we additionally computed and compared the RCS for Experiment 1 data (Figure 7SA) and the d' for Experiment 2 data (Figure 7SB); results and a cross-experiment summary table are provided in the Supplementary Materials (Table S1). Data processing and statistical hypothesis testing were performed using MATLAB (version 2020b; The MathWorks Inc., Natik, Mass, Portola Valley, CA, United States) and JASP (Version 0.18.1; JASP Team 2023).

EEG data. Following preprocessing, a mass Bayesian ANOVA (2 × 2 design: 'Face Race' [EA, WE] × 'Target' [Go, No-Go]) was conducted across all electrodes and time points within 0–600 ms post-stimulus onset (Cauchy prior scale 0.707). The 600 ms upper bound aligns with face-feature categorization related Go/No-Go studies, methodologically similar to ours, where inhibition-related activity (No-Go P3) was investigated up to this window (Zhang et al., 2016; Zhang and Lu, 2012). We used a mass approach to characterize the time course from stimulus onset across all time points, avoiding fixed a priori windows and allowing data-driven observation (Maris and Oostenveld, 2007; Groppe et al., 2011; Pernet et al., 2011; Fields and Kuperberg, 2020). To account for repeated measures, subject ID was treated as a random factor, and BF was calculated across matched models, comparing the interaction model with its counterpart excluding the interaction (Keysers et al., 2020). In accordance with previous studies (de Lissa et al., 2024), to lessen the likelihood of false-positives, the evidence boundary was set at $BF_{10} =>$ 10, corresponding to strong evidence (Stefan et al., 2019). Evidence in favor of the null hypothesis (comparable means) was set at $BF_{10} \leq 0.33$. A data-driven approach identified clusters of adjacent electrodes exhibiting BF above the evidence boundary within a continuous time segment. The precise time interval of significance for each cluster was defined as the span where the average BF across channels remained >10. Bayesian post hoc analyses were conducted within these electrode clusters looking for evidence in the relative time interval.

To complement these time-resolved, group-level results - which test for condition differences at each time point but do not fully account for temporal jitter across individuals - we conducted a follow-up subject-level peak analysis of the No-Go P3 (Groppe et al., 2011). This component subserves inhibitory control (Wessel 2018) and shows marked interindividual variability in latency compared to earlier perceptual components (Luck, 2014; Polich, 2007; Polich and Kok, 1995). We therefore used a collapsed localizer (Luck, 2014) to extract per participant peak latency and peak amplitude (EA vs. WE), compared via a Bayesian paired-samples t-test (Rouder et al., 2009; Cauchy prior r = 0.707, Supplementary).

All analyses were performed exclusively on trials with a correct response, which included responses for Go target stimuli and correctly inhibited responses (absence of key press) for No-Go targets. A Bayesian correlation analysis was conducted to assess the relationship between behavioral effect magnitude and neural responses. Specifically, for each participant, behavioral effect magnitude was quantified as the Δ RCS index between conditions (RCS 'EA No-Go' minus RCS 'WE No-Go'). This value was then correlated with EEG voltage differences in the No-Go condition (Δ EEG voltage = amplitude 'No-Go EA' minus 'No-Go WE'), computed at each time point and for each electrode. Statistical analyses were conducted in RStudio (2021.09.2) using the BayesFactor package, 0.9.12-4.3, (Morey and Rouder, 2026) and in MATLAB (version 2020b; The MathWorks Inc., Natik, Mass, Portola Valley, CA, United States) using the bayesFactor package 1.0.0, (Bart Krekelberg, 2026). Priors checks are reported in the Supplementary Materials.

EMG data. EMG analyses focused exclusively on correctly inhibited No-Go trials. Each trial's EMG trace was categorized as either 'fully inhibited' (absence of stimulus-related EMG activity) or as 'subthreshold activation' (muscular activity below key press detection). Categorization was performed using a custom code, which applied a threshold (calculated as baseline mean + $\alpha \times$ SD of baseline activity in the −200 to 0 ms pre-stimulus window, per each trial; where α is a constant of 20). Classifications were also visually inspected. A Bayesian paired sample analysis (Cauchy prior scale 0.707) was conducted to compare the proportion of 'subthreshold activation' between 'No-Go EA' and 'No-Go WE' conditions using JASP (Version 0.18.1; JASP Team, 2023).

3.2. Results

The familiarity questionnaire confirmed that in our sample mean familiarity was high for WE (4.91 ± 0.20 S.D.) and low for EA (2.15 ± 0.70 S.D.) individuals, sustaining the differentiation of WE as same-race and EA as other-race stimuli.

3.2.1. Behavioral data

Descriptives of the behavioral performance in the GNG task are reported in Table 2.

Starting with behavioral results, at the group level, 'Go accuracy', 'Go RTs' and 'No-Go inhibitory failures' reported inconclusive evidence respectively (BF_{10} = 0.23; BF_{10} = 0.95; BF_{10} = 0.57 respectively, Figure 2SA, Figure 2SB, Figure 2SC). Correlational analysis revealed the presence of speed-accuracy trade-off between 'EA No-Go' and 'WE No-Go' conditions once accounting for individuals' differences. Particularly, the race effect magnitude for 'No-Go inhibitory failures' showed a negative correlation with the race effect magnitude for 'Go RTs,' supported by extreme evidence (Pearson's r = -0.77; BF_{10} = 7795.10). This relationship is depicted in Fig. 2B. The blue segment of the graph denotes individuals exhibiting lower rates of 'No-Go inhibitory failures' when inhibiting WE faces compared to EA faces, contrary to our initial expectations. Notably, these individuals also exhibited slower responses to the Go target in the same condition, suggesting a reliance on proactive slowing to achieve successful inhibition outcomes. Conversely, the red segment of the graph illustrates participants who reported more inhibitory failures to WE rather than EA faces. These individuals were unable to mitigate this difficulty through adjustments in reaction time. Finally, strong evidence (BF_{10} = 13.40) supported a higher RCS score for the 'No-Go EA' condition (144 ± 18) compared to the 'No-Go WE' condition (135 ± 13) (Fig. 2B, Figure 2SD).

3.2.2. EEG data

The mass-Bayesian analysis revealed evidence for 'Face race' main effect in a time interval compatible with early processing, while the 'Target' main effect and the interaction highlighted evidenced in post perceptual processing stages.

Table 2
GNG measure (mean ± S.D.) per condition.

	EA No-Go	WE No-Go
GO ACCURACY (P)	0.98 ± 0.05	0.98 ± 0.04
GO RTS (MS)	387 ± 53	403 ± 42
NO-GO INHIBITORY FAILURES (P)	0.40 ± 0.22	0.46 ± 0.19
RCS SCORE	144 ± 18	135 ± 13

Particularly, 'Face race' predictor reported evidence for a main effect within 104 to 115 ms (mean BF_{10} = 29.40; max BF_{10} = 66.26 at 110 ms) over an occipital cluster (consistent in time and location with the P100 component). The amplitude was higher for EA compared to WE faces, hence, the P100 amplitude was enhanced for other compared to same-race faces (Fig. 3A, Figure 3S).

The 'Target' predictor reported evidence for a main effect in a time interval compatible with cognitive control processing. Particularly, within 388 – 600 ms (mean BF_{10} = 5.7807e + 19; max BF_{10} = 4.0739e + 20 at 493 ms), over frontocentral and parietal electrodes. In this cluster, No-Go target stimuli reported higher amplitude compared to Go target stimuli, consistent with the No-Go P3 component (Fig. 3B, Figure 3S).

Evidence for an interaction effect ('Face race' x 'Target') emerged within 336–398 ms (mean BF_{10} = 45.06; max BF_{10} = 76.31 at 370 ms) over fronto-central electrodes, aligning with the No-Go P3. To further investigate this interaction, we initially compared EA and WE faces within the No-Go target trials, expecting evidence for a difference. Subsequently, we compared face races within the Go trials, expecting an absence of difference. Corroborating our expectations, the amplitude for EA faces was higher than WE faces within No-Go trials during a time window within the interaction effect (i.e., 346–403 ms; mean BF_{10} = 26.37; max BF_{10} = 41.54 at 365 ms). Hence, the No-Go P3 varied as a function of 'face race': inhibiting to other-race faces elicited higher No-Go P3 amplitude compared to inhibiting same-race faces in the rising phase of the component – see waveforms (Fig. 3C, Figure 4S). No 'face race' differences emerged within Go trials during the interaction effect (mean BF_{10} = 0.96; max BF_{10} = 2.13 at 338 ms) (Fig. 3D, Figure 4S), ascribing differences between face races within conditions when inhibitory control was required.

The subject-specific peak analysis revealed that the difference between race conditions reflects a temporal shift of the No-Go P3. Peaks were estimated at a centroparietal site within 388–600 ms (Go/No-Go cluster): for each participant, we used a collapsed localizer across race conditions to select the electrode showing the maximal positive deflection in this window and extracted the 'EA No-Go' and 'WE No-Go' peaks from that site. The Bayesian paired-samples test provided very strong evidence for an earlier latency with EA relative to WE (EA < WE; BF_{10} = 65.79) (Fig. 4A, Figure 5SA), whereas peak amplitude did not differ reliably (BF_{10} = 0.31, Figure 5SB).

Finally, evidence for a positive correlation between the behavioral effect magnitude and the neural response emerged over central electrodes within 387–532 ms (mean BF_{10} = 53.87; max BF_{10} = 160.30 at 429 ms), aligning with the timing and location of the interaction effect. This implies that higher behavioral inhibitory performance to EA faces (i.e., other-race) corresponded to a greater amplitude of the corresponding neural response, occurring in a time interval and location consistent with the No-Go P3 (Fig. 4B, Figure 6S).

3.2.3. EMG data

The average proportion of subthreshold responses in inhibited 'No-Go' trials was 0.22 ± 0.21 in the 'WE No-Go' condition and 0.24 ± 0.18 S.D. in the 'EA No-Go' condition. Moderate evidence (BF_{10} = 0.27) indicates similarities between conditions in the number of subthreshold responses (Figure 5SC). While we found the presence of subthreshold responses, as typical of inhibitory tasks, these were not informative about the experimental factor 'face race'.

3.3. Discussion

A speed–accuracy trade-off based on face race emerged at the behavioral level. By using an integrated measure of both speed and accuracy, we found that inhibition toward EA faces seems to remain superior. At the neural level, EA faces elicited a greater amplitude in the P100 component. In later stages, EA faces also evoked higher amplitudes in the early phase of the No-Go P3, paired with a peak latency

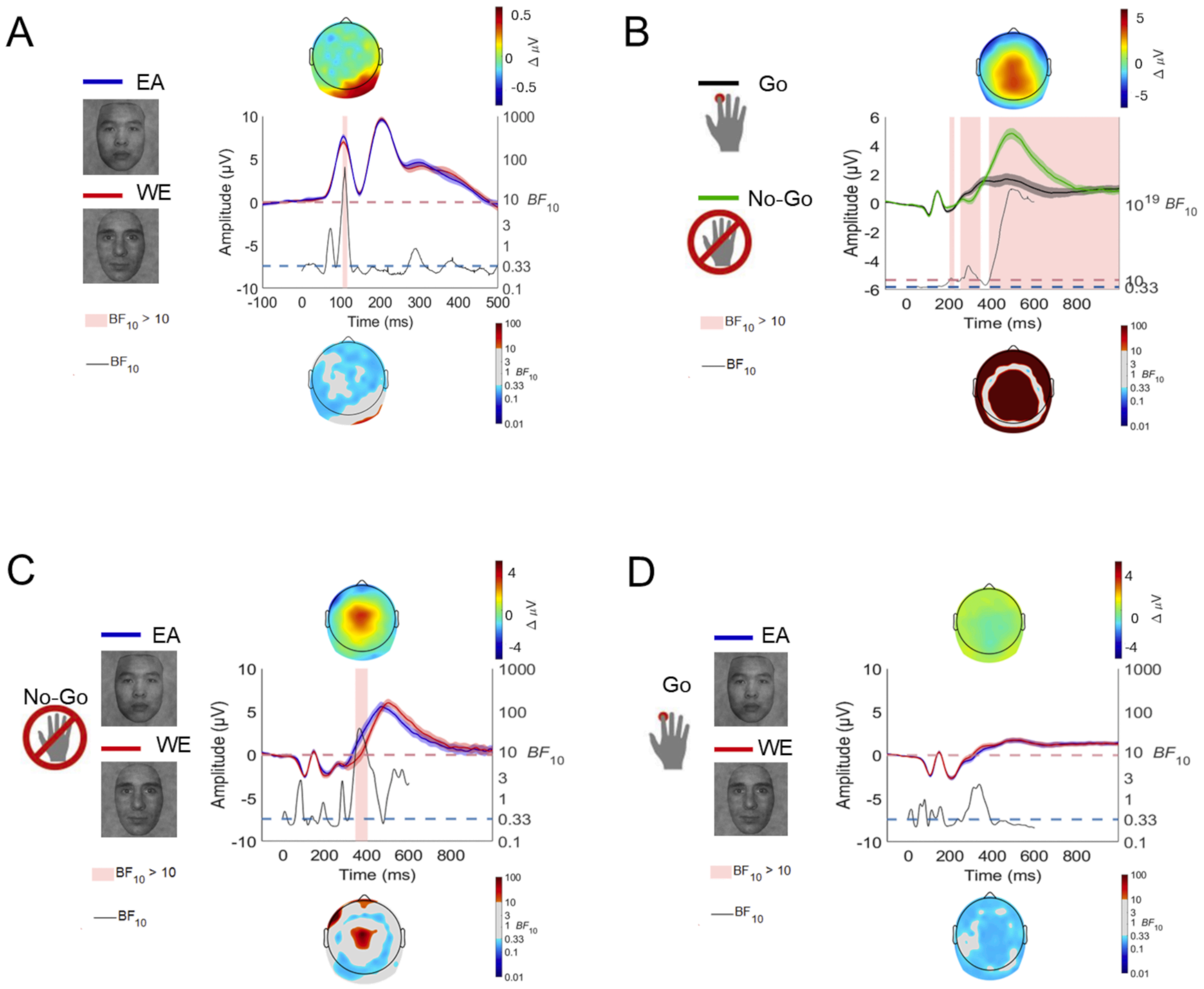

Fig. 3. (A) EA (blue) and WE (red) waveforms averaged over the occipital P100 cluster (top), with corresponding BF_{10} over time (bottom). Scalp maps show EA–WE voltage difference (top) and BF_{10} cluster evidence (bottom) during 104–115 ms. **(B)** Go (black) and No-Go (green) waveforms over the central No-Go P3 cluster (top) and BF_{10} across time (bottom). Topographies reflect No-Go – Go voltage and cluster evidence during 388–600 ms. **(C)** EA (blue) and WE (red) waveforms for the No-Go P3 interaction cluster (top), with BF_{10} (bottom); topographies reflect EA–WE voltages during 336–398 ms. **(D)** Same as (C), but for Go trials. In all waveforms, shaded regions indicate 95 % confidence intervals (Cousineau–Morey correction for repeated measures).

anticipation, suggesting more prompted engagement of inhibition-related processes. Notably, the magnitude of the behavioral race effect correlated with the race effect on the neural amplitude within the No-Go P3 time window and topography. Both early perceptual and post-perceptual neural modulations were highlighted. A methodological point worth noting concerns the multiple-comparisons testing issue. Here, we adopted a conservative evidential threshold of $BF_{10} \geq 10$ to reduce the risk of overinterpreting, consistent with proof that raising the evidence boundary lowers the rate of misleading evidence, with error rates not improving substantially beyond that threshold (Stefan et al., 2019). However, one limitation of this approach is that the threshold was applied as a fixed criterion. Instead, Bayesian boundaries can also be calibrated depending on the number of statistical tests, providing a multiplicity-adjusted criterion that may be a more precise approach for controlling false positives (Guo and Heitjan, 2010; Schönbrodt et al., 2017).

4. General discussion

In two experiments, we investigated whether inhibitory control in response to faces might be modulated by face race processing. Participants performed two GNG tasks, in which they had to quickly categorize faces of one race (Go stimulus) while inhibiting their responses to the other race (No-Go stimulus). This design ensured inhibitory demands to tap into face race perception and categorization directly.

Experiment 1 was conducted at a fast pace with short ITIs, aimed at minimizing floor effects within GNG tasks. The behavioral outcomes of experiment 1 revealed a performance advantage when inhibiting responses toward EA (other-race) compared to WE (same-race) faces. The lower proportion of inhibitory failures for EA stimuli, suggests enhanced inhibitory efficiency for other-race faces. This was further supported by an increased d' score, indicating improved discrimination sensitivity between target (Go stimulus) and non-target (No-Go stimulus) when the No-Go target belonged to other-race faces category. In GNG tasks attentional selection of the No-Go target helps adjust performance (Happer et al., 2021; O'Connell et al., 2009; Young et al., 2018). The attentional shift towards No-Go stimuli seems to interact with the advantage of categorizing other-race faces, influencing discriminability based on the inhibitory demands associated with the race-category. Therefore, distinct cognitive mechanisms appear to be at play when inhibitory demands vary based on face race, reporting an inhibitory advantage for other-race faces within this Go/No-Go context. Interestingly, these results relate to accuracy measures, with no discernible effects on RTs. This pattern is consistent with theoretical and empirical evidence showing that task pacing critically modulates how cognitive control is expressed behaviorally. When the pace is fast, between-trial

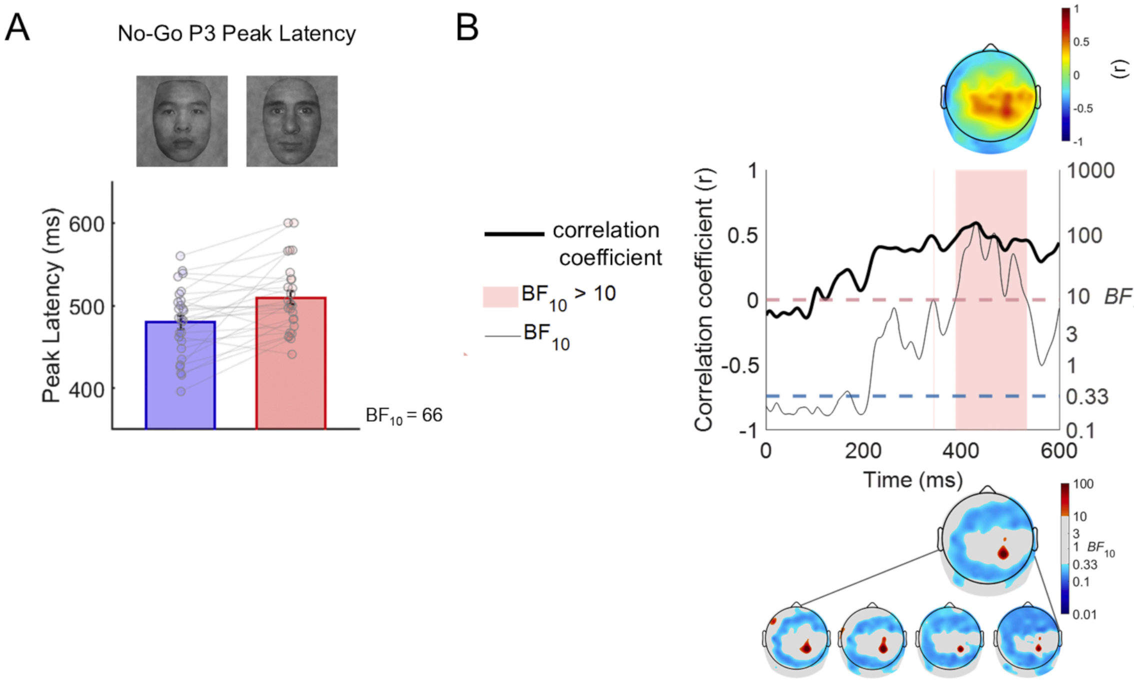

Fig. 4. **(A)** Mean values for the No-Go Peak Latency in the 'EA No-Go' (blue) and 'WE No-Go' (red) conditions. Dots represent individual participants; lines connect repeated measures. Bayes Factors (BF_{10}) are reported. **(B)** Black line represents the averaged correlation coefficient (r) over the central correlation cluster (top), with corresponding BF_{10} values across time (bottom). Scalp maps display the r-value (top) and BF_{10} (bottom), averaged over the 387–532 ms time window. Due to the extended duration of the effect, sub-averages were also computed in 36 ms intervals.

recovery is reduced (Smith, 1967; Zylberberg et al., 2012), and time pressure constrains the decision process, leading to increased errors and shortened reaction times (Heitz, 2014; Wickelgren, 1977). RTs became restrained by task timing and may carry limited discriminative power. Under such conditions, accuracy may become the most sensitive index of performance differences, as it would capture the loss of processing that would have been needed to avoid errors. On the same line, while RT modulations are typically observed in face race categorization studies (Caldara et al., 2004; Schaller et al., 2023; Valentine and Endo, 1992; Zhao and Bentin, 2011, 2008), accuracy effects have also been reported, especially in challenging tasks. For instance, accuracy was influenced in face categorization studies involving noisy visual sceneries (de Lissa et al., 2022, 2024) or extrafoveal face presentations (de Lissa et al., 2021). These findings suggest that under high cognitive demand (where face race discrimination is pushed to nearly maximum capacity), other-race faces may still effectively convey race signals, whereas same-race faces may not (de Lissa et al., 2022). The tasks in this experiment were highly demanding, which imposes strict time constraints on face categorization. Additionally, the need to actively counteract a prepotent and automatic response tendency increased cognitive load. Thus, our results support the idea that accuracy becomes the priority when face race processing demands are high.

Following the behavioral study, we adapted the task for EEG. Specifically, we lengthened the inter-trial interval to ensure stable baselines and reduce artifacts, which inevitably reduced time pressure compared to the fast pacing used in Experiment 1. This change in design does not allow to explore the replication of the exact behavioral effect across experiments. Experiment 1 and Experiment 2 are complementary perspectives on how the same conditions manifest under different cognitive loads. Despite this change in design, the direction of results remained consistent with enhanced overall performance when inhibiting to other-race faces as in Experiment 1, albeit the behavioral outcome showed a significant dependence on both RTs and accuracy. This might be due to the slower cadence compared to experiment 1. Accordingly, longer inter-trial intervals facilitate processing (Smith, 1967; Zylberberg et al., 2012) and, by reducing time pressure, create conditions that may favor proactive control, i.e., deliberate slowing to maximize information uptake and increase the likelihood of successful inhibition via a cautious approach (Braver, 2012). Evidence for proactive control pertains to longer foreperiods and is indeed reflected in longer reaction times, possibly pointing to higher stimuli processing or inhibitory needs (Criaud et al., 2012). This sent in contrast to the abrupt, reactive form of stopping, associated with faster pace (Gavazzi et al., 2023), where the chances for preparatory mechanisms are deeply lessened (Braver, 2012). On these grounds, in this experiment we found a pronounced speed-accuracy trade-off, with participants adapting their response time and accuracy based on face race. Correlation analysis revealed that individuals with lower No-Go inhibitory failures to WE faces (pointing to better inhibition, contrary to expectations), used proactive slowing strategies to enhance inhibitory accuracy (Criaud et al., 2012; Standage et al., 2014). This speed-accuracy trade-off translated in enhanced accuracy for same-race stimuli, but slowed response time. On the contrary, participants with a lower cognitive inclination for proactive slowing showed higher inhibitory failures for same-race faces. We integrated this trade-off phenomenon using the RCS index to balance speed and accuracy in the overall cognitive cost of inhibiting same or other-race faces. A higher RCS index emerged for inhibition to EA compared to WE faces, suggesting better inhibitory performance for other-race. Interestingly, this suggests that while the brain attempts compensatory strategies, such as slowing down responses to enhance accuracy for same-race faces, these efforts were not entirely effective, as revealed by the RCS. These findings align with evidence of increased processing demands for same-race faces in psychological refractory period studies (Duncan et al., 2022). The behavioral results of both experiments, although with different behavioral outcomes, suggest that inhibiting responses to faces of different races is less demanding. While outcomes differed in form (accuracy-driven in Experiment 1; accuracy and RTs in Experiment 2), the direction was consistent, pointing to an interaction between race-based processing and the control strategy recruited under different pacing conditions.

Regarding the modulation of electrophysiological correlates examined in Experiment 2, EEG analysis revealed both early (P100) and post-perceptual (No-Go P3) race signal processing. We observed an higher P100 amplitude for EA compared to WE faces over occipito-parietal location. This component is generally associated with enhanced early perceptual processing (Hillyard, Vogel and Luch, 1998). Although the P100 component has shown inconsistent sensitivity to face race differences (Serafini and Pesciarelli, 2023), some studies report an amplitude enhancement for other-race faces, especially when concerning categorization (Anzures et al., 2010; Colombatto and McCarthy, 2017; de Lissa et al., 2024). As the P100 is modulated by selective attention (Desmedt and Tomberg, 1989; Hillyard et al., 1973; Mangun et al., 1993), exhibiting higher amplitude when attended features match the visual input (Luck et al., 2000, 1994; Mangun and Hillyard, 1991; Van Voorhis and Hillyard, 1977), this enhancement may be due to the saliency of other-race features efficiently directing attention toward race-diagnostic cues that are especially relevant during task that requires race categorization (Bundesen, 1990; Duncan and Humphreys, 1989; Wen et al., 2019). This aligns with the face space model and its computational accounts (e.g., neural-network–based approaches; Caldara and Abdi, 2006), which clusters other race faces based on shared salient visual traits (Valentine and Endo, 1992; Valentine and Ferrara, 1991). In parallel, as suggested by some studies, this effect may also relate to and encompasses the P100’s sensitivity to early perceptual strategies, given that other-race faces are more likely to engage featural rather than configural processing (Valentine and Endo, 1992; Zhao and Bentin, 2011), in line with increased P100 amplitude (Hahn et al., 2012; Wang et al., 2020). However, it is important to note that the P100 is sensitive to multiple factors, including positive valence/reward associations (Hickey et al., 2010; Schacht et al., 2012), motivational relevance/selection history (e.g., Anderson, 2016; Bayer et al., 2016), and even low-level perceptual characteristics (Johannes et al., 1995). Each one could amplify early perceptual processing via partly distinct mechanisms. Possibly the same race information may elicit different P100 effects depending on context, motivational states, or the specific cognitive computations required. This broader perspective on the P100 should be considered when interpreting results. Although we observed early modulation at the P100 stage, no cluster-level effects were identified corresponding to typical components such as N170, P200, or N250. Given the mixed - and often task-dependent - nature of race effects on these components (Senholzi and Ito, 2013; Wiese, 2013), their absence in the present study might possibly reflect the specific cognitive demands of our inhibitory task. Here, face race was not a perceptual feature to be encoded by identity or semantically elaborated, but it was the discriminating rule guiding action and inhibition. Under such conditions, early and mid-latency components more linked to structural encoding or identity-related and semantic processing (N170, P200, N250) may be less subjected to modulation, while later components, such as the No-Go P3, might capture more directly the interplay between race-based categorization and inhibitory control.

Shifting to post-perceptual effects, the face-race effect emerged on the No-Go P3 component (Huster et al., 2013; Wessel, 2018) - associated with inhibitory control, with its latency varying due to task design or cognitive load (Luck and Kappenman, 2011). Interestingly, the timing of this component resembles those found in previous Go/No-Go studies using face stimuli in non-race-related categorization tasks (Zhang et al., 2016). The analysis of the No-Go P3 revealed a greater amplitude for EA compared to WE faces within a time window corresponding to the rising phase of the component. This pattern suggests an earlier onset of the P3 when inhibiting to other-race stimuli, as confirmed by the peak latency analysis showing that the No-Go P3 peaked earlier for EA than for WE faces. This pattern may suggest an enhanced inhibitory processing for other-race faces. The extent of the inhibitory advantage at the behavioral level well correlated with neural responses during inhibition. Specifically, a greater behavioral advantage for other-race faces correlated to an increased neural voltage amplitude to other race compared to same-race stimuli, occurring within the time interval and location consistent with the No-Go P3 component. Voltage at a fixed latency indexes the state of the waveform evolution, combining magnitude and temporal phase, so the observed coupling between behavioral and neural effects suggests a more efficient and less effortful engagement of inhibitory control for other-race stimuli. This correlation thus captures the relationship between the magnitude of the behavioral effect and the time-evolving amplitude dynamics that characterize the group-level waveform, providing a coherent account that links behavioral and neural findings. In line with previous work showing that smaller P3 amplitudes are associated with increased cognitive load and poorer performance (Dong et al., 2015; Scharinger et al., 2017), whereas larger P3 responses accompany more efficient control engagement (Zahedi et al., 2020a,b), our results point to facilitated recruitment of inhibitory control for other-race faces as the No-Go P3 unfolds. This result fits within inhibitory literature, where the No-Go P3 potential consistently correlates with behavioral inhibitory measures (Bokura et al., 2001; Gajewski and Falkenstein, 2013; Raud and Huster, 2017; Smith et al., 2008; van Gaal et al., 2009; Wessel and Aron, 2014).

Overall, a pattern consistent with an inhibitory advantage for other-race faces emerged both behaviorally and at the electrophysiological level. Our results are located within previous literature that explored how race processing interacts with cognitive control. Existing studies report that control and attentional systems engage differently depending on face race, often focusing on the other-race effect (ORE). This effect refers to the robust finding that same-race faces are recognized by identity more efficiently than faces of other races (Meissner and Brigham, 2001). The ORE is consistent with similar mechanisms previously described to account for the ORCA. Accordingly, extensive experience with, or motivation to, same-race faces seems to lead to a more precise representation of their identity-diagnostic features, facilitating fine-grained identity recognition. In contrast, other-race faces are often encountered less frequently, so race-related visual features tend to stand out more clearly relative to the familiar same-race face template, making them advantageous for rapid race categorization. At the same time, their features tend to be processed with lower identity-level expertise, resulting in poorer identity recognition (Caldara and Abdi, 2006; Schaller and Caldara, in press; Valentine, 1991; Valentine and Endo, 1992). In this regard, Brown et al. (2017) showed that the ORE in memory reflects a differential allocation of cognitive control during encoding, with same-race faces benefiting from stronger engagement of fronto-parietal control regions, whereas reduced recruitment of these networks predicted memory failures for other-race faces. In their study, participants intentionally encoded face identities. Although race was not explicitly relevant to the task goal, identity encoding requires the engagement of cognitive control processes. Within this context, expertise for same-race faces may facilitate the recruitment of control mechanisms that support identity-level processing. The interaction between race processing and cognitive control has also been explored in the context of inhibitory control. Concerning inhibition, Rubien-Thomas et al. (2021) used a Go/No-Go task where race was orthogonal to the task goal (gender discrimination) and found poorer inhibitory efficiency for Black compared to White faces. Also in their work, race information was not task-relevant, yet it still influenced inhibitory performance. Both behavioral and neural findings led the authors to suggest that socially salient race cues may automatically capture attention, thereby interfering with the goal-directed processes required to implement the task rule. Accordingly, race-related visual information may exert a form of bottom-up attentional capture that competes with task-related top--down control mechanisms, potentially disrupting inhibitory performance. These studies probe different race-related cognitive requirements (memory encoding; inhibition under a race-orthogonal goal) and involve distinct facets of the control-race relationship with task non relevant race processing. Our results provide a complementary perspective to literature showing enhanced inhibitory efficiency for other-race faces when race is task-relevant and tied to the action rule.

Within this task-dependent framework, a possible interpretation for the present experimental results might be that they could reflect our system's heightened sensitivity to face-race cues, particularly those of races different from one's own (de Lissa et al., 2021, 2022; Vizioli et al., 2010b). Because other-race faces are often less familiar, they become more salient during early processing stages, capturing attention and expediting the categorization process (Valentine et al., 2016). In our study, where inhibitory demands were based on categorizing face race, inhibitory action over automatic responses might have been triggered more efficiently for other-race targets. In contrast, decision making for same-race faces appears to require more time, potentially occurring after a sufficient interval for inhibiting dominant response tendencies. Our findings seem possibly in line with this interpretation: the d' score analysis in the first study showed greater discernibility when the inhibitory signal corresponds to other-race faces; while in the second study, the P100 results aligned with this trend. In addition, behavioral results suggested cognitive strategies delaying responses to allow more time for same-race processing. This strategy extends decision making before responses take over. Although this interpretation fits with our data, it should be viewed as tentative and requires further validation. Further studies are needed to confirm this hypothesis. While sensitivity seems relevant, future studies should also examine the possible influence of motivational valence-related, emotional (Hartikainen et al., 2012; Pessoa, 2009; Pessoa et al., 2012; Wilson et al., 2015) or social factors (Kite et al., 2022; Payne, 2001) within these phenomena. Altogether, our results suggest that face race interacts with inhibitory control in a task-relevant manner. Considered alongside previous studies, this finding suggests that the impact of face race on inhibition may partly depend on how task demands require the use of race information. Race cues are salient and may capture attention early on during face processing. When race information is not task-relevant, this salience may interfere with top-down control processes (Rubien-Thomas et al., 2021). Conversely, when race drives task-related processing, as in our case, the same salience may orient cognitive resources towards features that are diagnostic of the response in a bottom-up manner, therefore improving performance.

Although the present findings are limited to controlled experimental conditions, they offer preliminary insight into how inhibitory mechanisms interface with race-related information. Together with prior work, these observations raise questions about potential implications for social cognition, the task-specific cognitive mechanisms involved, and whether similar patterns extend to real-world contexts.

Data and code availability statement

The data and code supporting this study are available from the corresponding author upon request.

CRediT authorship contribution statement

Viola Benedetti: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Peter de Lissa:** Writing – review & editing, Supervision, Methodology, Formal analysis. **Gioele Gavazzi:** Writing – review & editing, Writing – original draft. **Fabio Giovannelli:** Writing – review & editing, Supervision. **Roberto Caldara:** Writing – review & editing, Supervision, Project administration, Conceptualization. **Maria Pia Viggiano:** Writing – review & editing, Supervision, Project administration, Conceptualization.

Declaration of competing interest

The authors declared no potential conflicts of interest.

Acknowledgements

PdL and RC were supported by the Swiss National Science Foundation awarded to RC (100019_189018).

This publication was produced with the co-funding European Union - Next Generation EU, in the context of The National Recovery and Resilience Plan, Investment 1.5 Ecosystems of Innovation, Project Tuscany Health Ecosystem (THE), CUP: B83C22003920001.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.neuroimage.2026.121856.

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