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More elaborate processing of own-race faces and less elaborate processing of other-race faces contribute to the other-race effect in face memory

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Abstract

Research suggests that own-race faces are naturally memorized in a more elaborate (e.g., many features of a face or the whole face) way, whereas other-race faces are memorized in a less elaborate (e.g., only selected features of the face) manner. Here, we tested if instructions for judgements about the whole face and a single facial feature modulated the other-race effect in face memory. White participants performed whole-face and single-feature tasks while memorizing White and Black faces for later recognition. Encoding instructions had a stronger impact on own-race than other-race faces. Whole-face instructions increased the other-race effect, whereas single-feature instructions decreased it. Own-race faces in the whole-face task demonstrated event-related potential (ERP) patterns of memory encoding comparable to previously observed natural memory encoding, suggesting naturally more elaborate encoding of own-race faces. ERPs of memory encoding for other-race faces were similar between task conditions and comparable to previously observed natural encoding patterns, suggesting naturally less elaborate encoding. No impact of the encoding tasks was found on ERPs related to memory retrieval, which may be an artefact of a perceptual task that does not enhance semantic details in memory. The current results indicate

that some contributions to the other-race effect are more elaborate (more detailed) memory encoding for own-race faces and less elaborate (less detailed) memory encoding for other-race faces. This study also provides evidence for more malleability of own-race than other-race faces through task instructions, consistent with assumptions of perceptual learning theories of the other-race effect.

KEYWORDS
elaboration, encoding task, ERP, face, other-race

INTRODUCTION

The other-race effect in face memory, the finding that people are more accurate in recognizing faces of their own race than faces from a different race, is a stable phenomenon (Meissner & Brigham, 2001). The typical pattern of results in a recognition memory task demonstrates increased recognition of previously studied own-race faces and increased false alarms of novel, other-race distracter faces. Theoretical accounts aiming to explain the other-race effect fall into two main areas: perceptual experience and social cognition. Perceptual experience accounts (Meissner & Brigham, 2001; Rossion & Michel, 2011) highlight the importance of perceptual experience with faces in a person's surroundings during development. Most of these experiences involve own-race people leading to higher perceptual expertise with own-race than other-race faces and thus better memory for own-race faces. Evidence for this account illustrates a reversal of the other-race effect following cross-racial adoption (McKone et al., 2019; Sangrigoli et al., 2005), a negative correlation of the other-race effect with experience with another race especially during childhood (McKone et al., 2019), and the malleability of the other-race effect by training efforts (Tanaka et al., 2013). Socio-cognitive accounts (Hugenberg et al., 2010; Levin, 2000; Sporer, 2001) instead highlight the importance of social cognition including prejudice and stereotypes. A negative perception of other-race faces as out-group is proposed to lead to reduced motivation of individualized processing and instead focuses on racial features of other-race faces, which in turn is assumed to lead to poor face memory for these faces. Evidence for the socio-cognitive account showed that instructing people to encode other-race faces at the level of the individual (Hugenberg et al., 2007; Young et al., 2010) or including other-race faces in an arbitrary in-group (Shriver et al., 2008; Shriver & Hugenberg, 2010) eliminates the other-race effect.

Both perceptual experience and socio-cognitive accounts propose very similar mechanisms to underlie the other-race effect. Perceptual expertise with own-race faces has been shown to lead to better holistic processing of own-race than other-race faces (Rossion & Michel, 2011). Holistic processing has been shown to facilitate individuation and recognition of individual people (DeGutis et al., 2013; Harrison et al., 2014) thus leading to better recognition of own-race than other-race faces. In agreement with a perceptual learning assumption, recent studies showed that holistic processing can be engaged for both own-race and other-race faces but correlate more positively with own-race faces recognition (DeGutis et al., 2013; Harrison et al., 2014; Wiese et al., 2009). Socio-cognitive accounts also focus on reduced individuation of other-race faces. The key assumption is that people chose to not holistically process other-race faces, while they possess the capacity for it, which leads to poorer recognition. Independent from theoretical explanations, previous research has started to elucidate the underlying cognitive and neural mechanisms of the other-race effect in face memory. The current study investigates the influence of elaboration during memory encoding (Winograd, 1981) on the other-race effect in behaviour and neural correlates of memory encoding and retrieval.

We previously found evidence that differential levels of elaborate memory encoding may contribute to the other-race effect (Herzmann et al., 2011). The elaboration hypothesis (Winograd, 1981) proposes a direct relationship between successful memory retrieval and the amount of information processed (i.e., elaboration) during memory encoding. Previous research (Bornstein et al., 2012; Winograd, 1981) showed that faces, which were encoded under instructions that required scanning multiple features or the whole face (i.e., more elaboration), were recognized more accurately than those encoded under instructions that focused on one single facial feature (i.e., less elaboration). It can be hypothesized that during memory encoding own-race faces are scanned more comprehensibly leading to a more elaborate representation in memory, whereas other-race faces are scanned less comprehensively leading to a sparse representation in memory. These assumptions show similarities to the holistic and feature-based processing proposed by theories of the other-race effect (Hugenberg et al., 2010; Levin, 2000; Meissner & Brigham, 2001; Rossion & Michel, 2011; Sporer, 2001).

Neural correlates of memory encoding can be measured with the difference due to memory (Dm), a component in the event-related potential (ERP). The Dm consists of brain activation elicited by items during the study phase in a recognition memory experiment. After the conclusion of the experiment, ERPs in the study phase are sorted based on the recognition memory judgements given during the test phase. Contrasting brain activation for subsequently recognized and subsequently forgotten items, the Dm is a positive difference occurring between 400 and 1000 ms over central-parietal areas (Herzmann et al., 2011; Paller et al., 1987). The magnitude of the Dm between recognized and forgotten faces has been shown to be positively correlated with the magnitude of the memory trace (Sommer et al., 1997) indicating it is an indicator of successful memory encoding (Friedman & Trott, 2000; Paller et al., 1987). Using a remember-know paradigm in which participants judge previously studied items as either 'familiar' or 'recollected', research can identify Dms of familiarity and recollection (Friedman & Trott, 2000; Herzmann et al., 2011, 2018), two sub-processes of recognition memory as postulated by the dual-process theory (Yonelinas, 2002). Recollection is the retrieval of a face together with context details, like where it was first seen. Familiarity reflects the recognition of face without retrieval of additional details. Previous research has typically observed a significant Dm for recollection (contrasting subsequently 'recollected' and subsequently 'familiar' faces) but no significant Dm for familiarity (contrasting subsequently 'familiar' and forgotten faces); this pattern of results can also be described in terms of ERP amplitudes which differed significantly between subsequently 'recollected' and subsequently 'familiar' faces, but subsequently 'familiar' and forgotten faces did not show a significant difference (Herzmann et al., 2011; Lucas et al., 2011; Paller et al., 1987; Sommer et al., 1997; Tüttenberg & Wiese, 2021).

Investigating the Dm for recollection and familiarity, we previously found evidence for more efficient and more elaborate memory encoding for own-race but not other-race faces (Herzmann et al., 2011, 2017, 2018). More efficient memory encoding was seen in less positive amplitudes for subsequently 'recollected' own-race faces indicating that less neural activity was necessary to successfully encode own-race faces. This finding is in line with other results showing increased neural activation of perceptual and memory processes for other-race faces (e.g., Herzmann, 2016; Liu et al., 2015). We recently found evidence that more efficient memory encoding may be based on better holistic processing of own-race than other-race faces because only own-race faces were impacted by turning faces upside down during memory encoding and retrieval (Herzmann et al., 2018).

We also found that own-race faces were encoded more elaborately into memory (Herzmann et al., 2011, 2018). More elaborate memory encoding of own-race faces was identified in indistinguishable Dms for recollection and familiarity (Herzmann et al., 2011). Indistinguishable Dms means that brain activation during memory encoding of subsequently recollected own-race faces was similar to that of subsequently familiar own-race faces. This suggests that independent of the type of subsequent retrieval, all subsequently recognized own-race faces were encoded in the same manner. This pattern

of results, where recollection and familiarity show equal neural activation, has previously been seen in studies that used task instructions during memory encoding prompting more elaborate processing (Friedman & Trott, 2000; Smith, 1993). We concluded that own-race faces may naturally, that is by default without any specific task instructions other than the instruction to memorize, be encoded in a more elaborate manner (Herzmann et al., 2011, 2018).

Neural correlates of memory retrieval are measured with old/new effects recorded during the test phase of a recognition memory experiment. Old/new effects contrast brain activation for old as compared to new items and have been found to show specific ERP components for familiarity, the FN400, and recollection, the parietal old/new effect (Curran, 2000; Rugg & Curran, 2007). The FN400 has been inconsistently observed in face recognition studies (Curran & Hancock, 2007; Herzmann et al., 2011, 2017, 2018; Yovel & Paller, 2004). We therefore focus our review on the parietal old/new effect. The parietal old/new effect is measured about 500–900 ms after stimulus onset over parietal locations. It is largest for items judged 'recollected' and smaller for 'familiar' items, which do not differ from new items accurately judged 'new'. Given that recollection reflects the retrieval of items with associated details whereas familiarity reflects the retrieval of items alone, the parietal old/new effect has been taken as an indicator of the amount of detail retrieved from memory (Curran, 2000; Rugg & Curran, 2007). We previously found that the parietal old/new effect was larger for own-race than other-race faces (Herzmann et al., 2011, 2017, 2018) and took it as an indication that retrieval of own-race faces is richer and more detailed. This may be a result of the more elaborate encoding during memory encoding as larger parietal old/new effects were seen following deep processing instructions (Marzi & Viggiano, 2010; Stahl et al., 2010), which have been connected to more elaborate encoding (Winograd, 1981).

No studies have investigated the elaboration hypothesis and the other-race effect. Given that the elaboration hypothesis has been used to explain findings from levels-of-processing studies on face memory (Craik & Lockhart, 1972; Winograd, 1981). We review the levels-of-processing literature as a proxy because deep processing (judgements about personality traits in Burgess & Weaver, 2003; attractiveness in Stahl et al., 2010) requires the scanning of the whole face, whereas shallow processing (judgements about a single perceptual feature in Burgess & Weaver, 2003; race categorization in Stahl et al., 2010) does not. Only two studies have investigated the influences of levels-of-processing on the other-race effect (Burgess & Weaver, 2003; Stahl et al., 2010). Neither of these studies found a significant impact of levels-of-processing on the other-race effect while both replicated the other-race effect and the levels-of-processing effect. Although not discussed in their paper, Stahl et al. (2010) reported reduced memory performance for own-race faces in the shallow as compared to the deep encoding condition, whereas memory performance for other-race faces remained consistent between deep and shallow processing. This provides support for Sporer's (1991) argument that own-race faces are naturally processed on a deep level and further deep processing may not enhance memory performance but shallow processing may reduce it.

Stahl et al. (2010) also report the effects of task instructions on ERPs during the study and test phase. In the study phase, the deep encoding task equated brain activation for own-race and other-race faces for the P2 ERP component, a neural correlate of perceptual encoding, and the late positive complex, a neural correlate of stimulus evaluation, suggesting that deep processing during memory encoding boosted neural processing for other-race faces. During the test phase, old/new effects were larger for own-race than other-race faces in the deep encoding task but indistinguishable in the shallow encoding task. This suggested that the shallow task reduced the memory advantage of own-race faces. It also suggested that the enhanced processing of other-race faces during memory encoding did not translate into facilitation during memory retrieval as evidenced by smaller old/new effects and comparable memory performance in the deep and shallow tasks. Stahl et al. (2010) argue that the perceptual and memory system for other-race faces is not sufficiently developed to benefit from deeper processing during memory encoding to successfully store these faces. Similar results have been found recently (Tüttenberg &

Wiese, 2021) where own-race and other-race faces were memorized under natural (no instruction) conditions or individuation instructions that emphasized the other-race effect and required participants to put effort into recognizing other-race faces. The Dm during memory encoding was larger for other-race faces in the individuating condition than in the natural condition. However, memory performance did not consistently benefit from this enhancement.

Taken together, previous findings suggest that own-race faces may be naturally processed at a deep or more elaborate level, whereas other-race faces may be naturally processed at a shallow or less elaborate level and may not benefit from deep processing because of insufficiently developed perceptual and memory systems (Stahl et al., 2010; Tüttenberg & Wiese, 2021). Previous studies also showed that the other-race effect was relatively robust against task instructions that manipulated levels of processing during memory encoding (Burgess & Weaver, 2003; Stahl et al., 2010; Tüttenberg & Wiese, 2021).

The current study investigated the impact of differences in elaboration during memory encoding on the other-race effect in behaviour and neural correlates of memory encoding (Dm) and memory retrieval (old/new effects). Our research goal was to test the assumption that natural memory encoding of own-race faces reflects more elaborate processing and that natural memory encoding of other-race faces reflects less elaborate processing, both of which are assumed to contribute to the other-race effect in face memory. White participants memorized Black and White faces while engaged in either a whole-face or single-feature processing task. The whole-face task used a distinctiveness-judgement task, which has been shown to rely on the information of the whole face (Santos & Young, 2011). The single-feature task emphasized attention to one facial feature. We interpret the whole-face processing task as representing more elaborate processing and the single-feature processing task as representing less elaborate processing. This is based on Winograd's (1981) definition of elaboration as the processing of an increasing number of features and the evidence Santos and Young (2011) presented that distinctiveness judgements (as used in the whole-face task) rely on the information of the whole face. As such, the single-feature processing task can be assumed to involve less elaborate processing than the whole-face task because more features of the face, according to Santos and Young (2011) supposedly the whole face, needed to be considered in the whole-face task.

If natural, that is default, memory encoding of own-race faces reflects more elaborate processing, we hypothesized that in the whole-face processing task we would find results identical to the patterns of the Dm and old/new effects for own-race faces from our previous studies (Herzmann et al., 2011, 2017, 2018). For own-race faces in the single-feature processing task, we expected to see patterns of the Dm that resembled those of other-race faces in the single-feature processing task because task instructions would prevent the naturally occurring more elaborate processing (Stahl et al., 2010). If natural memory encoding of other-race faces reflects less elaborate processing, we assumed that in the single-feature processing task we would find results identical to the patterns of the Dm and old/new effects for other-race faces from our previous studies (Herzmann et al., 2011, 2018). This prediction was also based on the finding that other-race faces have been shown to be processed less holistically in conditions where no task emphasized processing of the whole face (Rossion & Michel, 2011). In the whole-face processing task, other-race faces were assumed to not benefit from more elaborate processing and show similar patterns as in the single-feature processing task because the perceptual and memory system for other-race faces have been found to be not sufficiently developed for enriched memory encoding (Stahl et al., 2010; Tüttenberg & Wiese, 2021). This assumption reflects similarities to perceptual expertise accounts (Meissner & Brigham, 2001; Rossion & Michel, 2011) which postulate less developed perceptual learning mechanisms for other-race faces. However, following socio-cognitive accounts (Hugenberg et al., 2010; Levin, 2000; Sporer, 2001) and evidence that showed an amelioration of the other-race effect based on task instructions (Hugenberg et al., 2007; Young et al., 2010), other-race faces in the whole-face processing task would be expected to show similar patterns of Dms and old/new effects as own-race faces in the whole-face processing task.

METHOD

Method

Participants

Thirty-three healthy, right-handed, Caucasian adults (16 men; mean age 20.8 ± 2.9) volunteered for this study. All participants had normal or corrected to normal vision. The study was approved by the Institutional Review Board and was conducted in accordance with the Declaration of Helsinki. All participants gave written informed consent and were paid for their participation.

Materials

Stimuli were taken from the MORPH database, which is composed of public records images from the United States (Ricanek & Tesafaye, 2006). Coloured images of 360 (180 female) White and 360 Black (180 female) faces were included in the experiment (Figure 1). Another set of 30 faces (15 White and 15 Black) was used for practice trials. Faces were edited to only include face and hair; no neck, background, or clothing were visible. No faces had beards or glasses. Portraits were shown on a uniform grey background. Images were 180 by 227 pixels (3.4° by 4.8° visual angle). All faces showed neutral or weakly smiling expressions. Stimuli were viewed at a distance of 1 m on a 17-inch flat-panel LCD monitor (Dell Professional P170S, refresh rate 60 Hz). Stimulus presentation and EEG recording were time-locked to the refresh point.

Procedure

The experiment setup followed our previous studies (Herzmann et al., 2011, 2018). It was slightly longer than our 2011-study and had 12 instead of eight study blocks to accommodate the experimental manipulations of encoding tasks. The present study and 2018 study included half the number of non-studied faces as studied faces, whereas the 2011 study had equal numbers of non-studied and studied faces. During the study, images were displayed for 1500 ms instead of 2000 ms, which again followed our 2018-study.

The experiment consisted of 12 study blocks followed immediately by their corresponding recognition blocks. Equal numbers of Black and White faces were presented intermixed in all blocks. Forty targets had to be memorized in each study block: 20 under single-feature task conditions and 20 under whole-face task conditions, which were presented intermixed. In the subsequent recognition block, the 40 studied faces were randomly presented with 20 new, unfamiliar distracters. Face stimuli were randomly assigned to either the whole-face or single-feature task and as either targets or distracters for each participant. Short breaks were allowed within study blocks, between study and recognition blocks, and within recognition blocks to allow the participants to rest their eyes. Longer breaks were allowed before each new study block.

Each trial in the study blocks started with a fixation cross for 200 ms, followed by the presentation of the study-task prime (airport or nose, in Times New Roman, point 20) for 300 ms, followed by the presentation of a target face for 1500 ms, and followed by the prompt for the study-task response, which remained on the screen until a response was made. Participants were instructed to pay attention to the study-task prime, judge the following faces depending on the task, and withhold their response until the response options appeared. This was done to minimize movement-related artefacts. In the airport-task, participants responded using their index fingers with button presses representing 'hard' or 'easy' on whether it would be hard or easy to recognize this face at a crowded airport. In the nose-task, participants responded using their index fingers with button presses
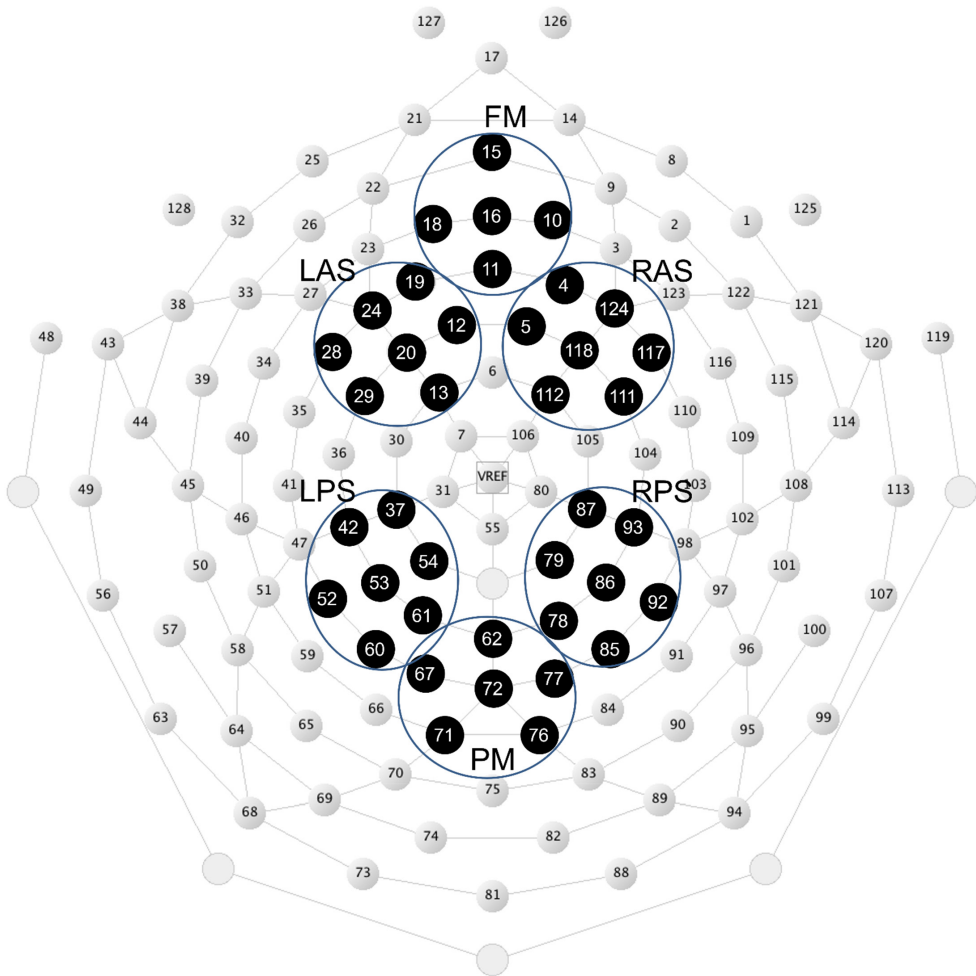
FIGURE 1 Geodesic sensor net layout. Electrode sites are numbered. Black clusters are regions of interest included in analyses. LAS, left anterior superior; RAS, right anterior superior; FM, frontal medial; LPS, left parietal superior; PM, parietal medial; RPS, right parietal superior

representing 'big' or 'small' on whether the nose of this face is big or small. Finger-to-response mapping was counterbalanced.

Each trial in the recognition blocks started with the presentation of a fixation cross for 200 ms, followed by a target or a distracter for 1200 ms. Again, participants were asked to withhold their response until the five response options appeared on the screen 1200 ms after the target onset. At that point, a horizontal, four-point rating scale and an additional square appeared on the screen below the stimulus. The rating scale consisted of four squares labelled 'definitely unfamiliar', 'maybe unfamiliar', 'maybe familiar', and 'definitely familiar'. The additional square was labelled 'recollect' (following Woodruff et al., 2006). For half of the participants, the following response button assignment was used: 'recollect' – right index finger, 'definitely familiar' – left index finger, 'maybe familiar' – left middle finger, 'maybe new' – left ring finger, and 'definitely new' – left pinky. For the other half of the participants, this assignment of hand to recollection or familiarity assignment was reversed to avoid motor planning activity impacting overall ERPs. Participants used a computer keyboard to make their responses. The interval between the response and the next fixation cross was 500 ms. One study phase lasted about 3 min and one test phase about 8 min.

TABLE 1 Means and standard deviations for the number of trials in each condition

| | Whole-face encoding task | | | | | | Single-feature encoding task | | | | | |
| | Study | | | Test | | | Study | | | Test | | |
	Recollect	Familiar	Forgotten	Recollect	Familiar	Correct rejection	Recollect	Familiar	Forgotten	Recollect	Familiar	Correct rejection
Cau Faces	56 (26)	37 (21)	26 (10)	56 (26)	37 (21)	87 (12)	39 (24)	39 (18)	42 (14)	39 (19)	39 (18)	87 (12)
AfA Faces	41 (21)	46 (20)	33 (12)	41 (21)	46 (20)	74 (19)	27 (13)	49 (20)	43 (15)	27 (13)	49 (20)	74 (19)

Abbreviations: AfA = African-American faces; Cau = Caucasian faces.

Correct rejections in the current study are not specific to whole-face or single-feature encoding. They are duplicated here for easier reading.

Before the experiment, participants received instructions and three kinds of practice trials. First, participants practice the nose task with six target-faces and three distracters. Then, they practiced the airport task with a different set of six target-faces and three distracters. Finally, they practiced both tasks in the intermixed design with yet another set of eight target-faces and four distracters. In addition to practicing the study task, participants practiced making 'recollect' and 'familiar' memory judgements and received feedback for their responses. The recollection was explained as consciously remembering specific details of the appearance of a face or of the experience learning it in the study phase: something else that happened in the room, what the participants were thinking or doing, an association that came to mind, or what came just before or after that item. In the case that they did not recollect a face, they were asked to rate the familiarity. They were told to use 'definitely familiar' or 'maybe familiar' if they believed that they had seen the face in the study phase but could not consciously remember anything particular about its appearance or the experience learning it. 'Maybe unfamiliar' or 'definitely unfamiliar' were to be used if they did not recognize the item from the study phase. Participants were encouraged to make their responses according to their first impression, without a time limit.

Performance measurement

For recognition memory performance, we considered the area below the receiver operating characteristic (ROC) curve, (P[A], Green & Swets, 1966), response bias c_a (positive values indicate a liberal response bias or saying 'old' more often than 'new' to all items and negative values indicate a conservative response bias or saying 'new' more often than 'old' to all items), and percent of hits as well as percent of false alarms of 'recollect' and 'familiar' responses. ROC curves were computed from all five possible response options, with 'recollect' responses treated as reflecting higher confidence than 'definitely familiar' responses. We interpreted raw 'recollect' judgements as corresponding to recollection. The raw 'familiar' condition (i.e., 'maybe familiar' and 'definitely familiar') cannot be taken as a direct reflection of familiarity because these responses are contingent upon non-recollection. We thus calculated the independent remember/know (IRK) estimate of familiarity (IRK = $F/[1 - R]$), where F refers to raw 'familiar' responses and R to raw 'recollect' responses (Yonelinas, 2002) for hits and false alarms in the 'familiar' condition.

Event-related recording and measurement

EEG data were recorded in the study and recognition test phase with a 128-channel Geodesic Sensor Net™ (HydroCel GSN 128 1.0, Tucker, 1993) connected to an AC-coupled, 128-channel, high-input impedance amplifier (200 MΩ, Net Amps™, Electrical Geodesics Inc.). Amplified analog voltages (0.1–100 Hz bandpass) were digitized at 250 Hz. The recording reference was the vertex channel (Cz). Individual sensors were adjusted until impedances were less than 50 kΩ.

Epochs of 1300 ms for study-phase and test-phase faces, each starting 100 ms before stimulus onset, were generated offline from the continuous record. Horizontal and vertical eye movements were corrected using the ocular correction ICA transformation in Brain Vision Analyser 2.2 (Brain Products GmbH). Trials with non-ocular artefacts were discarded. ERPs were aligned to a 100-ms baseline before target onset, averaged separately for each channel and condition, digitally low-pass filtered at 40 Hz, and recalculated to average reference. A minimum of 15 trials per condition was ensured for each participant (see Table 1 for the mean and standard deviation of trial counts for each condition).

Time segments and regions of interest (ROIs, see Figure 1) were defined according to previous research (Herzmann et al., 2011, 2018). Mean amplitudes were computed by averaging the channels within each ROI for each condition and participant. Time segments and regions of interest are given in Section 3.

TABLE 2   Indicators of behavioural memory performance for own-race and other-race faces in the current experiment (two left columns)

	Whole-face encoding task			Single-feature encoding task			Herzmann et al. (2018), Exp. 1[a]			Herzmann et al. (2018), Exp. 2[b]			Herzmann et al. (2011)[c]		
	Cau	AfA	d_ave	Cau	AfA	d_ave	Cau	Chin	d_ave	Cau	AfA	d_ave	Cau	Chin	d_ave
P(A)	0.82 (0.08)	0.74 (0.09)	1.84***	0.74 (0.09)	0.66 (0.07)	1.44***	0.83 (0.08)	0.73 (0.10)	1.11***	0.88 (0.08)	0.82 (0.08)	0.75***	0.77 (0.09)	0.68 (0.08)	1.06***
c_a	−0.13 (0.32)	−0.17 (0.40)	0.15	0.13 (0.34)	−0.05 (0.34)	1.35***	−0.02 (0.35)	−0.13 (0.42)	0.29	0.00 (0.30)	0.00 (0.39)	0.00	−0.07 (0.33)	−0.07 (0.39)	0.02
Hit 'recollect'	0.48 (0.20)	0.34 (0.17)	1.32***	0.32 (0.20)	0.22 (0.13)	0.84***	0.48 (0.19)	0.31 (0.20)	0.87***	0.47 (0.20)	0.36 (0.20)	0.55***	0.35 (0.16)	0.24 (0.16)	0.69***
Hit IRK 'familiar'	0.57 (0.20)	0.57 (0.19)	0.01	0.52 (0.18)	0.47 (0.15)	0.38*	0.56 (0.16)	0.57 (0.19)	0.06	0.64 (0.15)	0.61 (0.14)	0.21	0.57 (0.16)	0.55 (0.15)	0.13
FA 'recollect'	0.06 (0.09)	0.07 (0.11)	−0.14	0.06 (0.09)	0.07 (0.11)	−0.14	0.05 (0.06)	0.06 (0.07)	0.15	0.02 (0.03)	0.03 (0.04)	0.29	0.04 (0.08)	0.05 (0.11)	0.10
FA IRK 'familiar'	0.23 (0.11)	0.34 (0.17)	1.04***	0.23 (0.11)	0.34 (0.17)	1.04***	0.17 (0.10)	0.24 (0.15)	0.56***	0.21 (0.14)	0.34 (0.17)	0.83***	0.30 (0.13)	0.37 (0.14)	0.52***

Note: Provided are also performance parameters from previous, comparable experiments. Cohen's d_average, a measure of effect size for highly correlated data that uses the average standard deviation as the denominator (Cumming, 2012), gives the effect size of the other-race effect for each condition. Grey shading highlights the two measures where the other-race effect was influenced by the encoding tasks (i.e., a race × condition interaction). Standard deviations are given in parentheses

Abbreviations: AfA, African-American faces; Cau, Caucasian faces; Chin, Chinese faces; FA, False Alarms.

False alarms in the current study are not specific to whole-face or single-feature encoding. They are duplicated here for easier reading. ***p < .001, *p < .05.

[a]Data presented for the focused attention condition of Exp. 1, no encoding task, Caucasian participants.

[b]Data presented for the upright stimulus-presentation condition of Exp. 2, no encoding task, Caucasian participants.

[c]Data presented for Caucasian participants, no encoding task.

RESULTS

In all statistical analyses, post-tests that followed up on any significant main effect or interaction were Bonferroni-corrected for multiple comparisons. All *p*-values associated with more than one degree of freedom were corrected according to the Huynh and Feldt (1976) procedure for sphericity violations, but we report uncorrected degrees of freedom. We report only Bonferroni-corrected *p*-values for post-tests. Effect sizes are given as Cohen's *d* or partial eta-squared (η_p^2).

Memory performance

Table 2 summarizes the indicators of memory performance in the whole-face and single-feature task conditions. The table also provides information on the same performance indicators from previous studies (Herzmann et al., 2011, 2018) including only Caucasian participants and conditions that represent natural, not experimentally instructed encoding (e.g., no encoding task, upright presentation, and no distracting task). Figures 2 and 3 illustrate the behavioural results for the area below the ROC curve, (P[A], Green & Swets, 1966) and hit recollect, respectively.

The whole-face task led to more accurate memory performance than a single-feature task. Memory performance was more accurate for Caucasian than African American faces. Completing either a whole-face or single-feature task during encoding influenced memory performance for Caucasian and African American faces differently in only two measures: response bias and hit recollect. Statistical analysis using repeated measures ANOVAs with the within-subject factors race (Caucasian, African American) and condition (whole-face, single-feature) confirmed these observations by showing significant main effects of condition and race, as well as a significant condition × race interaction for response bias and a trend for such interaction for hit, recollect (Table 2; Figures 2 and 3).

Completing a whole-face task during memory encoding increased subsequent memory performance as measured with the area below the ROC curve (P[A] in Table 2 and Figure 2), hit recollect (Figure 3), and hit IRK familiar, $Fs(1,32) = 125.0, 107.5,$ and $24.3, ps = .0001, \eta_p^2s = 0.80, 0.77,$ and 0.43. The whole-face task also caused a more liberal response bias, or a tendency to say 'old' to faces during retrieval test, $F(1,32) = 93.2, p = .0001, \eta_p^2 = 0.74$.

Caucasian faces were recognized more accurately than African American faces as shown by the area below the ROC curve (Figure 2), hit recollect (Figure 3), hit IRK familiar, and false alarms IRK familiar, $Fs(1,32) = 122.6, 45.9, 4.2,$ and $35.5, ps = .0001, .0001, .048,$ and $.0001, \eta_p^2s = 0.79, 0.59, 0.12,$
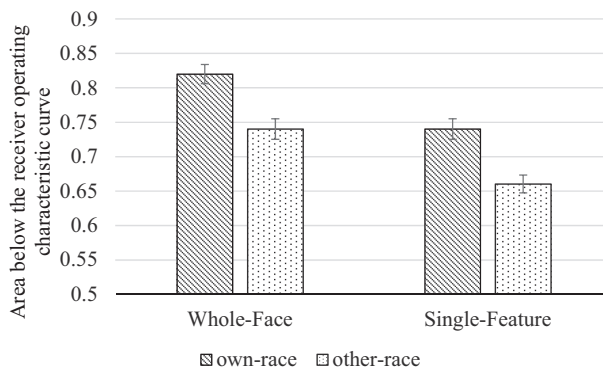

FIGURE 2 Memory recognition performance (M and SE) measured as the area below the ROC curve, (P[a], Green & Swets, 1966), computed from all five possible response options, with 'recollect' responses treated as reflecting higher confidence than 'definitely familiar' responses
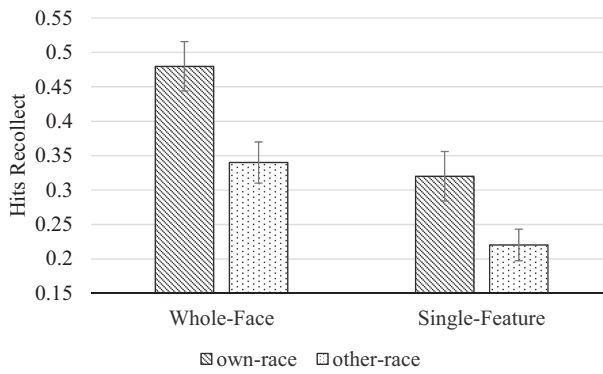
FIGURE 3 Memory recognition performance (M and SE) measured as hit recollect. We interpreted raw 'recollect' judgements as corresponding to recollection

and 0.53. The main effect of race was also significant for the response bias, $F(1,32) = 16.1$, $p = .0001$, $\eta_p^2 = 0.34$, but further qualified by a significant condition × race interaction.

The significant condition × race interaction for response bias c, $F(1,32) = 6.7$, $p = .014$, $\eta_p^2 = 0.17$, indicated that in the single-feature processing task Caucasian faces were judged with a conservative response bias whereas African American faces were judged with a liberal response bias, $t(32) = 7.7$, $p = .0002$, $d = 1.35$ (Table 2). In the whole-face processing task Caucasian and African American faces were both judged with a liberal response bias, $p = .81$, which in each case was more liberal than in the single-feature task, ts(32) = 6.9 and 3.9, ps = .0002 and .002, ds = 1.20 and 0.67, for Caucasian and African American, respectively (Table 2).

The trend for a significant condition × race interaction for hit recollect (Figure 3), $F(1,32) = 3.6$, $p = .066$, $\eta_p^2 = 0.10$, indicated that the difference in hit recollect between Caucasian and African American faces (i.e., the other-race effect) tended to be larger in the whole-face processing task than the single-feature processing task although it was significant in both, ts(32) = 7.6 and 4.8, ps = .0002 and .0002, ds = 1.32 and 0.84, for whole-face and single-feature processing task, respectively.

ERP correlates of memory encoding

Figures 4 and 5 show mean ERP amplitudes and topographies of the Dms (difference waveforms) for Caucasian and African American faces during memory encoding. Figures 6 and 7 illustrate the significant impact of different levels of elaborative processing on own-race and other-race faces. The Dms in the study phase were measured between 600 and 1000 ms. This time segment is the same as in our 2011-study (Herzmann et al., 2011) and similar to our 500–900 ms segment in our 2018-study (Herzmann et al., 2018). ROIs were LAS, FM, RAS, LPS, PM, and RPS (see Figure 1). These ROIs correspond roughly to those used in Herzmann et al. (2011), taking into consideration that a different electrode montage was used, and also correspond to Herzmann et al. (2018) with the exception of including FM instead of CM because the present data showed dominant frontal involvement. Repeated measures ANOVAs were calculated with the within-subject factors hemisphere (left, middle, right), anterior–posterior (anterior, posterior), race (Caucasian, African-American), condition (whole-face, single-feature), and memory judgement ('recollected' and 'familiar' for recollection; 'familiar' and forgotten for familiarity).

The Dms for recollection, contrasting subsequently 'recollected' and 'familiar' faces, yielded a significant main effect of memory (Figures 4 and 5), $F(1,32) = 10.1$, $p = .003$, $\eta_p^2 = 0.24$. Dms for Caucasian and African American faces were distributed differently as indicated by a significant memory × race × anterior/posterior interaction, $F(1,32) = 5.8$, $p = .022$, $\eta_p^2 = 0.15$, and a significant memory × race × anterior/

posterior × hemisphere interaction, $F(2,64) = 5.0$, $p = .012$, $\eta_p^2 = 0.14$. These interactions were further qualified by a significant 5-way interaction including condition, $F(2,64) = 5.7$, $p = .005$, $\eta_p^2 = 0.15$. This 5-way interaction can be scrutinized from the perspective of the other-race effect, focusing on differences between Caucasian and African American faces (Figure 6). It can also be analysed from the perspective of the influence of elaboration on memory encoding for Caucasian and African American faces (Figure 7).

Looking at the other-race effect, Dms for Caucasian and African American faces differed significantly in the whole-face, $F(2,64) = 9.9$, $p = .0002$, $\eta_p^2 = 0.24$, but not in the single-feature processing task, $p = .65$. In the whole-face processing task, the Dm for Caucasian faces was significantly more positive than the Dm for African American faces over left anterior (LAS) and middle anterior (FM) locations, $Fs(1,32) = 7.3$ and 11.8, $ps = .033$ and $.006$, $\eta_p^2 s = 0.19$ and 0.27 (Figure 6).

Focusing on the impact of elaboration during encoding for each race, Dms for Caucasian, $F(2,64) = 4.3$, $p = .044$, $\eta_p^2 = 0.12$, but not African American faces, $p = .54$, were significantly different between whole-face and single-feature task (Figure 7). Dms for Caucasian faces were significantly
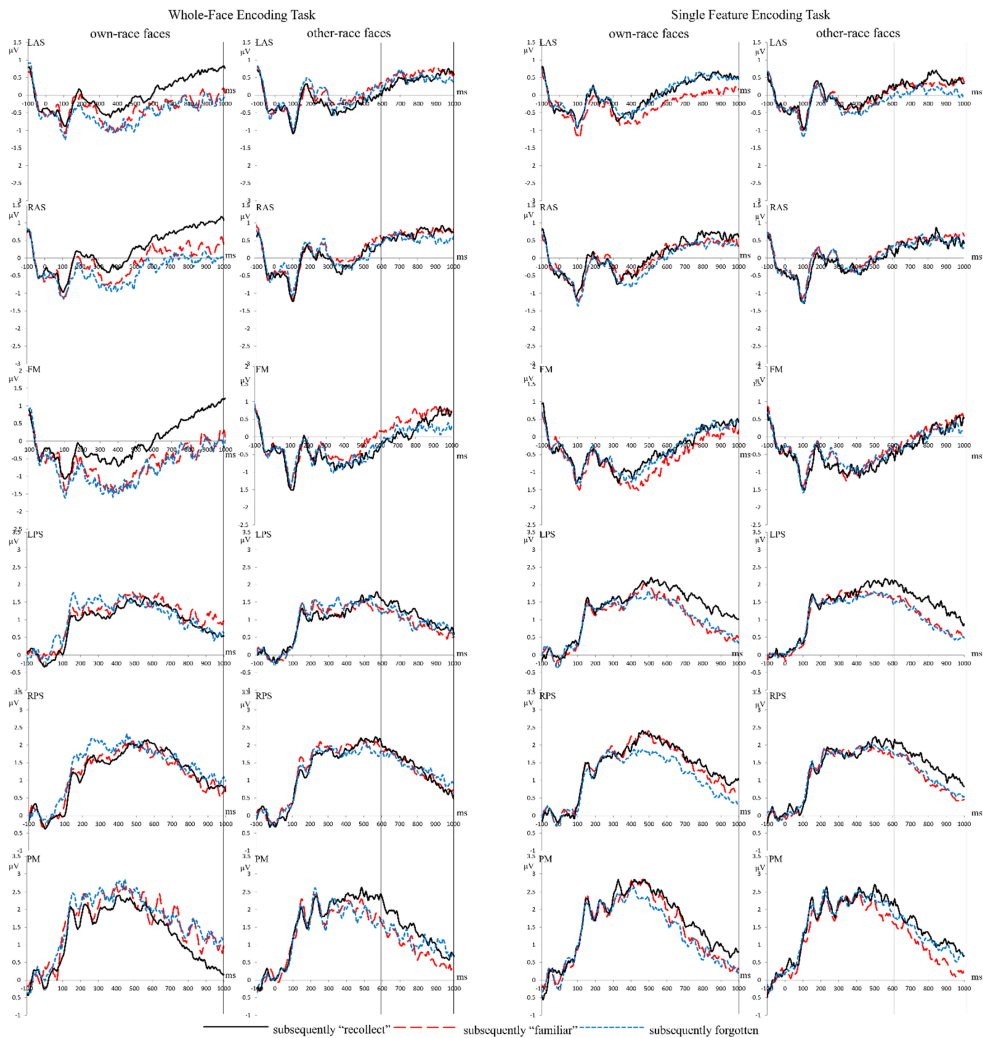

FIGURE 4 Mean amplitudes from the study phase depicting encoding-related brain activation for subsequently 'recollected', 'familiar', and subsequently forgotten own-race and other-race faces for the whole-face and single-feature processing tasks. Vertical lines highlight the time segment of 600–1000 ms used for statistical analyses
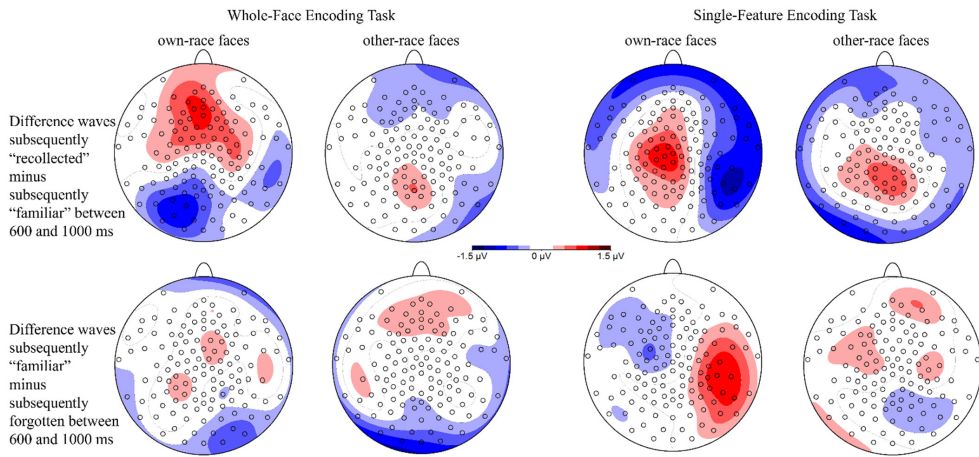
FIGURE 5 Voltage maps of ERP difference waves between subsequent memory judgements showing Dms at 600–1000 ms for own-race and other-race faces in the whole-face and single-feature processing tasks. Spherical spline interpolation was used
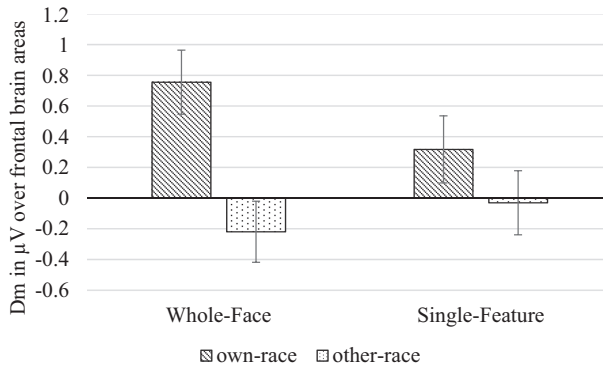

FIGURE 6 Frontal brain activation (M and SE, in μV) for the recollection related dm (i.e., difference measure between subsequently 'recollected' and subsequently 'familiar') averaged over left (LAS) and middle (FM) anterior recording sites showing that in the whole-face but not single-feature processing task Dms for own-race and other-race faces differed significantly

more positive in the single-feature than the whole-face processing task over left posterior (LPS) and middle posterior (PM) recording sites, $Fs(1,32) = 13.0$ and $6,5$, $ps = .003$ and $.042$, $\eta_p^2s = 0.29$ and 0.17 (Figures 4, 5, and 7).

The Dm for familiarity, contrasting subsequently 'familiar' and forgotten faces, did not yield a significant main effect or significant interactions with the memory factor, $ps > .08$, thus no familiarity-related Dm was observed (Figure 5). The mean amplitudes for subsequently 'familiar' and subsequently forgotten faces yielded a significant main effect of race, $F(1,32) = 4.2$, $p = .049$, $\eta_p^2 = 0.11$, indicating that amplitudes for African American faces were significantly more positive than those for Caucasian faces (Figure 4). The significant race × condition interaction, $F(1,32) = 4.0$, $p = .053$, $\eta_p^2 = 0.11$, showed that African American faces elicited significantly more positive amplitudes than Caucasian faces in the whole-face, $F(1,32) = 6.4$, $p = .032$, $\eta_p^2 = 0.17$, but not the single-feature processing task, $p = .92$. The significant race × condition × anterior/posterior, $F(1,32) = 4.3$, $p = .047$, $\eta_p^2 = 0.12$, and race × condition × hemisphere × anterior/posterior interactions, $F(2,64) = 5.2$, $p = .009$, $\eta_p^2 = 0.11$, showed that in the whole-face but not the single-feature processing task amplitudes for African American faces were
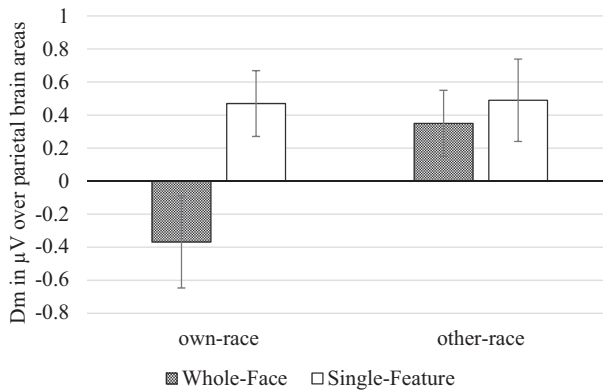
FIGURE 7 Parietal brain activation (M and SE, in μV) for the recollection related dm (i.e., difference measure between subsequently 'recollected' and subsequently 'familiar') averaged over left (LPS) and middle (PM) posterior recording sites showing that Dms for own-race but not other-race faces differed significantly between the whole-face and single-feature processing task

significantly more positive than those for Caucasian faces LAS, FM, and right anterior (RAS) recording sites, $Fs(1,32) = 18.1, 9.8$, and 6.1, $ps = .0002, .008$, and $.038$, $\eta_p^2s = 0.36, 0.23$, and 0.16 (Figure 4).

ERP correlates of memory retrieval

Figures 8 and 9 show mean ERP amplitudes and topographies of the old/new effects (difference waveforms) for Caucasian and African American faces during memory retrieval. The old/new effects in the test phase were measured in three-time segments, 300–600, 600–900, and 900–1200 ms, which were the same as in our previous studies (Herzmann et al., 2011, 2018). ROIs were the same as in the study phase, LAS, FM, RAS, LPS, PM, and RPS, and corresponded roughly with our previous studies (Herzmann et al., 2011, 2018, see Section 3.2 for a description of comparisons). For the recollection contrast ('recollect' vs. 'familiar'), repeated measures ANOVAs were calculated with the within-subject factors hemisphere (left, middle, right), anterior–posterior (anterior, posterior), race (Caucasian, African American), condition (whole-face, single-feature), and memory judgement ('recollected' and 'familiar'). Given the intermixed presentation of targets and distracters during the test phase, correctly judged distracters cannot be assigned logically to either the whole-face or the single-feature processing tasks. Therefore, the ANOVA for the familiarity contrast ('familiar' vs. correct rejections) combined the condition and memory judgement factors into a single variable: memory-condition (whole-face, familiar; single-feature, familiar; correct rejection).

Old-new effects between 300 and 600 ms

The old/new effect for recollection, contrasting 'recollected' and 'familiar' old faces, showed a trend for a significant race × anterior/posterior interaction, $F(1,32) = 3.9$, $p = .058$, $\eta_p^2 = 0.11$, because amplitudes tended to be more positive for African American than Caucasian faces over anterior, $F(1,32) = 5.0$, $p = .064$ (uncorrected .032), $\eta_p^2 = 0.14$, but not posterior recording sites, $p = .60$. The trend for a significant race × memory judgement interaction, $F(1,32) = 3.6$, $p = .066$, $\eta_p^2 = 0.10$, indicated a significant recollect/familiar effect for Caucasian, $F(1,32) = 6.1$, $p = .038$, $\eta_p^2 = 0.16$, but not African American faces, $p = .99$ (Figures 8 and 9). No main effect of or interaction with the factor condition was observed, all $ps > .10$.

The old/new effects for familiarity, contrasting 'familiar' old and correctly rejected new faces, yielded a significant main effect of race, $F(1,32) = 13.2$, $p = .001$, $\eta_p^2 = 0.29$, because African American faces elicited more positive amplitudes than Caucasian faces (Figure 8). No main effect of or interaction with the factor condition was observed, all $ps > .13$.

Old-new effects between 600 and 900 ms

The old/new effect for recollection, contrasting 'recollected' and 'familiar' old faces, showed a significant main effect of memory, $F(1,32) = 7.4$, $p = .011$, $\eta_p^2 = 0.19$, which was further qualified by a significant memory × anterior/posterior interaction, $F(1,32) = 8.0$, $p = .008$, $\eta_p^2 = 0.20$, indicating that old/new effects were significant over posterior, $F(1,32) = 13.1$, $p = .002$, $\eta_p^2 = 0.29$, but not over anterior recording sites, $p = .82$ (Figures 8 and 9). No main effect of or interaction with the factor condition was observed, all $ps > .11$.

The old/new effects for familiarity, contrasting 'familiar' old and correctly rejected new faces, yielded a significant main effect of race, $F(1,32) = 4.2$, $p = .049$, $\eta_p^2 = 0.12$ because African American faces elicited more positive amplitudes than Caucasian faces (Figure 8). No main effect of or interaction with the factor condition was observed, all $ps > .07$.

Old-new effects between 900 and 1200 ms

The old/new effect for recollection, contrasting 'recollected' and 'familiar' old faces, did not yield a significant main effect or significant interactions with the memory factor, $ps > .09$, thus no old/new effects related to recollection were observed. The mean amplitudes for 'recollected' and 'familiar' faces yielded a significant race × anterior/posterior interaction, $F(1,32) = 13.6$, $p = .001$, $\eta_p^2 = 0.30$, because African American as compared to Caucasian faces elicited more negative amplitudes over anterior, $F(1,32) = 5.7$, $p = .046$, $\eta_p^2 = 0.15$, and more positive amplitudes over posterior recording sites, $F(1,32) = 13.4$, $p = .002$, $\eta_p^2 = 0.30$. The significant race × condition × anterior/posterior × hemisphere interaction, $F(1,32) = 4.8$, $p = .013$, $\eta_p^2 = 0.13$, showed that over anterior middle recording sites, $F(1,32) = 6.3$, $p = .036$, $\eta_p^2 = 0.16$, amplitudes were more positive for Caucasian than African American faces in the single-feature processing task, $F(1,32) = 12.8$, $p = .003$, $\eta_p^2 = 0.29$, but were indistinguishable in the whole-face processing task, $p = .79$. No other recording site showed a race × condition interaction, $ps > .48$ (Figure 8).

The old/new effects for familiarity, contrasting 'familiar' old and correctly rejected new faces, yielded a significant race × memory-condition × anterior/posterior × hemisphere interaction, $F(4,128) = 3.3$, $p = .026$, $\eta_p^2 = 0.09$, but none of the post-tests were conclusive.

DISCUSSION

This study tested the assumption that natural memory encoding, that is default memory encoding without any encoding task, of own-race faces reflects more elaborate processing and natural memory encoding of other-race faces reflects less elaborate processing, both of which are assumed to contribute to the other-race effect in face memory (Meissner & Brigham, 2001; Rossion & Michel, 2011). Neural correlates of memory encoding confirmed these predictions. For own-race faces in the whole-face processing task similar patterns of brain activation were found over parietal brain areas (Figures 5 and 7) as in previous studies (Herzmann et al., 2011, 2018) suggesting naturally more elaborate encoding. Brain activation for own-race faces in the whole-face processing task showed larger activation over prefrontal areas (Figures 5 and 6) reflecting enhanced processing during the whole-face task in line with previous observations (Bernstein et al., 2002; Wig et al., 2004). In the single-feature task, patterns of brain activation for own-race faces resembled those of other-race faces (Figure 5) indicating that single-feature
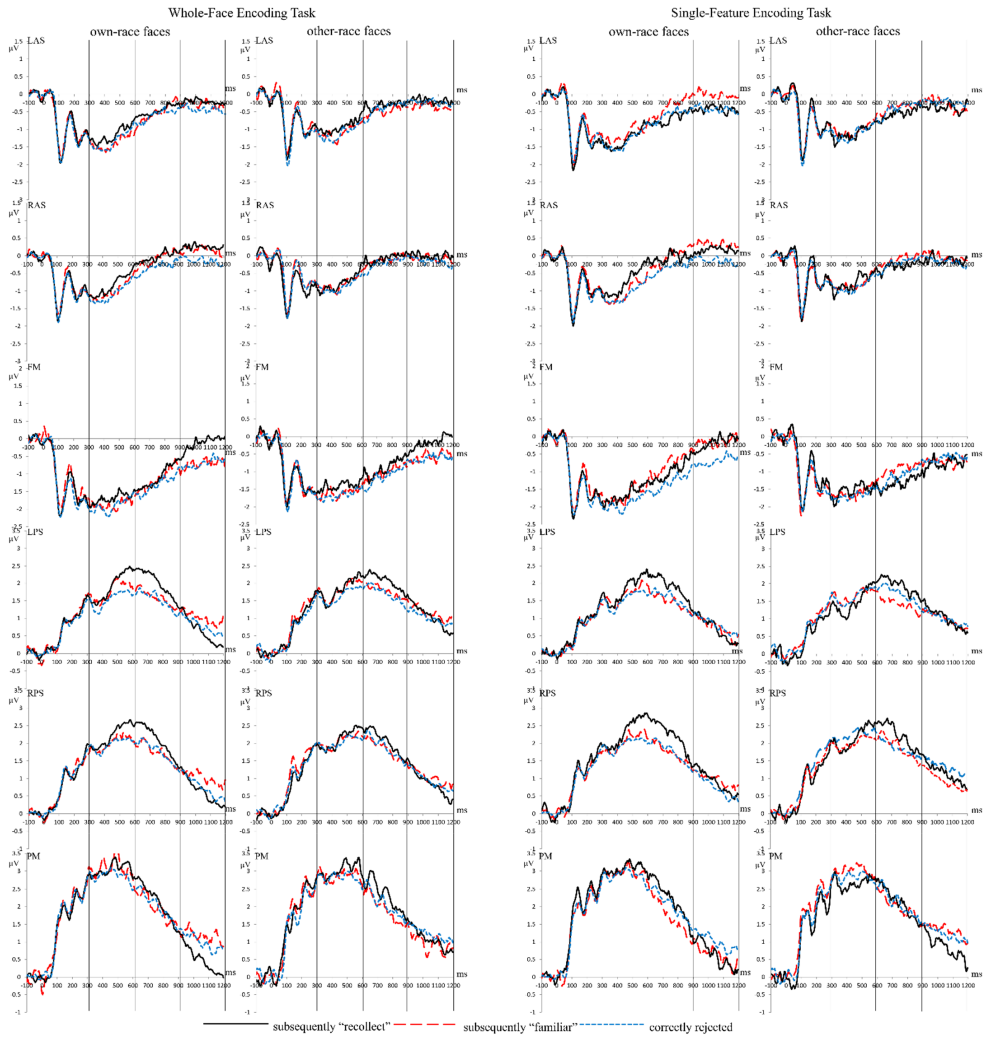
FIGURE 8 Mean amplitudes from the test phase depicting retrieval-related brain activation for 'recollected', 'familiar', and correctly rejected own-race and other-race faces for the whole-face and single-feature processing task. Note that ERPs for correctly rejected new faces are the same in the whole-face and single-feature panel because distracters were not assigned for one condition specifically. Vertical lines highlight the time segments of 300–600, 600–900, and 900–1200 ms used for statistical analyses

processing may reflect a deterioration from natural encoding for own-race faces (Sporer, 1991). This deterioration was also seen in performance data (Table 2; Figures 2 and 3) which showed a stronger reduction in recollection for own-race as compared to other-race faces. Brain activation during memory encoding of other-race faces was indistinguishable between whole-face and single-feature processing and resembled previous patterns (Herzmann et al., 2011, 2018) suggesting that memory encoding of other-race faces is naturally less elaborate.

The present study replicated the other-race effect on face memory performance (Meissner & Brigham, 2001). Own-race faces were recognized more accurately and elicited lower false alarms (Meissner & Brigham, 2001). The present study also replicated the facilitating effect of encoding tasks that focus on the whole face (Baddeley & Hitch, 2017; Bornstein et al., 2012; Sporer, 1991; Winograd, 1981). Comparisons with previous results (Table 2) showed that the whole-face processing task resulted in
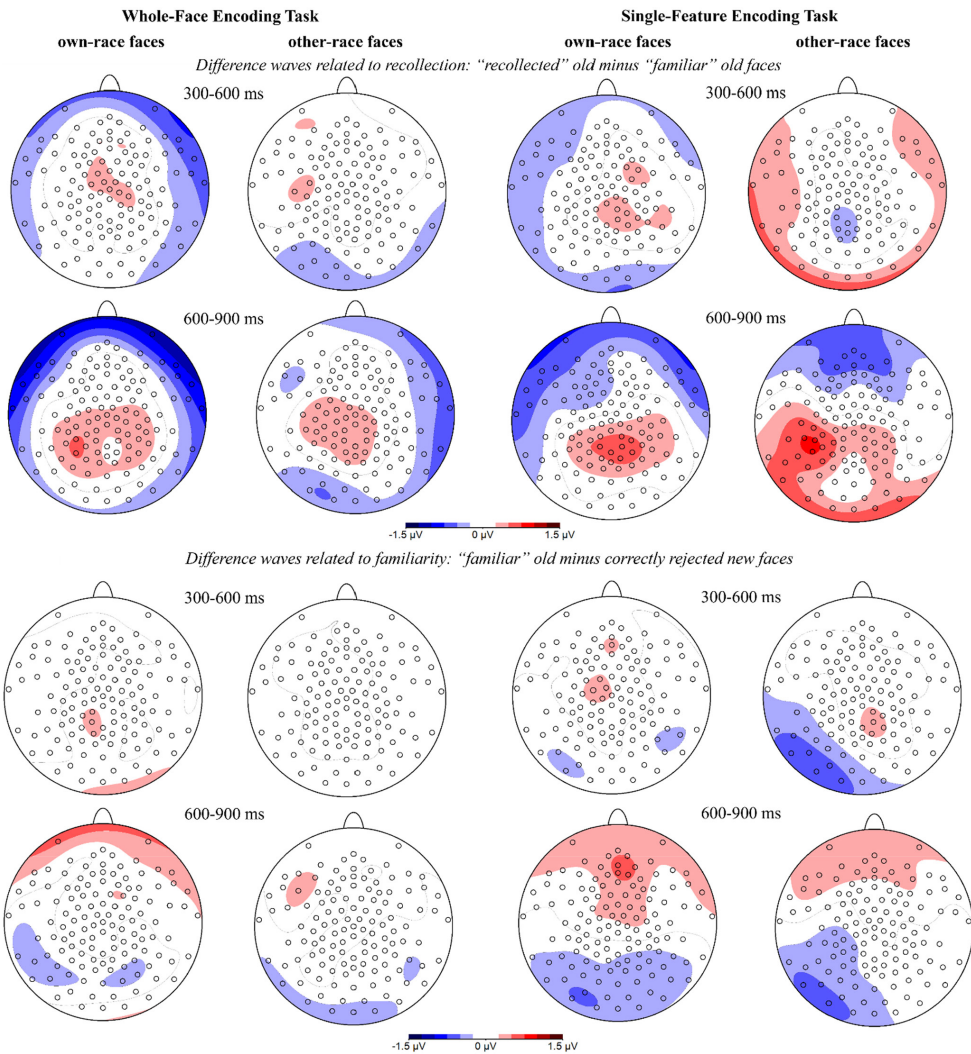
Whole-Face Encoding Task

own-race faces   other-race faces

Single-Feature Encoding Task

own-race faces   other-race faces

Difference waves related to recollection: "recollected" old minus "familiar" old faces

300-600 ms   300-600 ms

600-900 ms   600-900 ms

Difference waves related to familiarity: "familiar" old minus correctly rejected new faces

300-600 ms   300-600 ms

600-900 ms   600-900 ms

FIGURE 9   Voltage maps of ERP difference waves between memory judgements show old/new effects at 300–600 and 600–900 ms for own-race and other-race faces in the whole-face and single-feature processing tasks. Note that old/new effect related to familiarity use the same correctly rejected new faces in the whole-face and single-feature topographies because distracters were not assigned for one condition specifically. Spherical spline interpolation was used

memory performance comparable to prior findings that used upright presentation or focused attention during memory encoding (Herzmann et al., 2018). Performance following the whole-face processing task was higher than in a previous study (Herzmann et al., 2011), which differed from the present study because it used equal numbers of distracters and targets in the test phase, suggesting that the design of the memory retrieval test may have influenced overall memory results. These comparisons may suggest that the current whole-face processing task resembles previous default, task-free encoding.

Manipulating the levels of elaboration during memory encoding impacted own-race faces more than other-race faces, specifically by reducing memory performance in the single-feature processing task (Sporer, 1991; Stahl et al., 2010). Memory performance as measured with the hit 'recollect' for own-race as compared to other-race faces tended to be reduced more severely from the whole-face to the single-feature processing task. Significantly fewer detailed memory recollections were made for own-race faces after memory encoding that focused on facial features instead of the whole face. The disproportional

impact of the elaboration manipulation on own-race than other-race faces led to two findings. First, the whole-face processing task increased the other-race effect (Table 2; Figure 3) because it led to more accurate recognitions of own-race faces but did not have a comparable facilitating effect for other-race faces. The largest other-race effects in comparison to previous studies (Table 2) were found in the whole-face processing task. This finding corresponds to previous results that showed that other-race faces cannot benefit from more elaborate processing because of a lack of a sufficiently well-developed perceptual and memory system (Stahl et al., 2010; Tüttenberg & Wiese, 2021). Contrary to these previous findings, however, the present results for other-race faces showed an increase in memory performance in the whole-face as compared to the single-feature processing task providing some evidence that other-race faces can benefit from more elaborate processing. Second, the smallest other-race effects were observed in the single-feature processing task. This indicates that single-feature judgements induced less successful memory encoding for own-race faces whereas the impact on other-race faces was not as strong. This may suggest that own-race faces are naturally encoded at a more elaborate level. Other-race faces may naturally be processed less elaborately and thus suffer less from feature-based processing during memory encoding. This interpretation is in line with our previous findings, where inverting facial stimuli limited holistic processing and had a bigger impact on own-race than other-race faces (Herzmann et al., 2018, Exp. 2).

We proposed that one contribution to the other-race effect is naturally, or by default, more elaborate processing of own-race faces (Herzmann et al., 2011, 2018). Brain activation for own-race faces over posterior areas where Dms are typically observed (Herzmann et al., 2011; Lucas et al., 2011; Yovel & Paller, 2004) confirmed this assumption. Subsequently 'recollected' and subsequently 'familiar' faces showed indistinguishable brain activation in the whole-face processing task over posterior recording sites, suggesting that all subsequently recognized faces were encoded at the same level during more elaborate encoding instructions. A similar pattern of indistinguishable brain activation for subsequently 'recollected' and subsequently 'familiar' items had been found to be indicative of deep encoding (Friedman & Trott, 2000; Smith, 1993). The present Dm results over posterior regions also align with our previous findings of Dms for own-race faces after natural memorization (Herzmann et al., 2011, 2018). This result provides evidence that naturally more elaborate encoding of own-race faces is one contribution to the other-race effect in face memory.

The topography of the current recollection-related Dm for own-race faces in the whole-face processing task (Figure 5) does not fully resemble the Dm for own-race faces in our previous studies (Herzmann et al., 2011, 2018). In addition to the replication of similar activation between subsequently 'recollected' and subsequently 'familiar' faces over posterior areas, a novel pattern of brain activation was observed with a strong focus over prefrontal areas (Figures 5 and 6). A similar sensitivity of the prefrontal cortex has been observed before and related to the task demands of a more elaborate processing task (Bernstein et al., 2002; Wig et al., 2004). This prefrontal activation may reflect additional neural processes like evaluating faces as deviating from a norm of all previously encountered faces as proposed for a distinctiveness judgement task (Bruce et al., 1994). This prefrontal activation was greater for subsequently recollected than subsequently familiar own-race faces, suggesting a contribution of the prefrontal cortex to subsequent memory (Bernstein et al., 2002; Wig et al., 2004). This additional prefrontal activation implies that the natural encoding of own-race faces is not completely equivalent to an instructed, more elaborate processing task.

Interestingly, we observed similar brain activation for own-race and other-race faces during less elaborate memory encoding (Figures 5, 6, and 7). When instructed to judge an isolated feature, brain activation related to memory encoding of own-race and other-race faces appeared similar. This pattern reflects previous findings for inverted own-race and other-race faces (Herzmann et al., 2018). In both cases, faces were processed more feature-based, which may indicate that processing of the whole face contributes to a more elaborate encoding of own-race faces. This result also resembles some of the behavioural results that showed a smaller other-race effect following single-feature processing instructions, thus suggesting that own-race faces are naturally processed at a more elaborate level. We would like to note that the pattern of results reviewed here is based on the absence of significant results, which

does not provide strong evidence that there is indeed no difference between own-race and other-race faces in the single-feature processing task.

We found indistinguishable brain activation during single-feature and whole-face memory encoding for other-race faces (Figures 4, 5, 6, and 7) indicating that participants were not able to utilize different encoding mechanisms for these processing instructions. Furthermore, brain activation during memory encoding for other-race faces in the whole-face and single-feature processing task resembled previously observed natural memory encoding (Herzmann et al., 2011, 2018). These findings may suggest that other-race faces were processed less elaborately independent of task demands. This is in line with our previous observation that memory-related brain activation for other-race faces was not sensitive to inversion (Herzmann et al., 2018). These results provide evidence that another contribution to the other-race effect in memory is the reduced capability of the brain to more elaborately process other-race faces.

Similar patterns of Dms for other-race faces following whole-face and single-feature processing tasks are in contrast to a previous result where larger Dms were found for other-race faces after participants were instructed to memorize them at the individual level (Tüttenberg & Wiese, 2021). It is likely that procedural differences like task instructions and analysis of a general old-new Dm as compared to the present Dms for recollection and familiarity contributed to these variations. The current indistinguishable Dms for single-feature and whole-face other-race faces speak against assumptions that simply instructing participants to encode other-race faces in a more elaborate manner can eliminate the other-race effect (Hugenberg et al., 2007; Young et al., 2010). It also speaks against a significant contribution of motivation to the other-race effects, which suggests that people are able but not motivated to encode other-race faces at the same level as own-race faces (Hugenberg et al., 2007; Shriver et al., 2008; Shriver & Hugenberg, 2010; Young et al., 2010). It provides further evidence that the other-race effect is a stable phenomenon (Herzmann et al., 2018), which may be manipulated only with more long-term interventions (McKone et al., 2019; Sangrigoli et al., 2005; Tanaka et al., 2013).

Manipulating elaboration of processing during memory encoding did not impact the ERP old/new effects during memory retrieval. We did replicate previous findings of larger old/new effects between 300 and 600 ms for own-race than other-race faces (Herzmann et al., 2018) independent of task instructions. No evidence for differences between whole-face and single-feature processing tasks were found during the retrieval of details from memory, despite more accurate memory performance and, for own-race faces, a Dm suggesting additional neural processing in the whole-face than single-feature processing task. This suggests that faces recollected accurately after elaborate or less elaborate processing were retrieved with an equal amount of detail from memory. This finding is in line with our previous observation (Herzmann et al., 2018) where old/new effects were not influenced by manipulations of holistic processing or attention. It can, therefore, be argued that a more elaborate processing task that focuses on perceptual mechanisms like processing of the whole may not increase the quality of the memory trace as reflected in similar old/new effects in the whole-face and single-feature processing task. Instead, a perceptually dominated processing task led to quantitatively more traces as indicated by more accurate memory performance for faces in the whole-face processing task.

This finding is in contrast to a previous study on levels of processing, which can be seen as a proxy for our manipulation of elaboration. That study found larger old/new effects for faces following deep as compared to shallow processing (Marzi & Viggiano, 2010). Methodological differences may account for these disparate findings like the sole inclusion of own-race faces, the presentation of stimuli either upright or inverted, and the analysis of general old/new effects not separated for familiarity and recollection. The present results for the old/new effects are also in contrast to previous studies that used non-face stimuli (Rugg & Curran, 2007) and consistently observed a larger old/new effect for deep as compared to shallow conditions. Stimulus material used in these previous studies differs in two important ways from faces. First, (own-race) faces are visual stimuli of lifelong expertise reflecting exceptional levels of processing capabilities. Performance for overlearned material like faces is very hard to improve even further, especially for healthy young adults (Dolzyka et al., 2014; Limbach et al., 2018). Some evidence for this claim can be seen in Table 2, where memory performance for own-race faces in the whole-face processing task is not exceptionally higher

than that in previous studies. Second, unfamiliar faces are non-verbal stimuli. Verbal material is much better suited for semantic tasks during encoding (Baddeley & Hitch, 2017) as typically used in levels-of-processing investigations. Semantic encoding tasks facilitate associations with the to-be-learned stimulus and contribute unique information to memory traces, which can be recalled with more detail during the test phase. Retrieving more detail from memory has been shown to correlate with the size of the parietal old/new effect and larger parietal old/new effects were found after deep processing (Rugg & Curran, 2007). Following this argument, it can be hypothesized that processing tasks varying in elaboration could influence old/new effects for faces when a semantic or associative memory task is used. This is an opportunity for a future research investigation. Such future investigation should also include Black participants to investigate the other-race effect in a fully cross-over design, which would also rule out stimulus effects.

CONCLUSION

The present study found evidence for two factors that influence the other-race effect in face memory: less elaborate processing during memory encoding for other-race faces and more elaborate processing during memory encoding for own-race faces. Single-feature encoding tasks reduced the other-race effect in memory performance and led to similar recollection-related brain activation during memory encoding for own-race and other-race faces. Whole-face encoding tasks increased the other-race effect in memory performance and led to similar brain activation for subsequent recollection and familiarity for own-race faces which is indicative of more elaborate memory encoding.

The present ERP results showed that memory encoding processes for own-race faces were more affected by instructions whereas the impact of processing tasks was comparatively smaller for other-race faces. This provides support for the assumption that instructions alone are not enough to facilitate memory for other-race faces but that a sufficiently developed perceptual and memory system is necessary to observe such effects.

AUTHOR CONTRIBUTIONS
Grit Herzmann: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; visualization; writing – original draft; writing – review and editing. **Olivia Ogle:** Resources; writing – original draft. **Tim Curran:** Conceptualization; funding acquisition; supervision; writing – review and editing.

CONFLICT OF INTEREST
All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon request.

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