

The Impact of Distinctiveness on Face Recognition

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THE COMPOSITE FACE ILLUSION: THE
IMPACT OF DISTINCTIVENESS ON FACE
RECOGNITION

Master's Thesis submitted for the degree of Master in Psychological Sciences, Specialization in
Cognitive Neuroscience

by

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Melissa Hasanbelli

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Abstract

Face recognition depends on both the integration of facial information into a unified perceptual representation and the processing of individual facial features. Facial distinctiveness also contributes to recognition, as distinctive faces are generally more easily discriminated and remembered than typical faces. However, relatively little research has examined whether the distinctiveness of individual facial regions influences performance within a paradigm associated with holistic face processing. The present study addressed this question using a composite-face matching task.

A total of 104 participants completed a computerised task involving aligned composite faces constructed from well-known celebrity identities. Participants judged whether the upper or lower halves of two simultaneously presented composite faces were the same or different while ignoring the other half. Task-relevant regions had been independently classified as distinctive or non-distinctive, whereas task-irrelevant regions were consistently non-distinctive. Participants completed separate Top and Bottom matching blocks, and performance was assessed using perceptual sensitivity, correct reaction time, and error rate.

The results showed that participants discriminated distinctive target halves more sensitively than non-distinctive target halves, and this advantage was comparable for upper and lower facial regions. Contrary to the response-time prediction, correct judgements were slower for distinctive targets. Error rates did not vary systematically across the experimental conditions. Distinctiveness therefore enhanced discrimination sensitivity without producing a uniform improvement across all measures of performance.

Together, these findings reveal a trade-off between discrimination sensitivity and response speed and demonstrate that the diagnostic value of local facial information remains behaviourally influential within an aligned whole-face context. More broadly, the results support a flexible and feature-sensitive account of face processing in which the contribution of local information varies according to its distinctiveness.

Introduction

The face processing hypotheses

Researchers have extensively explored the distinctive processing of faces as opposed to other objects. A prominent concept often found in literature is that of holistic processing, which entails viewing faces as whole entities ("gestalts") rather than collections of individual facial components (Farah et al., 1998). In the context of face individuation, holistic processing is thought to facilitate the recognition of individual faces by encoding facial information as a unified representation that conforms to a general "face template." As a result, processing individual facial features independently becomes more challenging (Farah et al., 1998; Tanaka & Farah, 1993). The integrative perception of faces assists in forming strong facial representations, enabling recognition despite alterations in face viewpoint and facial expression (Calder et al., 2000; McKone, 2008). Certain computer vision algorithms, which rely on the consistent arrangement of facial features, are in line with this holistic face processing approach (Tsao & Livingstone, 2008). Also, it has been suggested that this process emerges from an automated attentional strategy shaped by experience. Within this context, facial components are independently encoded but not treated as such during perceptual decision-making (Richler, Palmeri, & Gauthier, 2012; Richler, Wong, & Gauthier, 2011).

Furthermore, an important distinction should be made between holistic processing and configural processing, concepts frequently used interchangeably in scientific publications. The first involves integrating all parts of the face simultaneously, whereas the latter focuses on sensitivity towards the spatial relationships among facial features (e.g., the width of the nose). Even though holistic processing may aid configural processing, both strategies operate independently and respond differently to experimental conditions (Maurer et al., 2002).

Although holistic processing is widely considered a defining characteristic of face perception, the mechanisms underlying its emergence remain the subject of ongoing debate. A central question in face perception research is whether faces are initially perceived as holistic entities, or whether we start by perceiving them as separate features which then are combined. The global-to-local hypothesis (Sergent, 1986), which is backed by many proponents of holistic perception (Jacques & Rossion, 2009), suggests that our initial representation of a face is coarse and holistic, gradually becoming more detailed. Nevertheless, the evidence supporting this hypothesis is inconsistent (Goffaux et al., 2005; Goffaux & Rossion, 2006; Jacques et al., 2007;

Jacques & Rossion, 2009; Meinhardt-Injac et al., 2010, 2011; Richler et al., 2009; Searcy & Bartlett, 1996; Sergent, 1986). More specifically, Fitousi (2019) examined this hypothesis through detailed analyses of response-time distributions in the composite face paradigm. The composite-face illusion occurs when the upper and lower halves of a face are perceived as an integrated whole, even when they belong to different identities. As a result, irrelevant information from one facial region interferes with judgments about the other, making the two halves difficult to process independently. The composite face illusion is considered one of the strongest behavioural demonstrations of holistic face processing and is commonly examined using the composite face paradigm (Young et al., 1987; Rossion, 2013). Fitousi (2019) found that the composite effect was negligible at faster response times but became more pronounced at slower response times. These findings may contradict the global-to-local processing account and instead provide tentative support for a local-to-global approach, although the evidence remains inconclusive. Based on traditional theories of attention, this alternative perspective proposes that face processing initially involves the rapid and automatic identification of individual facial features, followed by a controlled stage in which these features are integrated into a holistic facial representation (Treisman & Gelade, 1980; Biederman, 1987; Fitousi, 2018). Moreover, this hypothesis coincides with an application of a dual-route model (analytic-automatic route and holistic-slower route), suggesting that holistic face perception requires attention and resources over time (Ridderinkhof, 1997, 2002a, 2002b).

Beyond disagreements regarding the temporal dynamics of face processing, researchers have also debated the relative contributions of holistic and featural information to face recognition. These perspectives can be conceptualized as occupying different positions along a holistic–featural continuum. At one extreme, strongly holistic accounts propose that faces are recognized as integrated wholes rather than through the analysis of individual facial features (Tanaka & Farah, 1993, p. 226). At the other extreme of this continuum, we have an “independent features” view which postulates that facial features are processed and represented independently rather than as part of integrated wholes (Macho & Leder, 1998; Rakover & Teucher, 1997). In support of this view, Rakover and Teucher (1997) estimated that isolated features account for 91% of the variance in recognizing an upright whole face. Further in the continuum, we find a moderate holistic view that emphasizes holistic processing but also acknowledges the role that featural processing plays on face recognition (Farah et al., 1998; Tanaka & Farah, 1993; Tanaka & Sengco, 1997). And finally, as Cabeza and Kato (2000) suggest, there is an intermediate view

which combines elements from both perspectives, potentially balancing holistic and featural processing.

The latest approach capitalizes on the prototype effect in face recognition, which refers to the tendency to falsely recognize a new face that shares characteristics with previously encountered faces. This phenomenon was first demonstrated by [Solso and McCarthy \(1981\)](#) using **line-drawn Identikit faces**, that is, artificial faces constructed by combining individual facial features such as the eyes, nose, and mouth. Participants were exposed to a series of these faces and were later shown a novel prototype face composed of the most frequently presented features. Although this prototype had never actually been presented during the learning phase, participants frequently misidentified it as a previously seen face, suggesting that they had formed a generalized facial representation based on common features.

Building on this work, [Cabeza and Kato \(2000\)](#) distinguished between two types of prototypes. Unlike the prototypes used by Solso and McCarthy, which relied on the rearrangement of previously studied facial features, Cabeza and Kato preserved the overall facial configuration while subtly modifying individual features. They argued that false recognition of prototypes composed of rearranged features primarily reflects **featural processing**, whereas false recognition of prototypes that maintain a coherent facial configuration reflects **holistic processing**. Their results revealed that participants tended to falsely recognize both types of prototypes, supporting a dual-code view of face recognition in which both featural and holistic information contribute to facial representations. By comparing these two prototype types, the study highlighted the relative importance of featural and configural processing in face recognition and challenged extreme accounts that exclusively favor one form of processing over the other.

Distinctiveness

Related to prototype-based accounts of face recognition, facial distinctiveness has emerged as an important determinant of recognition memory. Numerous studies (e.g., [Going & Read, 1974](#); [Light et al., 1979](#); [Bartlett et al., 1984](#)) have demonstrated that distinctive faces are generally recognized more accurately and remembered better than typical faces. Conversely, typical faces are more likely to be mistakenly judged as familiar, suggesting that face recognition is influenced by prototypical facial representations. Because typical faces more closely resemble these representations, they may be particularly susceptible to false recognition ([Light et al., 1979](#)). This idea is further reinforced by findings that show distinctiveness also impacts the time

needed to recognize highly familiar faces (Valentine & Bruce, 1986). Thus, faces rated as highly distinctive or very familiar are recognized more rapidly than those rated as typical or less familiar. This supports the 'prototype hypothesis' which theorizes that a general face prototype is formed from previous encounters and used to recognize new faces. According to this hypothesis, face recognition involves comparing individual faces to a single general prototype, which is created by averaging the features of all previously encountered faces (Valentine & Bruce, 1986). This general prototype represents the average features of the faces the individual has experienced, rather than each face having its own unique prototype. Thus, recognition is based on how closely a new face matches this general prototype, rather than using a unique prototype for each individual face.

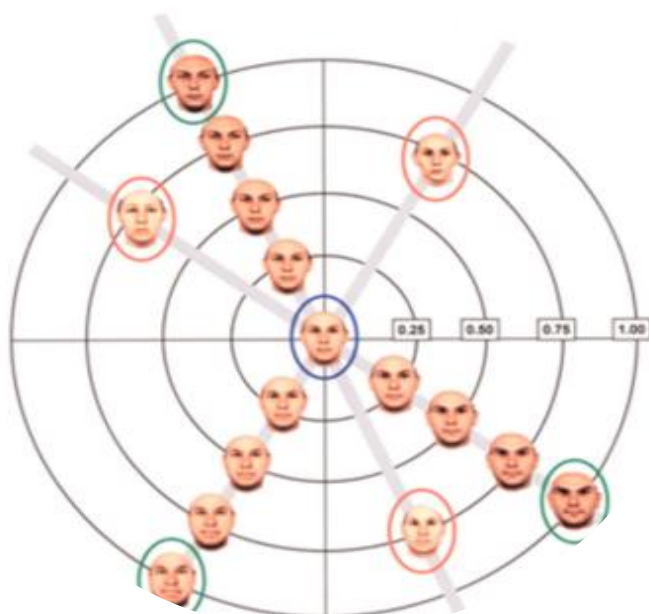
Hence, this perspective differs from other prototype theories that focus on discrete feature values or continuous feature dimensions. The research conducted by Valentine and Bruce (1986) provides compelling evidence for the involvement of a facial prototype in face recognition. Their study demonstrated that distinctive faces were categorized more slowly compared to typical faces, even when variations in familiarity were controlled for. This slower categorization of distinctive faces suggests that the process of matching faces to a general prototype involves additional cognitive steps for faces that deviate more from the prototype. Specifically, the prototype distance model posits that faces differing significantly from the general prototype are encoded more distinctly, aiding in their recognition. In their experiment, participants rated the distinctiveness of faces based on how easily they could recognize each face within a crowd. The results showed that famous faces were rated as more distinctive than unfamiliar faces. This finding supports the notion that facial distinctiveness reflects the degree to which a face deviates from a general prototype. Although such faces may require additional processing during categorization due to their greater distance from the prototype, this distinctiveness appears to facilitate their subsequent recognition.

To explain distinctiveness effects in face recognition, a theoretical framework has been proposed by Valentine (1991). This framework introduces the concept of a multi-dimensional "face-space" to represent various facial dimensions or characteristics. Faces are assumed to be distributed across dimensions in a manner similar to a normal distribution. This means that typical faces, which are more common and similar to each other, are clustered around the central tendency of each dimension. By contrast, distinctive faces, which are less common and more unique, are situated farther from the average in less densely populated sections of the face space (Fig. 1). Within this model, facial recognition is characterized as the process of comparing the

features of the observed face with stored facial templates in memory. For this reason, it is hypothesised that typical faces are susceptible to identification errors due to the clustering of numerous similar faces around them, leading to challenges in distinguishing them from each other. In contrast, distinctive faces are proposed to be identified with greater precision and certainty as they encounter fewer similar faces nearby, diminishing the likelihood of confusion during the matching process.

Figure 1

Face-Space Framework (Valentine, 1991; adapted from Leopold et al., 2001)



Note. The **central blue ellipse** represents the mean face, or facial prototype, corresponding to the average of all faces stored in memory. The **green ellipses** represent original facial identities distributed within the multidimensional face-space. The **antifaces** are located on the opposite side of the mean face and possess characteristics opposite to those of their corresponding original identities. The **concentric circles** represent identity strength, such that increasing distance from the prototype is associated with greater facial distinctiveness, whereas decreasing distance reflects more typical facial representations. Consequently, faces located near the centre of the space are perceived as more typical, while faces positioned toward the periphery are perceived as more distinctive.

Although distinctiveness has often been studied as an independent determinant of face recognition, it has also been examined in relation to familiarity. Both factors influence recognition performance, although evidence suggests that their contributions may be at least partly independent rather than reflecting a single underlying mechanism (Bruce et al., 1993; Valentine & Bruce, 1986). Indeed, distinctive faces tend to benefit from greater discriminability, whereas familiar faces benefit from well-established representations acquired through previous exposure. Examining the respective contributions of familiarity and distinctiveness may therefore provide further insight into the mechanisms underlying facial recognition and memory. In line with this perspective, Dewhurst et al. (2005) investigated the relationship between familiarity and face recognition, with particular attention to how facial distinctiveness influences memory performance. The researchers used the remember–know procedure to investigate this. In this method, participants classify their recognition decisions into two categories: **"Remember"** and **"Know"**. **"Remember"** responses occur when participants can recall specific details about the face's presentation during the study phase. As for **"Know"** responses, they reflect when participants feel a sense of familiarity with the face but cannot recall specific details. Dewhurst et al. (2005) found that faces eliciting **"Remember"** responses were more likely to be distinctive. In other words, faces characterized by unique or salient features were more likely to trigger conscious recollection accompanied by contextual details from the original encounter. By contrast, **"Know"** responses were associated with faces recognized on the basis of familiarity in the absence of specific episodic details. These faces also tended to receive more moderate ratings across characteristics such as facial expression, lighting, and background. This distinction suggests that facial distinctiveness enhances the likelihood of recollection-based recognition, whereas less distinctive faces are more often recognized through familiarity-based processes. The findings therefore support dual-process accounts of recognition memory by indicating that distinctiveness contributes primarily to recollection, while familiarity can support recognition even when detailed contextual information is unavailable.

Nevertheless, familiarity and distinctiveness may not be entirely independent. Devue (2023) highlighted the complex relationship between these two concepts by examining how the intrinsic visual characteristics that make a face distinctive interact with familiarity acquired through repeated exposure. This work describes an “illusion of distinctiveness,” whereby familiar faces may be perceived as more distinctive than unfamiliar faces. Distinctiveness and familiarity ratings were collected from 35 independent judges using 7-point Likert scales, with

visual familiarity assessed independently of semantic knowledge and distinctiveness ratings intended to distinguish typical from distinctive faces. The positive association between familiarity and distinctiveness ratings suggests that repeated exposure may influence the perceived uniqueness of a face. Importantly, however, this effect concerns subjective ratings of distinctiveness rather than demonstrating that familiar faces objectively possess more distinctive physical characteristics. From the perspective of [Valentine's \(1991\)](#) face-space framework, this relationship is particularly relevant because faces are represented according to their similarity to other faces: typical faces occupy relatively densely populated regions of face-space, whereas distinctive faces are represented in more sparsely populated regions. Familiarity may therefore influence how distinctive an individual face is perceived to be within this representational system, although familiarity and physical distinctiveness remain conceptually separable.

A cost-efficient account of face learning provides a complementary perspective by considering how the representation of an individual face develops with increasing familiarity ([Devue & de Sena, 2023](#)). According to this account, facial information is encoded dynamically, with representational weight allocated according to the stability and diagnostic value of different facial information across encounters. Rather than encoding every aspect of a face at the same level of detail, the visual system is proposed to prioritise relatively coarse information initially and to refine the representation when this information is no longer sufficiently reliable for identification.

The stability of an individual's appearance is therefore central to this account. When appearance remains relatively stable across encounters, large-scale information such as hairstyle, hair colour, head shape, and general facial patterns may remain sufficiently diagnostic to support recognition. A person with a relatively stable appearance (e.g., Adam Sandler) may consequently become recognisable relatively quickly because similar coarse visual characteristics remain informative across encounters. By contrast, a person with a highly variable appearance (e.g., Jared Leto) presents a greater recognition challenge because changes in hairstyle, hair colour, facial hair, or other aspects of appearance reduce the reliability of coarse visual information. Such variability may initially hinder recognition; however, with increasing exposure, finer diagnostic facial details and their spatial relationships can receive greater representational weight, resulting in a progressively more refined representation. [Devue and de Sena \(2023\)](#) provided empirical support for this proposal across three experiments involving famous faces that differed in appearance stability and media exposure. Stable

appearances facilitated recognition at relatively earlier stages of familiarisation, whereas greater exposure produced substantially larger improvements in recognition for variable than for stable faces. This pattern was interpreted as evidence that representations of variable faces become increasingly fine-tuned with experience, whereas representations of stable faces may remain comparatively coarse when coarse information continues to provide a reliable basis for identification.

The account is therefore described as cost-efficient because representational detail is proposed to develop according to what is necessary for reliable identification, rather than all faces being represented with the same degree of detail (Devue & de Sena, 2023). Importantly, this account addresses a different aspect of facial representation from Valentine's (1991) face-space framework. Whereas face-space primarily concerns the organisation and discriminability of faces relative to other faces, the cost-efficient account focuses on how the representation of a particular identity develops and is refined through experience. The two approaches can therefore be regarded as complementary perspectives on facial representation rather than treating the cost-efficient account as a direct extension of Valentine's model.

Face Processing- Experimental Paradigms

Building on the previous discussion of facial distinctiveness and holistic face perception, several experimental paradigms have been developed to investigate how faces are processed as integrated wholes rather than as collections of independent features. Although these paradigms differ in their experimental procedures and theoretical assumptions, they all provide behavioural evidence supporting the holistic nature of face perception. Among the most influential paradigms we find the Thatcher illusion, the whole-part paradigm, and the composite face paradigm. Together, these approaches have considerably advanced our understanding of face perception while providing complementary perspectives on the mechanisms underlying holistic processing.

The Thatcher illusion is one of the earliest and most striking demonstrations of holistic face perception. Originally introduced by Thompson (1980), the illusion consists of inverting the eyes and mouth within an otherwise upright face. When the manipulated face is presented upside down, the alterations often go unnoticed and the face appears relatively normal. However, once the same image is presented upright, the inverted features produce a highly distorted and grotesque appearance (Figure. 2). This phenomenon demonstrates that facial perception depends not only on the recognition of individual features but also on the spatial

relationships between them. Thus, the illusion illustrates that faces are processed holistically, with facial orientation playing a crucial role in the perception of facial identity and configuration. Moreover, the magnitude of the illusion may vary depending on additional factors such as facial expression and emotional content, highlighting the complexity of holistic face processing and suggesting that multiple perceptual mechanisms contribute to facial recognition.

Figure 2

The Thatcher illusion (Thompson 1980; adapted from Carbon et al., 2007)



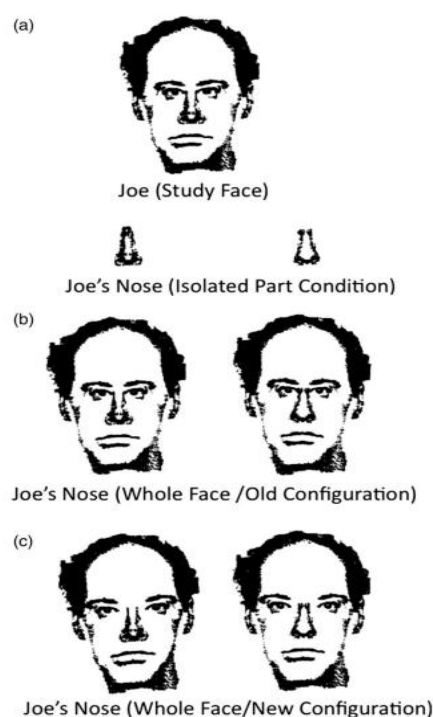
Note. The inversion of the eyes and mouth results in a grotesque perception of the face only when it's upright, not when it's inverted.

The part–whole paradigm, originally introduced by [Tanaka and Farah \(1993\)](#), provides another important behavioural measure of holistic face processing. Whereas the composite-face paradigm primarily examines whether participants can selectively attend to one facial region while ignoring another, the part–whole paradigm investigates how holistic processing influences memory for individual facial features ([Tanaka & Simonyi, 2016](#)). In the standard version of the paradigm, participants first learn a series of faces, typically presented with corresponding names. Their memory is subsequently assessed using a two-alternative forced-choice recognition task. During this task, a previously studied facial feature, such as the eyes, nose, or mouth, is presented either in isolation or within the context of a whole face. In the whole-face condition, the target and foil faces are identical except for the critical feature being tested. As illustrated in [Figure 3](#), the feature may be presented within either the original facial configuration encountered during learning or a new configuration in which the spatial arrangement of the features has been modified.

Holistic processing is measured by comparing recognition performance across the isolated-part and whole-face conditions. Recognition of a facial feature is typically more accurate when it is presented within the context of the whole face than when it is shown in isolation, a finding referred to as the whole-face advantage (Tanaka & Farah, 1993; Tanaka & Simonyi, 2016). The greater the difference between these conditions, particularly when the feature is presented within its original configuration, the stronger the evidence for holistic processing. This advantage suggests that memory for an individual facial feature is embedded within a unified representation of the entire face rather than encoded independently. Nevertheless, one methodological limitation of the paradigm concerns the definition of what constitutes a facial “part” or “whole.” Studies may differ in the facial regions selected, the amount of surrounding facial context presented, the configuration of the features, or the precise testing procedure employed. Such variations may influence the magnitude of the whole-face advantage, thereby reducing methodological consistency and complicating direct comparisons across studies (Tanaka & Simonyi, 2016).

Figure 3

Example of the Part–Whole Face Paradigm (From Tanaka and Simonyi (2016). Copyright 2016 by The Experimental Psychology Society. Originally adapted from Tanaka and Sengco (1997).)



Note. Participants first study a face associated with a name. Memory for a target feature—in this example, Joe’s nose—is subsequently tested in isolation (a), within the whole face in its

original configuration (b), or within the whole face in a new configuration (c). In the whole-face conditions, the target and foil faces differ only in the critical feature being tested.

Although both the Thatcher illusion and the whole-part paradigm have made significant contributions to the understanding of holistic face perception, the composite face paradigm has become one of the most widely adopted behavioural methods for investigating holistic processing because of its methodological robustness and objective experimental design (Rossion, 2013). As the present research relies on this paradigm as its principal methodological framework, it is described in greater detail below.

Composite Face Paradigm

The composite face paradigm demonstrates the tendency of the visual system to integrate separate facial features into a single perceptual representation. As previously explained, in this task, the upper half of one face is combined with the lower half of another face to create a novel composite stimulus. Participants are typically instructed to attend selectively to one facial half while ignoring the other. When the two halves are perfectly aligned, observers automatically perceive them as belonging to a single face, making it considerably more difficult to focus exclusively on the target region. In contrast, when the facial halves are horizontally misaligned, the perceptual integration between the two halves is substantially weakened, allowing participants to process the target half more independently (Young, Hellawell, & Hay, 1987). The performance difference between aligned and misaligned composite faces is referred to as the composite face effect and is widely regarded as one of the strongest behavioural indicators of holistic face processing.

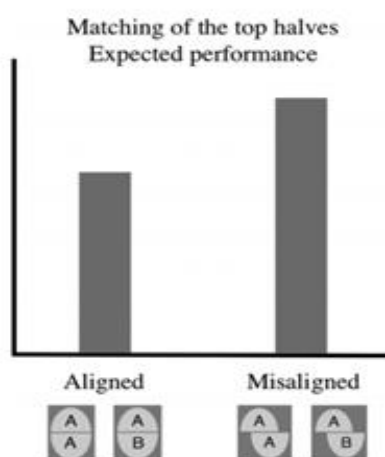
The original version of the paradigm was introduced by Young et al. (1987) to investigate face identification processes. Their study demonstrated that participants found it considerably more difficult to recognize familiar facial halves when irrelevant facial information was aligned with the target region. The interference produced by the irrelevant half suggested that facial information is processed automatically as a unified whole rather than as separate components. These findings provided some of the earliest behavioural evidence supporting holistic face perception and established the composite face paradigm as an important experimental tool within face recognition research. Hole (1994) subsequently expanded the paradigm by introducing a simultaneous matching task. Rather than identifying familiar faces, participants were required to compare two composite faces and determine whether their upper halves were

identical while ignoring mismatching lower halves. Similar to the original findings, participants exhibited longer reaction times and reduced performance when the facial halves were aligned than when they were misaligned. This delay reflects the automatic integration of facial information, illustrating the difficulty of selectively attending to one facial region while suppressing irrelevant information from another region. Thus, the paradigm provides compelling behavioural evidence that holistic processing occurs automatically during face perception.

A more recent version of the paradigm, extensively reviewed by [Rossion \(2013\)](#), further refined the experimental procedure and has become the standard protocol adopted in contemporary research on holistic face processing. In this version, participants are required to determine whether one half of two sequentially presented composite faces is identical while ignoring the irrelevant half, which varies across trials. Performance is consistently poorer when the facial halves are aligned than when they are misaligned, as reflected by lower accuracy rates and longer reaction times. This decrease in performance is interpreted as evidence that the visual system automatically integrates the two facial halves into a unified perceptual representation, making it difficult to process each facial component independently ([Figure 4](#)). Therefore, the composite face effect has become one of the most robust behavioural indicators of holistic face processing.

Figure 4

Matching task in composite face illusion (Rossion, 2013)



Note. Performance measured in accuracy rates and in correct response times (RTs). Higher accuracy rates for misaligned condition than for aligned. Correct RTs higher for aligned than misaligned (Rossion, 2013)

Compared with earlier paradigms, [Rossion \(2013\)](#) argues that the composite face paradigm offers several methodological advantages that have contributed to its widespread adoption in face perception research. First, the experimental manipulation is relatively simple, relying primarily on the alignment or misalignment of two facial halves. Unlike paradigms that require subjective decisions regarding which facial regions should be considered individual parts, the composite face paradigm provides a clear and objective definition of the target and irrelevant facial information. Second, the misaligned condition serves as a theoretically grounded control condition. According to Gestalt principles, horizontally shifting one facial half disrupts the perceptual integration of the face while preserving the individual facial features themselves. As a result, differences in performance between aligned and misaligned conditions can be attributed more confidently to holistic processing rather than to changes in the facial features. [Rossion \(2013\)](#) further emphasizes that the paradigm produces highly reliable behavioural measures based on both accuracy and reaction time. These objective outcome measures consistently reveal robust composite effects across different participant populations and experimental settings, making the paradigm particularly suitable for investigating holistic face perception. Also, the horizontal alignment manipulation represents a precise and quantifiable experimental manipulation that is relatively easy to standardize across studies, thereby improving methodological consistency and facilitating comparisons between experiments. In contrast, paradigms such as the Thatcher illusion and the whole-part paradigm may involve greater variability in stimulus construction or in the definition of facial regions, potentially introducing additional methodological subjectivity.

Several methodological factors, however, may influence the magnitude of the composite face effect. One important consideration concerns the presence of a visible gap between the upper and lower facial halves. Although eliminating the gap may appear to create a more natural-looking face, [Rossion \(2013\)](#) described what has become known as the paradoxical gap composite illusion, whereby introducing a small gap between the two facial halves can, under certain conditions, strengthen rather than weaken holistic processing. This seemingly counterintuitive finding demonstrates that subtle modifications of the stimulus configuration can substantially influence perceptual integration and illustrates the complexity of the mechanisms underlying holistic face perception. Thereby, careful stimulus construction remains essential when designing experiments based on the composite face paradigm.

Another important methodological consideration concerns the comparison between aligned and misaligned composite faces. Traditionally, both conditions are included to quantify the magnitude of holistic interference. Consistent with the findings of [Young et al. \(1987\)](#) and [Rossion \(2013\)](#), holistic interference is strongest when the two facial halves are perfectly aligned, whereas misalignment substantially reduces the automatic integration of facial information. Because aligned composite faces maximize holistic processing, they provide the most sensitive experimental condition for detecting subtle variations in performance associated with holistic interference. For this reason, the present experimental design employed only aligned composite faces, thereby maximizing the likelihood of observing variations in holistic processing while maintaining consistency with previous research using the composite paradigm.

An additional advantage of the composite face paradigm is that the resulting stimuli retain a high degree of ecological validity. Although the faces are artificially constructed by combining halves originating from different identities, the resulting composite images generally maintain a realistic facial appearance, apart from the visible separation between the two halves. This characteristic distinguishes the paradigm from more artificial manipulations that substantially distort facial structure. Moreover, behavioural effects obtained with the composite paradigm are often considerable. [Rossion and Boremanse \(2008\)](#) reported that differences in reaction times and accuracy between experimental conditions may approach 20%, illustrating the sensitivity of the paradigm for detecting holistic interference. Beyond its methodological strengths, the composite face paradigm has also contributed to broader theoretical debates concerning the temporal dynamics of face perception. More specifically, it has been used to investigate whether holistic representations emerge immediately during the earliest stages of visual processing or whether individual facial features are initially processed separately before being integrated into a unified percept. Although considerable evidence supports holistic processing, the precise sequence through which facial representations are constructed remains the subject of ongoing investigation. Some studies have suggested that stronger composite effects are associated with longer response times, potentially challenging strictly global-to-local models of face perception and indicating that local feature processing may contribute to later stages of holistic integration. However, no consensus has yet been reached regarding these competing theoretical accounts.

Importantly, although the composite-face paradigm is widely used as a behavioural measure of holistic face processing, comparatively little research has examined whether performance

within this paradigm is influenced by the distinctiveness of the facial information being judged. This constitutes an important gap in the literature, given that distinctive faces are generally recognized more accurately than typical faces, while it remains unclear whether this advantage extends to judgments of individual facial regions made in the presence of conflicting information from another face half. By requiring participants to focus selectively on one part of a composite face while disregarding the other, the composite-face paradigm provides an appropriate framework for addressing this question. It therefore makes it possible to bring together two previously discussed areas of face-perception research—facial distinctiveness and holistic processing—and to determine whether distinctive facial information facilitates face-part judgments under conditions in which holistic integration may interfere with selective processing.

Objectives and Hypotheses

Against this theoretical background, the present study examined whether facial distinctiveness affects performance in a composite-face matching task. Participants judged whether the top or bottom halves of two composite faces were identical while attempting to ignore the task-irrelevant halves. By combining the study of facial distinctiveness with a paradigm commonly used to assess holistic processing, this research sought to clarify whether distinctive information facilitates judgments of individual facial regions when those regions are embedded within complete composite faces. More broadly, the study aimed to contribute to a better understanding of the relationship between facial distinctiveness, selective face-part judgments, and holistic face processing.

It was hypothesized that participants would demonstrate higher accuracy and faster response times when judging distinctive facial halves than when judging non-distinctive facial halves. Distinctive facial information was expected to facilitate performance by providing more salient and discriminable cues on which participants could base their judgments. This advantage was expected to occur in both task conditions, regardless of whether participants were required to judge the top or the bottom half of the composite face. Thus, the predicted benefit of distinctiveness was not expected to be restricted to a particular facial region. By testing these predictions, the present study sought to provide further insight into how the distinctiveness of individual facial regions contributes to face recognition and performance under conditions involving holistic face processing.

Methods

Participants

An a priori power analysis was conducted using G*Power ([Faul et al., 2007](#)) to determine the minimum sample size required for the planned analyses. The calculation was based on a 2×2 repeated-measures analysis of variance (ANOVA) with two within-subject factors: facial distinctiveness (distinctive vs. non-distinctive) and tested facial half (upper vs. lower). Assuming a medium effect size ($f = .25$), a significance level of $\alpha = .05$, and a statistical power of .80, the analysis indicated that a minimum sample of 95 participants was required.

Participants were recruited through the Participant Pool of the Faculty of Psychology at the University of Liège. Inclusion criteria required participants to be between 18 and 30 years of age, to have normal or corrected-to-normal vision, and to report no history of neurological or psychiatric disorders likely to affect face-processing abilities (e.g., prosopagnosia). Participation was voluntary, and first-year psychology students received course credits in exchange for their participation.

A total of 106 participants were initially recruited. Two participants were excluded because of visual impairments that could interfere with performance on the face-perception task. The final sample therefore consisted of 104 participants. Of these, 83 were women (79.8%) and 21 were men (20.2%). Participants had a mean age of 20.20 years ($SD = 2.95$, range = 18–30 years). Regarding handedness, 93 participants were right-handed (89.4%) and 11 were left-handed (10.6%). Regarding ethnic background, 87 participants identified as European (83.7%), 7 as North African (6.7%), 7 as African (6.7%), and 3 as Turkish (2.9%). All participants were French-speaking. The study was approved by the Ethics Committee of the University of Liège, and all participants provided informed consent prior to participation.

Materials

Stimuli Preparation

The stimuli were created using the GNU Image Manipulation Program ([GIMP; Version 3.0.0; The GIMP Development Team, 2025](#)). A total of 36 celebrity identities were selected for the experimental stimuli, comprising 18 female and 18 male faces. In addition, four supplementary

identities (two female and two male) were used exclusively during the training phase and were not included in the experimental trials. The celebrity identities were selected from a pilot study previously conducted in the laboratory by an intern. During this pilot study, participants rated the distinctiveness of the upper and lower facial halves separately. In addition, media exposure was controlled using the IMDb StarMeter rankings, a proprietary index reflecting the popularity of actors and public figures based on user activity on the IMDb platform. The mean distinctiveness ratings and standard deviations obtained during the pilot study for male and female celebrity identities across the different stimulus categories are presented in [Table 1](#).

For the present study, the celebrity identities were selected according to several criteria to ensure the consistency and suitability of the experimental stimuli. First, identities were chosen based on the stability of their facial appearance, as established through ratings obtained in previous studies. More specifically, selected celebrities displayed relatively stable facial characteristics over time and were not substantially affected by changes in hairstyle, facial hair, or makeup. This criterion was intended to minimise variability unrelated to facial distinctiveness and to ensure that participants recognised each identity based primarily on stable facial features ([Figure 5](#)).

Table 1

Mean and standard deviation of distinctiveness ratings obtained during the pilot study according to gender, stimulus category, and facial half

Gender	Stimulus category	Upper half M (SD)	Lower half M (SD)
Female	Distinctive TOP	4.44 (0.68)	2.77 (0.35)
	Distinctive BOTTOM	3.24 (0.51)	4.27 (0.09)
	Non-distinctive	3.20 (0.25)	2.82 (0.45)
Male	Distinctive TOP	4.12 (0.29)	3.05 (0.39)
	Distinctive BOTTOM	3.38 (0.42)	4.28 (0.45)
	Non-distinctive	3.22 (0.41)	2.87 (0.38)

Note. *M* = mean; *SD* = standard deviation. Distinctiveness ratings were obtained separately for the upper and lower facial halves during the pilot study. The ratings were used to classify

celebrity identities into distinctive upper-half, distinctive lower-half, and non-distinctive categories before selecting the final experimental stimuli. Comparable rating patterns across male and female identities indicate that the manipulation of facial distinctiveness was balanced across genders.

Figure 5

Illustration of stability versus non-stability in facial appearance



Note. The top image depicts Adam Sandler, whose facial features remain consistent over time, representing stability. The bottom image shows Jared Leto, whose varying hairstyles and facial hair exemplify non-stability.

Second, the selected faces could **not be globally distinctive**. Instead, identities were chosen so that facial distinctiveness was localized to a single facial region rather than distributed across the entire face. Consequently, each celebrity possessed either a distinctive upper half or a distinctive lower half, but not both simultaneously. This selection criterion ensured that the experimental manipulation specifically targeted one facial region, thereby allowing any observed effects to be attributed to local facial distinctiveness rather than to the overall uniqueness of the face. Furthermore, only well-known celebrities were selected to maximise the likelihood that participants were familiar with the identities. In combination with the control

of media exposure using IMDb StarMeter rankings, this criterion helped minimise variability associated with differences in participants' familiarity with the selected celebrities, ensuring that performance was primarily influenced by the manipulation of facial distinctiveness rather than by unequal levels of prior exposure to the identities.

For the main experimental stimuli, there were six male distinctive tops and six female distinctive tops, resulting in 12 distinctive top halves in total. There were also six male distinctive bottoms and six female distinctive bottoms, resulting in 12 distinctive bottom halves in total. Non-distinctive top and bottom halves were used to construct non-distinctive match trials and control trials. Separate training stimuli were used for the practice trials and were not included in the main experimental trials.

Based on this list, the images used in the present study were located through Google Images searches. Image selection criteria included: good image quality, a neutral facial expression, a straight gaze, and little to no facial hair or makeup. Selected photographs were cropped into an oval shape to remove external facial information such as hair, ears, and background cues. Faces were then divided horizontally at the level of the nose bridge to create independent upper and lower face halves. The facial stimuli were presented in grayscale, with contrast and other low-level visual properties controlled across images, and all celebrity identities included in the stimulus set were White individuals.

Unlike traditional composite-face paradigms that compare aligned and misaligned conditions, the present experiment included only aligned composite faces to investigate the influence of facial distinctiveness under conditions that promote holistic face processing. The experimental stimuli were created from a fixed set of upper and lower facial halves selected during the pilot study. Each composite face consisted of the upper half of one celebrity identity combined with the lower half of a different celebrity identity. To prevent participants from recognising an original identity, facial halves originating from the same celebrity were never combined within the same composite. In addition, male and female facial halves were never paired together. Each composite face measured 173×256 pixels and contained a constant horizontal gap separating the two facial halves. During each trial, two composite faces were presented simultaneously with a fixed vertical offset and a constant centre-to-centre separation ([Figure 6](#) and [Figure 7](#)). These spatial parameters were kept identical across all trials to ensure that performance differences reflected the experimental manipulation rather than variations in stimulus configuration. Because the stimuli were assembled dynamically during the experiment, all face halves were prepared using identical image dimensions and standardized positioning

procedures to ensure consistency across stimulus combinations. This approach allowed the manipulation of facial distinctiveness while preserving the holistic appearance characteristic of aligned composite faces.

Figure 6

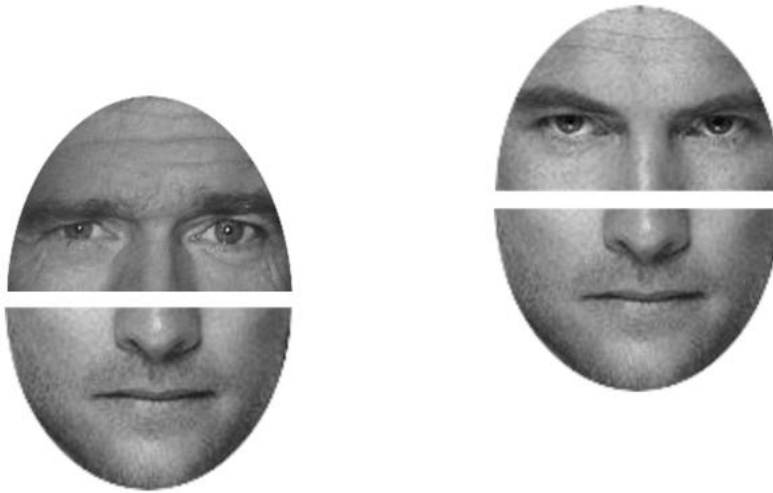
Example of aligned composite-face stimuli used in the experiment (Female faces)



Note. The bottom facial regions are identical, whereas the top facial regions differ. Despite the identical bottom regions, the two composites are typically perceived as different identities, illustrating the composite face illusion.

Figure 7

Example of aligned composite-face stimuli used in the experiment (Male faces)



Note. The bottom facial regions are identical, whereas the top facial regions differ. Despite the identical bottom regions, the two composites are typically perceived as different identities, illustrating the composite face illusion.

Procedure

Task Implementation

The experiment was administered on the Testable platform as a computerized composite-face matching task (Rezlescu et al., 2020). Data collection took place in a laboratory setting, where participants completed the experiment individually in a quiet testing room under controlled lighting conditions. These conditions were maintained throughout testing in order to limit visual distractions and provide a consistent environment for viewing the facial stimuli. Participants performed the task on a desktop computer and were seated 60 cm from the monitor. The experimental procedure required participants to compare two composite faces presented simultaneously and to determine whether a predefined target region of the two faces was identical or different.

The task was organised into two experimental blocks: a **Top** matching block and a **Bottom** matching block. The distinction between the blocks concerned the facial region that participants were required to judge. In the Top matching block, participants attended exclusively to the top

halves of the two composite faces and determined whether these regions were exactly the same or different, while disregarding the information contained in the bottom halves. In the Bottom matching block, the reverse instruction applied: participants compared the bottom halves and ignored the top halves. Written instructions in French were presented before each block to specify which facial region constituted the target for the upcoming trials and to remind participants of the response requirements.

The order in which the two blocks were completed was counterbalanced across participants. One group performed the Top matching block first and subsequently completed the Bottom matching block, whereas the other group received the opposite block order. Counterbalancing was implemented to distribute any effects associated with practice, fatigue, or increasing familiarity with the task across the two matching conditions, rather than systematically confounding these effects with the facial region being tested. Within each block, the individual experimental trials were presented in a randomised order for each participant, preventing the sequence of trial conditions from becoming predictable over the course of the task.

Before proceeding to the main experimental trials, participants completed a short training phase using the supplementary identities reserved specifically for practice. The purpose of this phase was to familiarise participants with the appearance of the composite stimuli, the requirement to selectively judge one facial half while ignoring the other, and the response procedure. Unlike the experimental phase, feedback was provided following responses during training, allowing participants to determine whether they were applying the matching instructions correctly. Once the experimental trials began, no accuracy feedback was provided, thereby preventing feedback from influencing participants' subsequent judgements.

Response mapping was counterbalanced across participants independently of the block-order manipulation. For one response-mapping group, pressing the F key indicated that the two target halves were the “same,” whereas pressing the J key indicated that they were “different.” For the other group, this assignment was reversed, with F corresponding to “different” and J to “same.” The use of two response mappings distributed any potential differences associated with the response keys across the two response categories and prevented either “same” or “different” judgements from being systematically associated with a single key throughout the sample.

Each experimental trial followed an identical temporal sequence. A fixation cross was initially displayed at the centre of the screen for 1000 ms, orienting participants towards the central region of the display before presentation of the faces. Immediately afterwards, two aligned

composite faces appeared simultaneously and remained visible for a maximum of 3000 ms. The two faces occupied different horizontal positions and were also vertically offset, with the composite presented on the right positioned higher than the composite presented on the left (see [Figure 6, 7 and 8](#)). Participants made their same–different judgement during this 3000-ms presentation period by pressing the appropriate F or J key according to their assigned response mapping. Their judgement concerned only the facial half designated as relevant for the current block; the other half had to be ignored. After completion of the trial (by either a response or the end of the 3000-ms limit), the following trial began with another 1000-ms fixation cross before presentation of the next pair of composite faces. Two consecutive trials and the response mapping used in the experiment are represented schematically in [Figure 8](#), illustrating the alternating sequence of fixation and stimulus presentation.

The 3000-ms stimulus presentation also constituted the maximum response window. When a participant failed to respond before the end of this interval, the trial terminated automatically and Testable recorded the observation as a *timeout* rather than as a valid same–different response. Timeout trials were rare in the final analytical sample, with 31 of 7,488 experimental trials (0.41%) recorded as timeouts. Participants therefore provided a response within the allotted interval on 99.59% of trials, indicating that failures to respond within the 3000-ms response window represented only a negligible proportion of the observations.

The main experiment comprised 72 trials per participant, divided equally between the Top and Bottom matching blocks, with 36 trials presented in each block. Within each block, trials varied according to two characteristics: the matching status of the task-relevant halves and the distinctiveness of the target facial region. These characteristics produced four trial categories: match–distinctive, match–non-distinctive, non-match–distinctive, and non-match–non-distinctive. Match and non-match trials were equally represented, with 18 trials of each type. Within both matching-status conditions, 6 trials involved distinctive target halves and 12 involved non-distinctive target halves. Each block therefore contained 12 distinctive and 24 non-distinctive trials, corresponding to a 1:2 ratio, and the experiment as a whole contained 24 distinctive and 48 non-distinctive trials.

On match trials, the task-relevant halves presented in the two composite faces originated from the same identity and required a “same” response. On non-match trials, they originated from different identities and required a “different” response. The equal representation of these two trial types ensured that neither response was more frequent within the experiment. In all four trial categories, the task-irrelevant facial regions were non-distinctive. The distinctiveness

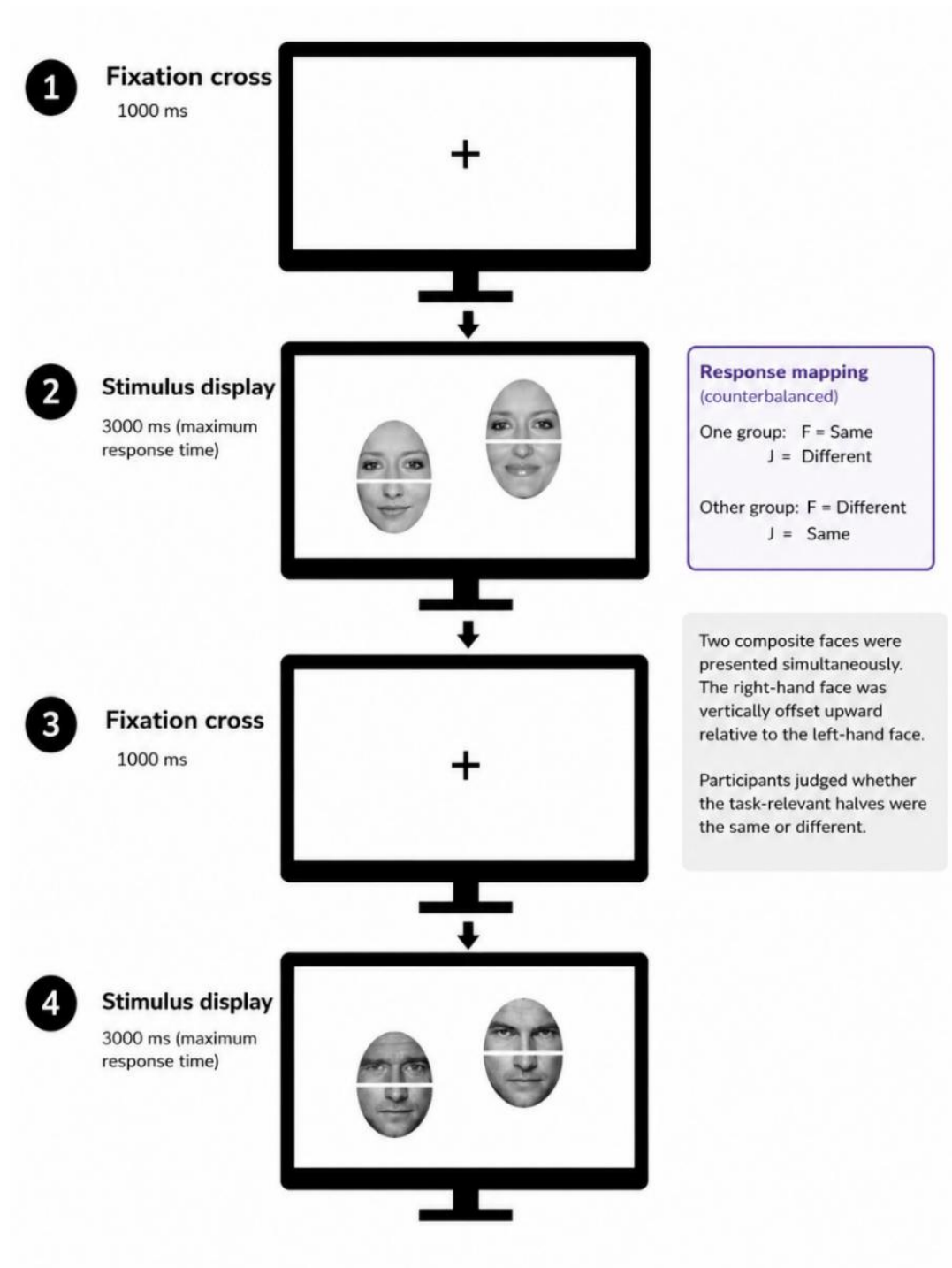
manipulation therefore concerned specifically the target facial region on which participants were instructed to base their judgement.

In the Top matching block, this experimental structure was applied to the upper facial region. The top halves constituted the targets, whereas the non-distinctive bottom halves provided the task-irrelevant information that participants were instructed to disregard. In the Bottom matching block, the allocation of the facial regions was reversed: the bottom halves constituted the targets, and the non-distinctive top halves were task-irrelevant. The same distribution of match, non-match, distinctive, and non-distinctive trials was used in both blocks. Consequently, the overall structure and response requirements of the task remained constant, with only the facial region relevant to the judgement changing between blocks. This equivalence permitted performance in the Top and Bottom matching blocks to be compared directly.

Gender was also balanced within each of the four trial categories. The 6 trials in each distinctive condition comprised 3 female and 3 male trials, whereas the 12 trials in each non-distinctive condition comprised 6 female and 6 male trials. Thus, although distinctive and non-distinctive trials occurred at different frequencies, female and male faces were equally represented within each level of distinctiveness and matching status. This distribution prevented the gender of the facial stimuli from being systematically associated with a particular experimental condition. The complete organisation of the trial categories and their distribution across the Top and Bottom matching blocks is summarised in [Figure 9](#).

Figure 8

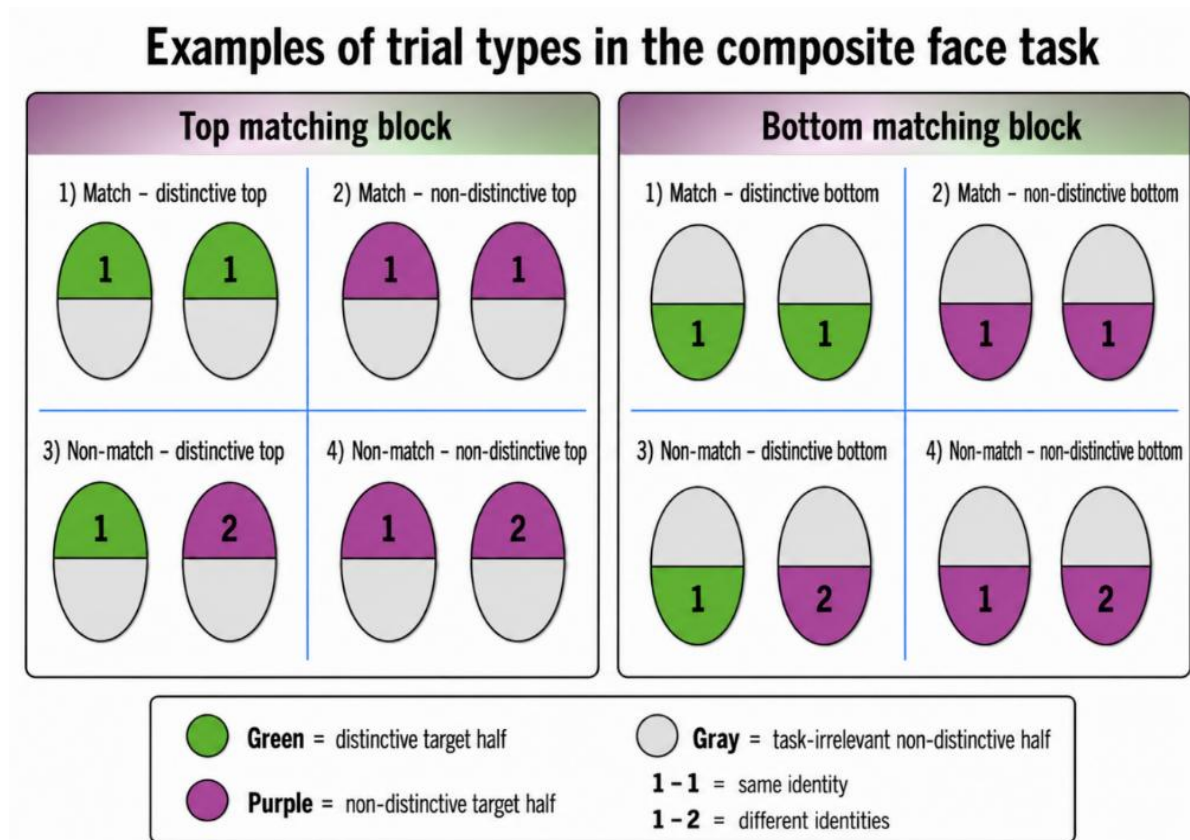
Illustration of the experimental trial



Note. Schematic representation of two consecutive experimental trials in the composite-face matching task. Each trial began with a fixation cross presented for 1000 ms, followed by the simultaneous presentation of two composite faces for a maximum response period of 3000 ms.

Figure 9

Schematic representation of the trial categories in the Top and Bottom matching blocks



Note. Green represents a distinctive target half, purple represents a non-distinctive target half, and grey represents the task-irrelevant non-distinctive half. Numerical labels indicate whether the target halves corresponded to the same identity (1–1) or different identities (1–2). Each distinctive condition comprised six trials (three female and three male), whereas each non-distinctive condition comprised 12 trials (six female and six male), resulting in 36 trials per block and 72 experimental trials overall.

Data processing and statistical analyses

All data analyses were conducted in R ([Version 4.3.1; R Core Team, 2023](#)). Before statistical analyses, the dataset was screened for participant-level exclusion criteria, practice trials, invalid responses, and stimulus-coding errors. Participants who reported vision problems that could interfere with their ability to perceive the facial stimuli accurately were excluded. Two participants met this criterion, leaving 104 participants in the analytical sample. Practice trials were removed because they were included only to familiarise participants with the task.

Following participant-level exclusions and removal of practice trials, the dataset contained 7,488 experimental observations. Preliminary error-rate descriptives showed that the highest error rate occurred in bottom-half distinctive mismatch trials ($M = .091$), compared with lower error rates in the other match/mismatch conditions ($M_s = .050-.074$). To determine whether this reflected a general condition-level effect or was disproportionately influenced by a fixed stimulus pair, an item-level diagnostic was conducted across the six stimulus pairs in this condition, with male and female pairs considered together. Error rates were calculated for each fixed stimulus pair and evaluated using both an interquartile-range criterion and a median absolute deviation criterion. The Connelly-Linney pair produced 30 errors out of 104 presentations, corresponding to an error rate of .288. This was substantially higher than the remaining five stimulus pairs in the same condition, whose error rates ranged from .038 to .067. Across the six pairs, the median error rate was .053. The Connelly-Linney pair exceeded both the interquartile range (IQR) outlier threshold (.090) and the median absolute deviation (MAD) outlier threshold (.096), with a robust MAD z score of 16.53, and was therefore identified as an extreme stimulus-pair observation. This pair was removed from the primary analyses; no additional participants or stimulus pairs were excluded. After removal of this pair, the primary dataset contained 7,384 experimental observations. The full item-level diagnostic is provided in [Appendix A](#).

The main within-subject factors were tested half, with two levels, top and bottom, and distinctiveness, with two levels, distinctive and non-distinctive. Sensitivity was assessed using mean d' . For each participant and condition, hits, misses, false alarms, and correct rejections were calculated. A hit was defined as a mismatch trial on which the participant correctly responded that the two target halves were different. A miss was a mismatch trial on which the participant failed to identify that the halves were different. A false alarm was a match trial on which the participant incorrectly responded that the halves were different. A correct rejection was a match trial on which the participant correctly responded that the halves were the same. Hit and false-alarm rates equal to 0 were replaced with .01, and rates equal to 1 were replaced with .99, to avoid infinite z scores. The existing d' calculation was then applied.

Timeouts were retained as incorrect responses in accuracy-based analyses, including error rate and d' , because the task required a correct same/different response within the 3000-ms response window. Thus, timeout trials on mismatch trials contributed to misses, whereas timeout trials on match trials contributed to false alarms. Reaction-time analyses were restricted to trials on which participants gave a correct response and a valid positive reaction

time was recorded. No additional reaction-time trimming was applied. A supplementary IQR diagnostic of participant-level condition mean RTs identified no low-end outliers, indicating that there was no evidence for implausibly fast responding at the condition-mean level. Some high-end condition means were flagged, but these were retained because no a priori reaction-time trimming rule had been specified and analyses were based on correct participant-level condition means.

For mean d' and correct reaction time (i.e., reaction times from trials on which participants gave the correct response), separate 2×2 repeated-measures ANOVAs were conducted with tested half and distinctiveness as within-subject factors. To examine whether the effects differed between same and different trials, and to evaluate whether reaction-time patterns were accompanied by corresponding error-rate differences, correct reaction time and error rate were also analysed using $2 \times 2 \times 2$ repeated-measures ANOVAs with tested half, distinctiveness, and trial condition as within-subject factors. Participant identity was included in the error structure to account for the dependency between repeated measurements from the same participant. Partial eta squared (η^2) was reported as an effect size for every ANOVA main effect and interaction. For significant main effects, means and standard deviations were calculated after first averaging within each participant across the factor or factors not involved in the effect. Figures show within-participant standard errors, calculated following the normalization approach described by [Morey \(2008\)](#).

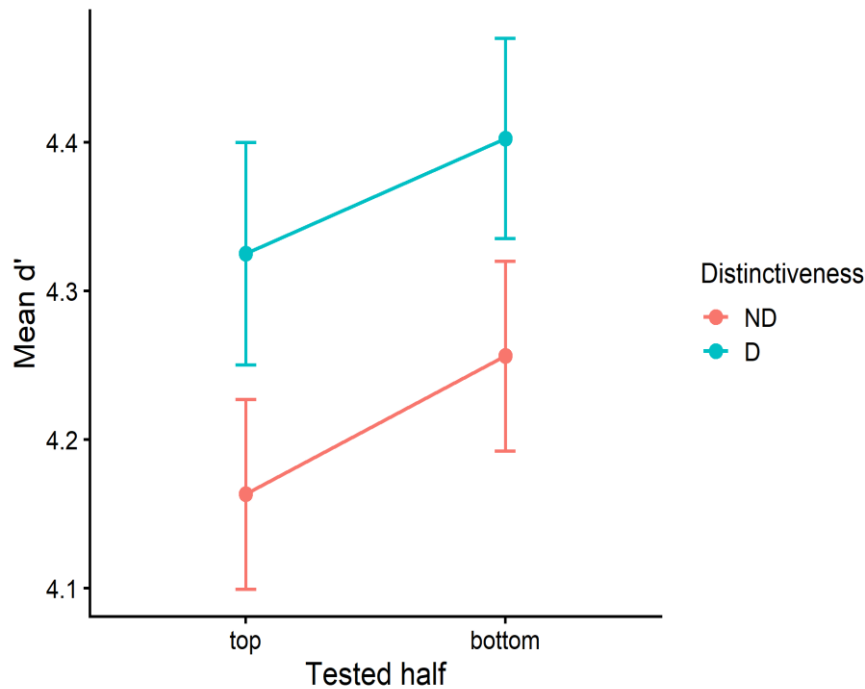
Results

Mean d'

The 2×2 repeated-measures ANOVA conducted on mean d' revealed no significant main effect of tested half ($F(1, 103) = 1.58, p = .211, \eta^2 = .015$). A significant main effect of distinctiveness was observed ($F(1, 103) = 5.15, p = .025, \eta^2 = .048$; see [Figure 10](#)). Mean d' was higher for distinctive target halves ($M = 4.36, SD = 0.84$) than for non-distinctive target halves ($M = 4.21, SD = 0.67$). The tested half $\times$ distinctiveness interaction was not significant, $F(1, 103) = 0.01, p = .909, \eta^2 < .001$.

Figure 10

Mean d' as a function of tested half and distinctiveness



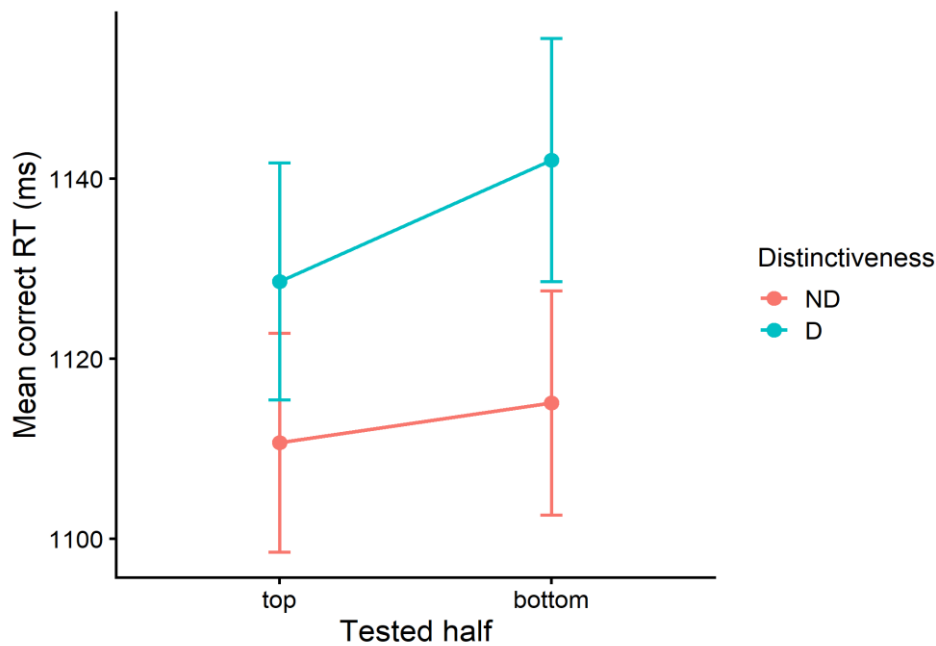
Note. Mean d' is shown separately for top and bottom tested halves and for distinctive (D) and non-distinctive (ND) target halves. Error bars represent within-participant standard errors calculated using the normalization method described by [Morey \(2008\)](#).

Correct Reaction Time

The 2×2 repeated-measures ANOVA conducted on mean correct reaction time revealed a significant main effect of distinctiveness, $F(1, 103) = 7.85, p = .006, \eta p^2 = .071$. Mean correct reaction time, averaged across tested half, was slower for distinctive target halves ($M = 1135.35$ ms, $SD = 271.28$) than for non-distinctive target halves ($M = 1112.90$ ms, $SD = 262.67$; see [Figure 11](#)). Neither the main effect of tested half ($F(1, 103) = 0.22, p = .641, \eta p^2 = .002$), nor the tested half $\times$ distinctiveness interaction ($F(1, 103) = 0.32, p = .570, \eta p^2 = .003$) was significant.

Figure 11

Mean correct reaction time as a function of tested half and distinctiveness



Note. Mean correct reaction time is shown separately for top and bottom tested halves and for distinctive (D) and non-distinctive (ND) target halves. Reaction times are based on correct-response trials only. Error bars represent within-participant standard errors calculated using the normalization method described by [Morey \(2008\)](#).

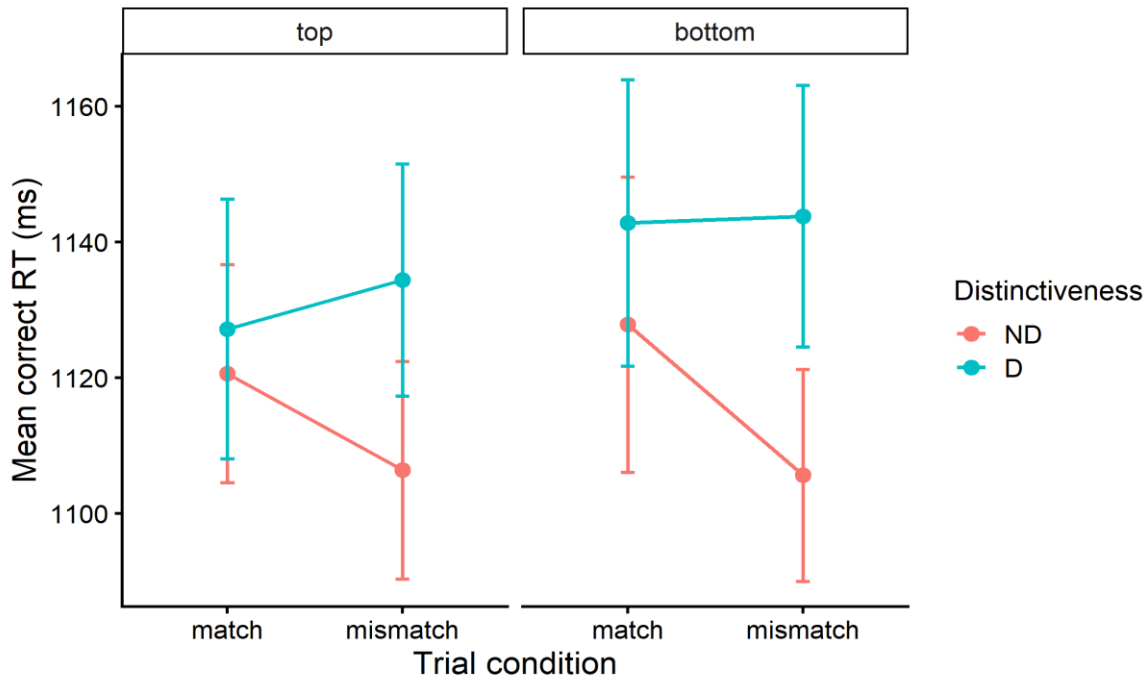
Match/Mismatch Reaction Time

The $2 \times 2 \times 2$ repeated-measures ANOVA conducted on mean correct reaction time showed a significant main effect of distinctiveness, with slower responses for distinctive target halves than for non-distinctive target halves ($F(1, 103) = 7.81, p = .006, \eta p^2 = .070$). Mean correct reaction time, averaged across tested half and trial condition, was slower for distinctive target halves ($M = 1137.07$ ms, $SD = 273.01$) than for non-distinctive target halves ($M = 1115.11$ ms, $SD = 265.33$). The main effects of tested half ($F(1, 103) = 0.16, p = .689, \eta p^2 = .002$) and trial condition ($F(1, 103) = 0.13, p = .720, \eta p^2 = .001$) were not significant.

None of the interactions reached significance: tested half $\times$ distinctiveness ($F(1, 103) = 0.32, p = .574, \eta p^2 = .003$), tested half $\times$ trial condition ($F(1, 103) = 0.08, p = .774, \eta p^2 = .001$), distinctiveness $\times$ trial condition ($F(1, 103) = 1.97, p = .164, \eta p^2 = .019$), or tested half $\times$ distinctiveness $\times$ trial condition ($F(1, 103) = 0.003, p = .959, \eta p^2 < .001$). The pattern of correct reaction times across tested half, distinctiveness, and trial condition is shown in [Figure 12](#).

Figure 12

Mean correct reaction time as a function of tested half, distinctiveness, and trial condition



Note. Mean correct reaction time is shown separately for top and bottom tested halves, distinctive (D) and non-distinctive (ND) target halves, and match and mismatch trials. Reaction times are based on correct-response trials only. Error bars represent within-participant standard errors calculated using the normalization method described by [Morey \(2008\)](#).

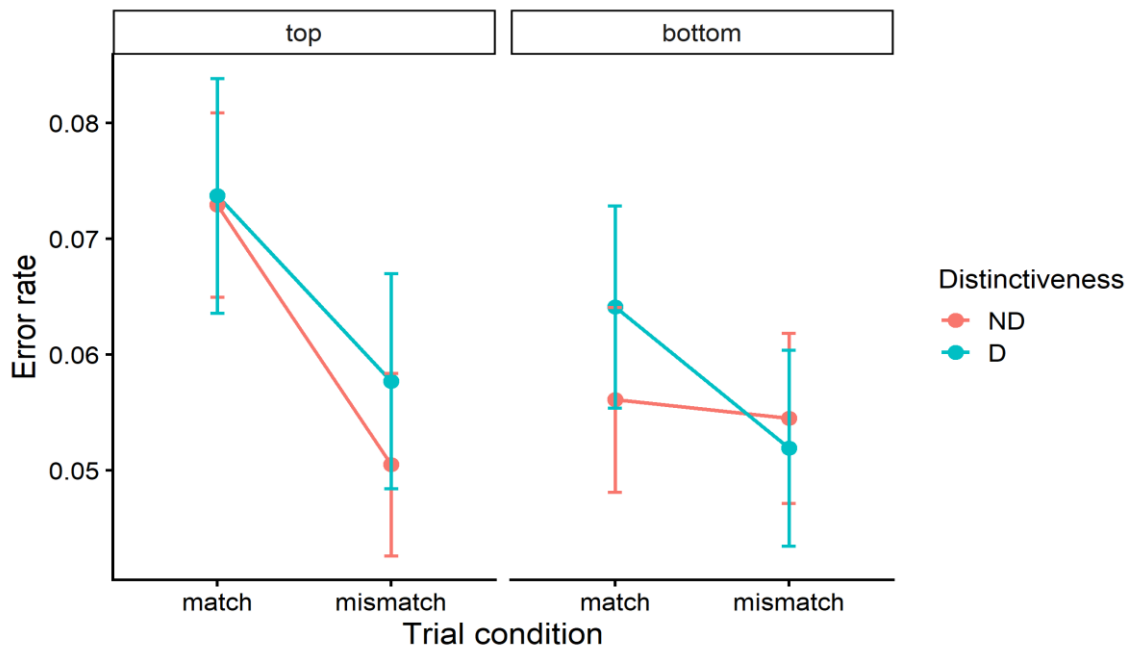
Error Rate

The $2 \times 2 \times 2$ repeated-measures ANOVA conducted on error rate showed no evidence that errors varied systematically as a function of tested half, distinctiveness, or trial condition. The main effects of tested half ($F(1, 103) = 1.67, p = .199, \eta p^2 = .016$), distinctiveness ($F(1, 103) = 0.37, p = .543, \eta p^2 = .004$), and trial condition ($F(1, 103) = 2.42, p = .123, \eta p^2 = .023$) were not significant. None of the interactions reached significance: tested half $\times$ distinctiveness ($F(1, 103) = 0.01, p = .906, \eta p^2 < .001$), tested half $\times$ trial condition ($F(1, 103) = 1.05, p = .308, \eta p^2 = .010$), distinctiveness $\times$ trial condition ($F(1, 103) = 0.04, p = .848, \eta p^2 < .001$), or tested half $\times$ distinctiveness $\times$ trial condition ($F(1, 103) = 0.64, p = .427, \eta p^2 = .006$). The pattern of error rates across tested half, distinctiveness, and trial condition is shown in [Figure 13](#). Because distinctive target halves showed slower correct reaction times, the error-rate

analysis was also used to assess whether this was accompanied by a corresponding reduction in errors. This was not supported, as neither the main effect of distinctiveness nor the distinctiveness $\times$ trial condition interaction was significant.

Figure 13

Error rate as a function of tested half, distinctiveness, and trial condition



Note. Mean error rate is shown separately for top and bottom tested halves, distinctive (D) and non-distinctive (ND) target halves, and match and mismatch trials. Error bars represent within-participant standard errors calculated using the normalization method described by [Morey \(2008\)](#).

Discussion

The present study investigated how facial distinctiveness influences face-part discrimination within the composite-face paradigm. Participants judged whether a task-relevant facial half matched across two composite faces while ignoring the other half, with the distinctiveness of the target region systematically manipulated. By examining distinctive and non-distinctive facial information within aligned composite faces, the study directly brought together two central areas of face-perception research: the diagnostic value of local facial information and the tendency to integrate facial regions into a unified perceptual representation. This approach

provided a means of determining whether locally distinctive information remains sufficiently accessible to influence discrimination when it is presented within a perceptual context that promotes integration across facial regions.

The findings are particularly relevant to theoretical accounts concerning the relative contributions of holistic and feature-based processing. Strong holistic accounts propose that facial parts are integrated into a unified representation and are consequently difficult to process independently (Tanaka & Farah, 1993), whereas feature-based accounts emphasise the contribution of individual facial components to recognition (Macho & Leder, 1998; Rakover & Teucher, 1997). Intermediate and dual-process accounts instead propose that holistic and featural information both contribute to face recognition, with their relative influence varying according to the quality of the available facial information and the perceptual demands of the task (Cabeza & Kato, 2000; Goffaux, 2012). A related debate concerns the temporal organisation of these processes. Global-to-local accounts propose that an initially coarse and holistic representation is followed by progressively finer analysis of local facial information (Sergent, 1986), whereas local-to-global accounts suggest that individual features may become available before being integrated into a more complete facial representation (Fitousi, 2019). Within this theoretical framework, the manipulation of target distinctiveness provided an informative test of whether diagnostically valuable local information continues to influence performance when the organisation of the stimulus encourages holistic integration.

The results revealed greater perceptual sensitivity for distinctive than for non-distinctive target halves, indicating that participants were better able to discriminate matching from mismatching facial regions when the task-relevant information was distinctive. This advantage did not differ between judgements of the upper and lower halves, showing that the contribution of distinctiveness was not confined to a particular facial region. There was also no overall difference in sensitivity between upper- and lower-half judgements. The sensitivity findings therefore supported the prediction that distinctive facial information would facilitate face-part discrimination across both target locations. The reaction-time results, however, revealed a different pattern: correct responses were slower for distinctive targets, contrary to the original prediction that distinctiveness would improve both sensitivity and response speed. Neither tested half nor match/mismatch trial condition produced an overall difference in correct reaction time, and none of the interactions was significant, indicating that the temporal cost associated with distinctive targets was consistent across facial regions and trial types. The error-rate analyses likewise revealed no significant effects of tested half, distinctiveness, or trial condition

and no interactions among these factors. These measures capture different aspects of performance, as d' reflects participants' ability to distinguish mismatching targets from matching targets while accounting for false-alarm tendencies, whereas error rate represents the overall proportion of incorrect responses. Taken together, the findings show that distinctive information enhanced perceptual sensitivity without producing a uniform improvement across every measure of performance. Instead, greater sensitivity was accompanied by a longer decision time, raising the possibility that the processing of distinctive facial information involves a trade-off between discrimination sensitivity and response speed.

The sensitivity advantage can first be understood in relation to [Valentine's \(1991\)](#) face-space framework. According to this account, distinctive identities are represented in relatively sparsely populated regions of face-space and are therefore less confusable with neighbouring identities than more typical faces, which occupy densely populated regions closer to the central tendency. Although the present task involved discrimination between facial halves rather than recognition of complete identities, the underlying principle of enhanced discriminability remains directly relevant. Distinctive target halves are likely to contain facial information that separates the identities from which they were derived more effectively than comparatively typical target halves. Their location within a less densely represented region of the perceptual space may consequently have reduced the similarity between competing identity signals and supported more precise discrimination. Importantly, this advantage remained evident when the target region was embedded within an aligned composite face and participants were required to disregard the information supplied by the other facial half. The principle of distinctiveness proposed within face-space therefore appears to extend beyond the recognition of whole identities to the discrimination of diagnostically informative facial regions.

More broadly, the findings help situate the present results within the theoretical accounts of face processing outlined above. The reliable influence of target distinctiveness challenges the strongest version of a strictly holistic account in which individual facial regions make little independently accessible contribution to performance. Manipulating the diagnostic value of a single target region systematically altered discrimination sensitivity, demonstrating that information contained within that region remained behaviourally influential despite its incorporation into a complete aligned face. Moreover, successful discrimination was not restricted to distinctive targets: participants were also able to discriminate non-distinctive halves, although with lower perceptual sensitivity. Local facial information therefore remained accessible even when it was comparatively typical and less diagnostic, while the greater

sensitivity for distinctive targets demonstrates that the strength of its contribution varied according to its discriminability. This graded pattern supports a moderate or flexible holistic–feature account in which featural information makes a substantial contribution to face perception without requiring the complete independence of individual facial regions. The present design did not include the alignment or congruency comparisons traditionally used to calculate the magnitude of composite interference directly (Rossion, 2013). However, this does not diminish its central contribution: the results demonstrate that local distinctiveness influences face-part discrimination under aligned viewing conditions specifically selected to promote perceptual integration. The findings therefore support a feature-sensitive intermediate account rather than either a strictly holistic or completely independent feature-based position.

Direct support for this interpretation is provided by Goffaux (2012), who parametrically manipulated the discriminability of local facial features within a congruency paradigm. The magnitude of contextual interference decreased progressively as the target features became more discriminable: highly similar targets were more strongly affected by the surrounding facial information, whereas clearer local differences reduced the influence of the facial context. These findings demonstrate that holistic and featural processing do not operate as mutually exclusive or fixed modes. Instead, their relative contribution varies dynamically according to the strength and discriminability of the task-relevant local signal. The greater perceptual sensitivity observed for distinctive target halves in the present study closely accords with this principle. Distinctive regions provided a stronger and more informative local identity signal, enabling participants to discriminate the relevant halves more successfully despite their presentation within a whole-face context containing task-irrelevant facial information. Considered together, the present findings and those of Goffaux indicate that the accessibility of local facial information is graded by its diagnostic quality: the more discriminable the target region, the more effectively it can guide performance within an integrated facial representation.

The slower responses to distinctive targets add an important dimension to this interpretation by showing that enhanced sensitivity was accompanied by greater temporal demands. Distinctiveness did not facilitate performance uniformly; rather, it improved the quality of discrimination while increasing the time required to produce a correct response. One explanation is that distinctive target halves activated highly diagnostic information associated with familiar identities while simultaneously creating uncertainty because only part of the information normally available for recognition was accessible. Research involving personally familiar faces shows that familiarity can facilitate feature-based processing by directing

perception towards features that are particularly informative for identity ([Visconti di Oleggio Castello et al., 2017](#)). Although the present stimuli depicted celebrities rather than personally familiar individuals, a similar process may have occurred whenever participants recognised the identity represented by a target half. Because only one facial region was relevant and the other originated from a different identity, participants could not rely on the complete familiar face. A distinctive target region may therefore have strongly activated a known identity without immediately providing all the converging information normally used to confirm it. Participants would consequently have needed additional time to retrieve, evaluate, and verify the identity-related information activated by the incomplete facial representation before committing to a same–different judgement.

This interpretation is consistent with evidence-accumulation accounts of binary decision making, according to which information is progressively accumulated until sufficient evidence is available to support one of the possible responses ([Ratcliff & McKoon, 2008](#)). When identity-related information is highly diagnostic but incomplete, the decision process may involve further evaluation before the evidence reaches the level required for a confident response. Applied to the present task, distinctive facial information may have supplied a stronger identity signal while also activating a richer set of stored representations that required additional verification. This would allow participants to arrive at a more sensitive discrimination while taking longer to reach the final decision. The combination of higher d' and slower correct responses can therefore be understood as a trade-off in which the greater diagnostic value of distinctive information improves the eventual quality of discrimination at the cost of increased retrieval, evaluation, or verification time. Rather than indicating a general impairment in processing, the prolonged response time may reflect the more extensive use of identity-relevant information elicited by distinctive facial regions.

The reaction-time pattern also contributes to the broader discussion concerning the temporal organisation of face processing, although it does not by itself establish whether processing proceeded from global to local information or from local information towards a more integrated representation. In binary decision tasks, observed response time reflects both evidence accumulation and non-decision components, including perceptual encoding and motor execution ([Voss et al., 2013](#)). The slower responses to distinctive targets could therefore have resulted from differences in the encoding of the facial information, the activation and verification of identity-related evidence, the accumulation of information towards the decision threshold, the execution of the response, or a combination of these processes. Accordingly, the

present behavioural data do not permit the additional response time to be attributed conclusively to any single component of the processing sequence. The present findings nevertheless demonstrate that diagnostically useful local information influenced performance within a whole-face context and that the use of this information involved measurable temporal consequences. They therefore establish the behavioural contribution of locally distinctive information under conditions that favour facial integration, while leaving the precise temporal sequence of local and global processing open for further investigation. In other words, the results identify a reliable temporal consequence of local distinctiveness without specifying exactly when, or through which processing operation, that consequence emerged. Future studies incorporating time-sensitive measures, variable stimulus durations, or response-deadline manipulations could build directly on these findings by identifying the stage at which the distinctive local signal begins to influence performance.

Familiarity is also central to understanding the present findings because the stimuli depicted well-known celebrities. Devue (2023) demonstrated a positive association between perceived familiarity and perceived distinctiveness for familiar faces, describing this relationship as an illusion of distinctiveness whereby repeated exposure amplifies perceived uniqueness alongside the contribution of intrinsic facial characteristics. The stimulus-selection procedure used in the present study addressed this relationship in several ways. Upper and lower facial halves were classified as distinctive or non-distinctive using independent pilot ratings, while the selection of celebrity identities also considered media exposure and the stability of their facial appearance. These procedures strengthened the manipulation by ensuring that distinctiveness was localised to the target facial region and that the selected identities were broadly comparable in terms of their public visibility and visual consistency. Although individual familiarity with each celebrity was not measured, the deliberate selection of well-known identities maximised the likelihood that participants possessed established representations of the faces used in the task. The observed advantage may therefore reflect the combined contribution of intrinsic visual distinctiveness and identity representations refined through previous exposure. These sources are not mutually exclusive; indeed, Devue's findings indicate that real-world perceived distinctiveness emerges through their interaction. Whatever their relative contribution, the behavioural consequence of the resulting distinctiveness was clear: facial regions previously classified as distinctive supported greater perceptual sensitivity than non-distinctive regions. The present findings therefore extend research on familiarity and distinctiveness by demonstrating that the diagnostic value of distinctive information remains evident at the level

of individual facial regions, even when those regions are incorporated into aligned composite faces. At the same time, the possible contribution of established celebrity representations raises an important question: would the same advantage emerge for previously unfamiliar faces, for which participants had no established identity representation? Addressing this question provides a direct and theoretically informative extension of the present study.

Future Research: A Direct Familiar–Unfamiliar Extension

The clearest next step would therefore be a closely matched follow-up experiment using genuinely unfamiliar, non-celebrity faces. The purpose would not be to manipulate familiarity experimentally or to train participants on previously unknown identities. Instead, the present celebrity experiment and the proposed unfamiliar-face experiment would provide two parallel tests of the same distinctiveness effect under naturally different familiarity conditions. This comparison follows directly from the present findings because [Devue \(2023\)](#) showed that exposure can amplify perceived distinctiveness, while [Megreya and Burton \(2006\)](#) demonstrated that unfamiliar-face identity matching is not simply a less efficient version of familiar-face processing. Testing the same manipulation with unfamiliar faces would consequently help determine whether the sensitivity advantage primarily reflects the intrinsic discriminability of distinctive facial regions or whether it is strengthened by identity representations established through previous exposure.

[Megreya and Burton \(2006\)](#) found substantial individual differences in unfamiliar-face matching and, across several experiments, strong relationships between performance with upright and inverted unfamiliar faces. The relationship between familiar- and unfamiliar-face processing, however, depended on the orientation of the familiar stimuli: unfamiliar-face matching was strongly associated with the processing of inverted familiar faces but not with the processing of upright familiar faces. On this basis, the authors concluded that unfamiliar identities are processed for identity in a qualitatively different manner from familiar identities. Their findings do not suggest that unfamiliar faces are processed without any face-specific information, as performance remained better for upright than for inverted faces. Instead, they indicate that unfamiliar-face matching depends comparatively strongly on image-bound or local visual information, whereas familiar-face processing benefits from more stable identity representations developed through repeated exposure. Unfamiliar faces therefore provide a particularly informative test of the present distinctiveness effect. If their processing relies more

strongly on the currently available visual information, the diagnostic contribution of a distinctive facial half may become especially apparent when no pre-existing identity representation is available.

The follow-up experiment should reproduce the present procedure closely, making familiarity the principal difference between the two studies. Non-celebrity identities would be photographed under standardised conditions and independently rated for the distinctiveness of their upper and lower facial halves. These ratings would allow the construction of distinctive-upper, distinctive-lower, and non-distinctive stimuli while preserving the existing gender balance and keeping the task-irrelevant regions non-distinctive. The facial halves would then be combined into aligned composites using the same dimensions and spatial configuration as in the present experiment. Participants would complete the same Top and Bottom matching blocks, with the same trial composition, temporal sequence, 3000-ms response window, randomisation, and counterbalancing procedures. A post-task familiarity check would verify that the identities were unknown to participants. Using the same dependent measures— d' , correct reaction time, and match/mismatch error rate—would allow direct comparison between the celebrity and unfamiliar-face experiments. The critical question would be whether the sensitivity and reaction-time effects of distinctiveness remain stable when established identity representations are no longer available.

The theoretical predictions follow directly from the present findings. If distinctive halves again produce higher d' for unfamiliar faces, this would demonstrate that the sensitivity advantage can arise from the intrinsic discriminability of local facial information without pre-existing identity representations. Conversely, if the advantage is markedly smaller or absent for unfamiliar faces, this would indicate that previous exposure strengthens the perceptual weighting and usefulness of distinctive identity information. Such a result would extend [Devue's \(2023\)](#) illusion-of-distinctiveness account by showing that familiarity affects not only how distinctive a face appears, but also how effectively its distinctive information guides discrimination.

The reaction-time pattern would provide an additional test of the explanation developed from the present findings. If distinctive targets produce slower but more sensitive responses only for celebrity faces, this would support the proposal that the delay reflects the activation, retrieval, and verification of stored identity information. In contrast, if the same combination of higher d' and slower responses also emerges for unfamiliar faces, the temporal cost may reflect a more general property of processing distinctive visual information. Together, these comparisons

would reveal whether familiarity modifies the sensitivity benefit of distinctiveness, its temporal cost, or both.

Limits

The findings should be considered in light of several limitations that indicate useful directions for extending the present research. First, distinctiveness was operationalised through independent pilot ratings of the upper and lower facial halves. These ratings provided an empirical basis for identifying which regions were perceived as distinctive, but they did not reveal which visual properties produced that perception. This distinction is important because facial identity processing draws on multiple sources of information: feature shape and surface cues make partly separable contributions to familiar-face recognition, while sensitivity also varies across featural and configural facial changes ([Andrews et al., 2016](#); [Logan et al., 2017](#)). A facial half could therefore have been perceived as distinctive because of the shape of a particular feature, the spatial relationships between features, facial texture or contrast, or a combination of these properties. Because the pilot ratings captured an overall judgement of each region rather than the contribution of individual cues, the present study demonstrates that perceived regional distinctiveness enhances discrimination sensitivity without identifying the specific visual information responsible. Future research could combine subjective ratings with objective image measurements or controlled feature manipulations to determine which facial properties contribute most strongly to this advantage.

Second, the task-irrelevant facial halves were consistently non-distinctive. This was a deliberate feature of the design that isolated the distinctiveness manipulation to the region participants were required to judge. However, it remains unknown whether a distinctive irrelevant half would capture more attention and interfere more strongly with target discrimination than a non-distinctive irrelevant half. A future experiment could manipulate the distinctiveness of both the target and irrelevant regions, allowing direct examination of whether distinctive contextual information increases interference, response time, or errors when participants attempt to judge the other facial half.

Third, the item-level diagnostic identified one stimulus pair with an unusually high error rate in the bottom-half distinctive mismatch condition. Importantly, the elevated error rate was confined to this individual pair rather than being distributed across the other stimuli in the same condition, indicating an item-specific anomaly rather than a general difficulty with distinctive

bottom-half mismatches. Its removal was supported independently by both the interquartile-range and median absolute deviation criteria and prevented this atypical pair from disproportionately influencing the condition estimate. No other stimulus pair was excluded. The occurrence nevertheless illustrates the value of examining item-level performance alongside condition-level effects in face-matching research.

Finally, the participant sample and stimulus population were relatively homogeneous. Most participants identified as European, while the celebrity set consisted predominantly of White or White-presenting identities. Own-race faces are generally recognised more accurately than other-race faces ([Meissner & Brigham, 2001](#)), and the Categorization-Individuation Model proposes that perceptual experience, social categorisation, and motivation to individuate jointly contribute to this recognition advantage ([Hugenberg et al., 2010](#)). The demographic correspondence between much of the participant sample and the stimulus population may therefore have facilitated the extraction of diagnostic identity information. Replication with more diverse participant and stimulus populations would determine whether regional distinctiveness produces a comparable discrimination advantage across faces from different racial and ethnic groups.

Conclusion

The present study demonstrates that regional distinctiveness influences face-part discrimination within aligned composite faces. Distinctive target halves produced greater perceptual sensitivity than non-distinctive halves across judgements of both upper and lower facial regions. The absence of an interaction between distinctiveness and the tested half indicates that this sensitivity advantage was not restricted to a particular facial region. However, distinctive targets also required longer correct response times, while overall error rates remained comparable across conditions. Distinctiveness therefore produced a trade-off between discrimination sensitivity and response speed: distinctive information supported more sensitive discrimination but required additional time to reach a correct decision. Although the present behavioural measures cannot identify the precise processing stage responsible for this additional time, they show that the improvement in sensitivity was not accompanied by a general improvement across all measures of performance.

Together, these findings support a flexible and feature-sensitive account of face processing. Participants successfully discriminated both distinctive and non-distinctive halves, showing

that local facial information remained accessible within a context promoting whole-face integration, while the sensitivity advantage for distinctive targets demonstrates that the contribution of this information varied according to its diagnostic value. Because this pattern emerged for aligned composite faces, the findings indicate that diagnostically useful regional information can continue to influence performance when the facial configuration encourages integration across the two halves. At the same time, successful discrimination of non-distinctive halves shows that access to local information was not limited to unusually salient facial regions. Rather, distinctiveness influenced the sensitivity with which this information was used. The results therefore show that the discriminability of local cues meaningfully shapes performance within an integrated facial context. By extending the distinctiveness effect from complete identities to individual facial regions, the present study establishes regional distinctiveness as an important determinant of face-part discrimination and provides a foundation for examining how this contribution develops through familiarity and repeated exposure.

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Appendix

Item-Level Diagnostic for the Connelly-Linney Stimulus Pair

This appendix documents the item-level diagnostic conducted for the bottom-half distinctive mismatch condition. Across the six fixed stimulus pairs in this condition, the Connelly-Linney pair produced 30 errors in 104 presentations (error rate = .288), whereas error rates for the remaining five pairs ranged from .038 to .067. The pair exceeded both the interquartile-range and median absolute deviation thresholds and was therefore removed from the primary analyses. This exclusion concerned a single fixed stimulus pair; no additional stimulus pairs or participants were removed.

Table A1

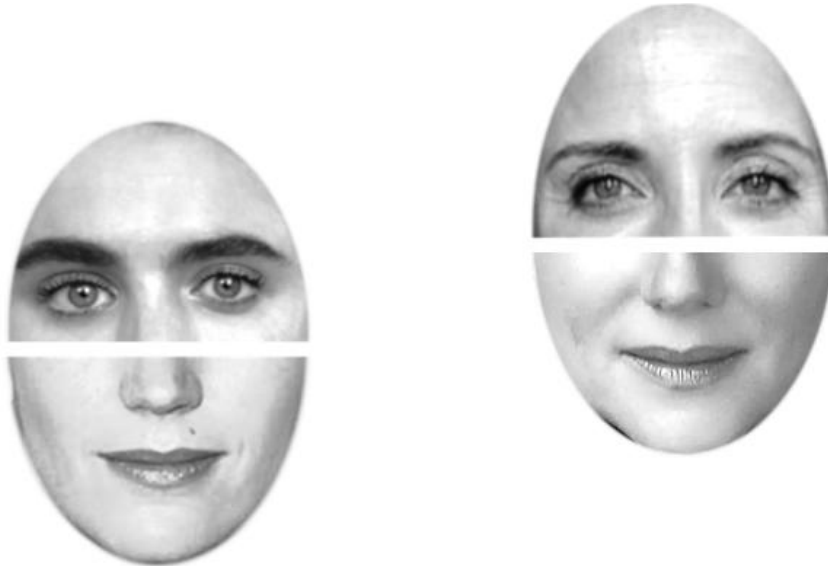
Diagnostic Summary for the Connelly-Linney Stimulus Pair

Diagnostic quantity	Value
Presentations	104
Incorrect responses	30
Error rate	.288
Median error rate across the six pairs	.053
Error-rate range for the remaining five pairs	.038-.067
IQR outlier threshold	.090
MAD outlier threshold	.096
Robust MAD z score	16.53
Decision	Removed from primary analyses

Note. IQR = interquartile range; MAD = median absolute deviation. The two outlier criteria were calculated across the six fixed stimulus pairs in the bottom-half distinctive mismatch condition.

Figure A1

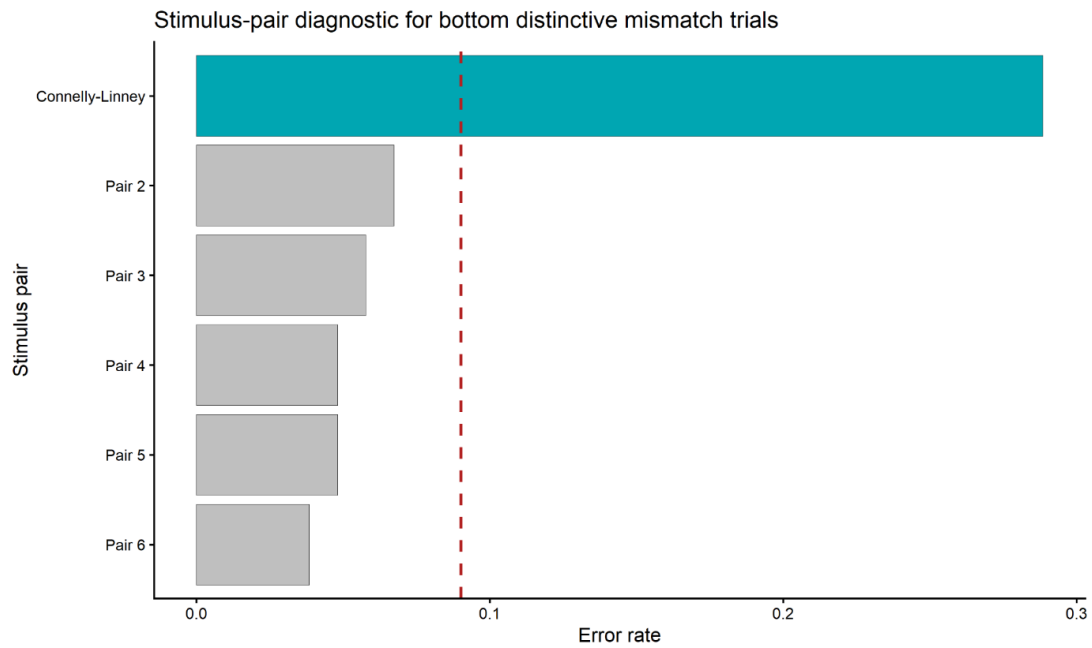
Connelly-Linney Stimulus Pair Removed From the Primary Analyses



Note. The two aligned composite faces formed the fixed Connelly-Linney pair in the bottom-half distinctive mismatch condition. The task-relevant bottom halves were distinctive and originated from different identities, whereas the task-irrelevant upper halves were non-distinctive. The pair produced 30 incorrect responses across 104 presentations (error rate = .288).

Figure A2

Item-Level Error-Rate Diagnostic



Note. Bars represent the error rate for each of the six fixed stimulus pairs in the bottom-half distinctive mismatch condition. The Connelly-Linney pair is highlighted. The red dashed line marks the IQR outlier threshold (.090). The pair also exceeded the MAD threshold (.096; not displayed) and had a robust MAD z score of 16.53. Error rates for the remaining five pairs ranged from .038 to .067.