Holistic processing of face configurations and components

William G. Hayward
School of Psychology and Australian Research Council Centre of Excellence in Cognition and Its Disorders, University of Auckland
Department of Psychology, University of Hong Kong

Kate Crookes
Australian Research Council Centre of Excellence in Cognition and Its Disorders, School of Psychology, University of Western Australia

Ming Hon Chu
Department of Psychology, University of Hong Kong

Simone K. Favelle
School of Psychology, University of Wollongong

Gillian Rhodes
Australian Research Council Centre of Excellence in Cognition and Its Disorders, School of Psychology, University of Western Australia

RUNNING HEAD: Holistic processing of configurations and components

KEYWORDS: Face perception, face recognition, holistic processing, composite task

WORDS (main text): 3169

Comments to:

William G. Hayward
School of Psychology
University of Auckland
Private Bag 92019
Auckland
New Zealand.
E-mail: w.hayward@auckland.ac.nz

Abstract

While many researchers agree that faces are processed holistically, we know relatively little about what information holistic processing captures from a face. Most studies that assess the nature of holistic processing do so with changes to the face affecting many different aspects of face information (e.g., different identities). Does holistic processing affect every aspect of a face? We used the composite task, a common means of examining the strength of holistic processing, with participants making same-different judgments about configuration changes or component changes to one portion of a face. Composites were either aligned or misaligned, and were presented either upright or inverted. Both configuration judgments and component judgments showed evidence of holistic processing, and in both cases it was strongest for upright face composites. These results suggest that holistic processing captures a broad range of information about the face, including both configuration-based and component-based information.

Faces are a highly homogenous class of visual stimuli, yet we are able to recognize them with high levels of accuracy. Considerable evidence now suggests that faces are perceived *holistically*, so that all regions of a face are processed obligatorily (e.g., Rossion, 2008; Maurer, et al., 2002). Nevertheless, little is known about the scope of holistic processing, and in particular, the kinds of information to which it is sensitive. It is well accepted that holistic processing involves sensitivity to *configural* information or the spatial relationships among face features. The connection between holistic processing and configural information is so tight that many researchers consider it unnecessary to distinguish between them, because of an assumption that face-specific processes are holistic in nature and sensitive to configural information about a face (e.g., McKone, 2008; Rossion, 2008; Tanaka & Farah, 1993; Tanaka & Sengco, 1997).

Less clear is whether face component (part or feature) information is also included in the holistic representation. Some accounts view the shape of independent face *components* as also being implicitly represented in the holistic face representation, with limited component information available directly to recognition mechanisms (e.g., Tanaka & Farah, 1993; Tanaka, et al, 2004; Michel, Caldara, & Rossion, 2006; see Piepers & Robbins, 2012). Other accounts have argued that at least some aspects of component information do not form part of the holistic representation and are processed separately. For example, McKone and Yovel (2009) reviewed studies of face inversion and concluded that component colour and brightness are not captured by holistic processing, since such judgments are unaffected by face inversion.

One of the difficulties of drawing conclusions on the basis of the inversion effect is that it is not a direct test of holistic processing. The composite effect (Young, Hellawell, & Hay, 1987; Hole, 1994) is a more direct test of holistic processing. In the composite task, the top half of one face is combined with the bottom half of another face, and participants are asked to attend to one half. Due to holistic processing, judgments of target halves are impaired by changes in the irrelevant halves when upright face composites are aligned (forming the basic face configuration), but not when they are misaligned (e.g., Cheung, Richler, Palmeri, & Gauthier, 2008; Hole, 1994; Le Grand, Mondloch, Maurer, & Brent, 2004; McKone, 2008). The composite task is taken by many researchers to be the "gold standard" to measure holistic face processing (e.g, Maurer, et al., 2002; Rossion, 2013; Richler, Cheung, & Gauthier, 2011), although some present counterevidence that effects of holistic processing in face perception have been overstated (e.g., Gold, Mundy, & Tjan, 2012; Sekuler, Gaspar, Gold, & Bennett, 2004).

Jiang et al (2011) adapted the composite task to assess whether certain types of face information are represented perceptually. They found that shape changes to the irrelevant half of the face affected judgements of the target half whereas surface reflectance changes did not. Jiang et al therefore argued that shape is processed holistically but surface information is not. In this study, we take a similar approach to explore the effects of holistic interference on detection of configural versus component changes. Participants were required to make judgments on configuration or component information in target halves. We then examined whether each judgment is subject to interference from irrelevant portions of the composite (due to holistic processing).

We created a version of the composite task in which target halves (top) differed only in terms of configuration or component information. To test sensitivity to configuration information we varied the distance between the eyes in each face. For component information we varied the lightness of the eyebrows; since McKone and

Yovel (2009) found that component brightness/color, unlike component shape, failed to show strong inversion effects, this property seemed a relatively strong candidate to avoid being captured by holistic processing.

One further issue to consider is whether the composite effect varies by participant and face ethnicity. Michel, et al. (2006) reported that the composite effect is stronger for own-race than other-race faces. However, a number of other studies have tested Caucasian and Chinese participants and have found equally-strong composite effects for own-race and other-race faces by both groups (e.g., Harrison, et al., 2014; Horry, Cheong & Brewer, 2015; Mondloch, et al., 2010; see Hayward, et al., 2013, for a review). Because of the uncertainty regarding population-specific effects, and to ensure the generality of our results, we tested both Chinese participants living in Hong Kong and Caucasian participants living in Australia with both Chinese and Caucasian faces.

Method

Participants

We tested 32 Chinese participants at the University of Hong Kong and 32 Caucasian participants at the University of Wollongong, Australia, in return for either a small payment or course credit. Three Caucasian participants were dropped from the analyses due to a large number of extremely quick (<100 ms) responses.

Stimulus Materials

We used 20 Caucasian and 20 Chinese faces, all male, which were standardised with an interocular distance of 80 pixels. These stimuli were taken from a previous study (Rhodes, Hayward, & Winkler, 2006).

For each individual face, several versions of each target (top) half were created. For configuration changes, the two eye regions were moved simultaneously away from or toward the centre of the face. For component changes, both eyebrows were either lightened or darkened. Specific images were created by morphing between two extreme endpoints for each type of change, and then choosing intermediate values which varied from each other by 10%, 20%, 30%, or 40% as test stimuli. Composites were created by pairing one top half with the bottom-half of another randomly assigned face of the same race. Misaligned composite faces were created by moving the top half to the right by 80 pixels. All composites were shown on a black background with a black line two pixels thick between the halves. Final aligned composite faces had a canvas size of 320 x 420 pixels and misaligned composite faces had a canvas size of 400 x 420 pixels. Example stimuli are shown in Figure 1.

Figure 1 about here

Design

There are a number of ways of testing the composite effect. Following Richler and Gauthier (2013) we use the "complete" design (for discussion of the merits of the various designs see Rossion, 2013; Richler & Gauthier, 2013).[1]

[1] We also provide analyses of the "traditional" design of the composite effect in our supplementary materials. We found only minor differences between the two analyses.

In this experiment, we changed the faces in two ways; either a configural difference (spatial position of the eyes) or component difference (lightness of the eyebrows). For each type of change, we manipulated five independent variables. There were two between-participant variables: Orientation (upright or inverted) and Participant Race (Caucasian or Chinese). There were three within-participant variables. Face composites were either aligned or misaligned, and were either Caucasian or Chinese faces. Finally, signals from the target (top) halves and irrelevant (bottom) halves could be congruent (both same or both different) or incongruent (one same, one different). Under holistic processing we expect congruent trials to be relatively easy because the irrelevant halves provide the same signal as the target half. However incongruent trials would be relatively difficult under holistic processing, because the irrelevant half provides the opposite signal to the target half.

Following removal of the three participants for guessing there were 15 participants (eight Chinese and seven Caucasian) in each of the upright configuration, inverted configuration and upright component conditions, and 16 participants for inverted component composites.

Procedure

The experiment was conducted under normal illumination conditions on a Power Mac G5 computer with a CRT screen (resolution 1280 x 1024 pixels), using Matlab and the Psychophysics toolbox (Brainard, 1997; Pelli, 1997). Participants were told that they would be shown two composite faces on each trial. They were told to attend to the top-halves of the faces and judge whether they were identical. Participants were explicitly told that a response of “same” meant that the two top-halves were identical whereas “different” meant the two top-halves differed in the distance between the eye regions, or the lightness of the eyebrows. Furthermore they were shown a number of examples (of faces not used in the experiment) of the differences that they would need to detect. Responses were made via the keyboard. Due to the difficulty of the task, participants were asked to respond as accurately as possible, and were not given instructions about the speed of their responses.

On each trial, after a fixation cross for 300 ms and a blank screen for 200 ms, the study composite (aligned or misaligned) was shown for 600 ms at the centre of the screen. Following a blank screen of 300 ms, the test composite (same alignment as study) was presented at a position offset by 20 pixels in a random direction from centre. The test face remained on the screen for 3000 ms or until a response was made, whichever was shorter.

Trials were blocked by alignment condition and race of face. The four blocks were run in two 40-minute sessions, held on different days no more than 8 days apart. All participants completed two blocks in the first session and the remaining two blocks in the second session. The order of blocks was counterbalanced with a Latin Square. Each block contained 240 trials.

Results

Under holistic processing, irrelevant (bottom) face halves are expected to influence judgments of target (top) halves, resulting in larger congruency effects for aligned than misaligned composites. Thus, an interaction is expected between congruency and alignment. This interaction is crucial because a main effect of congruency might simply reflect general interference between stimulus features without any particular reference to the face configuration (crucial for holistic processing).

Because of the complexity of our design, we separate our results in two ways. First, we report our results separately for configuration and component changes. Second, we present the results separately for upright and inverted faces, since inversion generally reduces composite effects, so we didn't expect many differences for inverted stimuli (Rossion & Boremanse, 2008; McKone, et al., 2013; but see Richler, Mack, Palmeri, & Gauthier, 2011). The analyses of inverted faces will show, as predicted, relatively few statistically significant effects, and for completeness we provide analyses including orientation at the end of this section.

In all conditions, we calculated d' using the standard formula d' = z(Hits) - z(False Alarms) (Green & Swets, 1966).

Configuration differences

Results are shown in Figure 2 and in the Appendix. We performed a mixed ANOVA for each orientation with one between-participants factor (Race of Participant) and three within-participant factors (Alignment, Congruency, and Race of Face). For upright faces, we found a statistically significant main effect of Congruency, $F(1,13)=56.97$, $p<.001$, $\eta^2=.81$, and a Congruency x Alignment interaction, $F(1,13)=40.82$, $p<.001$, $\eta^2=.76$, showing holistic processing since the congruency effect (influence of irrelevant halves) was larger for aligned than misaligned composites. No other main effects were statistically significant (Fs<1). Race of Face interacted with Alignment, $F(1,13)=4.77$, $p<.05$, $\eta^2=.27$, and with Congruency, $F(1,13)=59.98$, $p<.001$, $\eta^2=.82$, and the three-way interaction of these factors was also significant, $F(1,13)=11.83$, $p<.01$, $\eta^2=.48$, as was the three-way interaction between Race of Face, Race of Participant, and Congruency, $F(1,13)=6.04$, $p<.05$, $\eta^2=.32$. As these results were not theoretically interesting (they appear generally caused by slightly stronger effects for our Chinese than Caucasian stimuli), no further analysis of them was undertaken. Crucially, the four-way interaction of Race of Face, Race of Participant, Congruency, and Alignment was not statistically significant, $F<1$. No other interactions were statistically significant, all *Fs* < 2.6, $p > .13$. In summary, for upright configural judgments, we found a congruency effect for aligned faces that was much weaker for misaligned faces, suggesting holistic processing,. We found no evidence that these effects varied as a function of race expertise.

Figure 2 about here

For inverted faces, there was no evidence for holistic processing. The same ANOVA showed a significant main effect for Congruency, $F(1,13)=5.28$, $p<.05$, $\eta^2=.29$, with higher sensitivity in congruent than incongruent trials, but crucially no Congruency x Alignment interaction, $F<1$. There was also a significant Race of Face x Race of Participant interaction, $F(1,13)=6.02$, $p<.05$, $\eta^2=.32$, as Caucasian participants showed worse performance for own-race faces (largely driven by poor performance on own-race incongruent trials) whereas Chinese participants showed relatively similar performance for the two races. The four-way interaction was marginally significant, $F(1,13)=4.17$, $p=.06$; had it been significant, it would have been because of a particularly large congruency effect by Caucasian participants for misaligned own-race faces. No other effects were statistically significant, all *Fs*<2.2, *p*>.17. Overall, we found a mild congruency effect, but it did not vary with alignment, and therefore is not indicative of holistic processing.

Figure 3 about here

Component differences

Results can be seen in Figure 3 and the Appendix. For upright faces, we found a main effect of Congruency, *F*(1,13)=15.11, *p*<.001, η^2=.54, and an interaction between Congruency and Alignment, *F*(1,13)=16.35, *p*<.001, η^2=.56, indicating holistic coding for component information. The only other statistically significant effect was an interaction between Congruency and Race of Face, *F*(1,13)=8.16, *p*<.05, η^2=.39, because congruency effects were larger for Chinese than Caucasian faces. No other effects were statistically significant, *Fs*<1.8, *p*>.2. This pattern of results is very similar to that found for configuration differences. In other words, judgments of eyebrow lightness were affected by irrelevant information in aligned composites, but much less so in misaligned composites.

For inverted composites, no main effects were statistically significant, but two interactions were significant. The Alignment x Congruency interaction, *F*(1,14)=5.13, *p*<.05, η^2=.27, showed a slight congruency effect for aligned composites but an equal-sized advantage for incongruent stimuli that were misaligned. There was also a significant interaction between Alignment and Race of Participant, *F*(1,14)=6.14, *p*<.05, η^2=.31, because Chinese participants performed better than Caucasians for aligned faces, but Caucasians performed slightly better for misaligned faces. No other effects reached statistical significance, $Fs<2.2$, $p>.16$.

Orientation Effects

To examine more directly the effects of orientation on the size of the composite effect, we computed ANOVAs for each type of change (configuration and component) as above, but included orientation (upright vs inverted) as a between-participants factor. For both analyses (configuration and component), the three-way interaction of Congruency, Alignment, and Orientation was significant (configuration changes: $F(1,26)=31.66$, $p<.001$, $\eta^2=.55$; component changes: $F(1,27)=7.69$, $p<.05$, $\eta^2=.22$), showing that for both change types, the Congruency x Alignment interaction was larger for upright than inverted composites (see Figures 2 and 3).

Discussion

We evaluated whether judgments of facial configurations or components would be affected by holistic processing of irrelevant face information. We found that detection of both types of change showed interference from the irrelevant bottom half of the face, at least for upright face composites. Therefore, the key finding is that component changes are susceptible to holistic processing in the same way that configuration changes are. This is the first direct demonstration that holistic processing includes more than just configural information, but also information about components. Although the term “holistic processing” is widely used in the face perception literature, very little work has sought to understand exactly what it encompasses, and so our result helps us understand the breadth of information that it captures from a face.

For inverted faces, there was no evidence of holistic processing. For configuration changes, there was a main effect of congruency but it did not vary with alignment; component changes did not show a pattern of results that was consistent with holistic processing and the main effect of congruency was not significant. There is a large body of data suggesting that holistic processing of faces is weaker when they are inverted (e.g., Rossion, 2008; McKone & Yovel, 2009), and these results are supported by the interactions with orientation reported above; but see Richler, Mack, et al. (2011) who reported that inverted face composites showed holistic processing effects which had the same magnitude as those observed for upright composites (though the effects required longer presentations of stimuli).

Our results stand in some contrast to previous studies showing holistic processing of configural information, but not component or surface information (e.g., Jiang, et al., 2011; Leder & Bruce, 2000; Le Grand et al., 2001). There are several ways to account for these differences. As has been noted in several recent articles (e.g., Hayward, et al., 2013; Rossion, 2008, 2013; Mondloch, et al., 2010), a number of different tests are used to assess holistic processing, yet these tests correlate poorly with each other. Therefore, they likely measure different aspects of face processing in ways that we are not yet able to clearly characterize. Many studies showing a lack of holistic processing for component information, for example, have used the size of the face inversion effect as a proxy for holistic processing, when inversion may not be a particularly good measure of this construct (e.g., Richler, Mack, et al., 2011; Russell, et al., 2007).

However, not all contrasts in results can be accounted for by the use of different methodologies. Like us, Jiang et al. (2011) also used the composite task to assess the sensitivity of holistic processing for different sources of information. In that study, participants judged face composites in which the irrelevant half of the stimulus differed either in shape or in surface information, while the other property was held constant. Although not specifically examining face components, faces that differ in surface information will be differentiable on the basis of brightness differences. As noted above, Jiang et al. did not find any holistic coding of surface differences. This study differs from ours because they looked for interference effects from face components, whereas we assessed sensitivity to component brightness directly. We speculate that stimulus differences in surface changes in Jiang et al.'s experiment were relatively small, producing weaker interference. This was not an issue in our study because we have a direct measure of discriminability for both our stimulus types.

Race effects

We tested two races of participants (Chinese and Caucasians) with own-race and other-race faces, and found little difference in the size of the composite effect between own-race and other-race faces. This result stands in contrast to Michel, et al. (2006), which found larger composite effects by Caucasians and Koreans for own-race than other-race face composites. However, like the present study, other recent studies have also found similar-sized composite effects for own-race and other-race faces (e.g., Bukach et al., 2012; Mondloch, et al., 2010; Harrison, et al., 2014; Horry et al, 2015; for a review see Hayward, et al., 2013). The weight of the evidence suggests that there is no effect of face race on the size of the composite effect.

Conclusions

Our results show definitively that holistic processing of a face includes both configuration and component information. The simplicity of our component change suggests a broad range of facial information is included in the holistic representation. Importantly, the results were consistent for both races of participant ensuring the conclusions are generalizable and not simply a characteristic of one particular population. These results help elucidate the nature of a key theoretical construct in face processing which despite its ubiquity as a concept is remarkably underspecified.

Acknowledgement

This work was supported by the Hong Kong Research Grants Council (HKU744209).

References

Brainard, D. H. (1997) The Psychophysics Toolbox, *Spatial Vision 10*, 433-436.

Bukach, C. M., Cottle, J., Ubiwa, J., & Miller, J. (2012). Individuation experience predicts other-race effects in holistic processing for both Caucasian and Black participants. *Cognition, 123,* 319-324

Cheung, O., Richler, J. J., Palmeri, T. J., & Gauthier, I. (2008). Revisiting the role of spatial frequencies in holistic processing of faces. *Journal of Experimental Psychology: Human Perception and Performance, 34,* 1327-1336.

Gold, J. M., Mundy, P. J., & Tjan, B. S. (2012). The perception of a face is no more than the sum of its parts. *Psychological Science, 23,* 427-434.

Green, D. M. & Swets, J. A. (1966). *Signal detection theory and psychophysics*. New York: Wiley.

Harrison, S., Gauthier, I., Hayward, W. G., & Richler, J. (2014). Other-race effects manifest in overall performance, not qualitative processing style. *Visual Cognition, 22,* 843-864.

Hayward, W. G., Crookes, K., & Rhodes, G. (2013). The other-race effect: Holistic coding differences and beyond. *Visual Cognition, 21,* 1224-1247.

Hole, G. J. (1994). Configural factors in the perception of unfamiliar faces. *Perception, 23,* 65-74.

Horry, R., Cheong, W., & Brewer, N. (2015). The other-race effect in perception and recognition: Insights from the complete composite task. *Journal of Experimental Psychology: Human Perception and Performance, 41*(2), 508-524.

Jiang, F., Blanz, V., & Rossion, B. (2011). Holistic processing of shape cues in face identification: Evidence from face inversion, composite faces, and acquired prosopagnosia. *Visual Cognition, 19,* 1003-1034.

Le Grand, R., Mondloch, C. J., Maurer, D., & Brent, H. P. (2001). Neuroperception: Early visual experience and face processing. *Nature, 410,* 890.

Le Grand, R., Mondloch, C. J., Maurer, D., & Brent, H. P. (2004). Impairment in holistic face processing following early visual deprivation. *Psychological Science, 15,* 762-768.

Leder, H., & Bruce, V. (2000). When inverted faces are recognized: The role of configural information in face recognition. *Quarterly Journal of Experimental Psychology, 53A*, 513-536.

Maurer, D., Le Grand, R., & Mondloch, C. J. (2002). The many faces of configural processing. *Trends in Cognitive Science, 6*, 255□260.

McKone, E. (2008). Configural processing and face viewpoint. *Journal of Experimental Psychology: Human Perception and Performance, 34,* 310-327.

McKone, E., Davies, A. A., Darke, H., Crookes, K., Wickramariyaratne, T., Zappia, S., Fiorentini, C., Favelle, S., Broughton, M., & Fernando, D. (2013). Importance of the inverted control in measuring holistic face processing with the composite effect and part-whole task. *Frontiers in Psychology: Perception Science, 4,* 33.

McKone, E., & Yovel, G. (2009). Why does picture-plane inversion sometimes dissociate perception of features and spacing in faces, and sometimes not? *Psychonomic Bulletin and Review, 16,* 778-797.

Michel, C., Rossion, B., Han, J., Chung, C. S., & Caldara, R. (2006). Holistic processing in finely tuned for faces of our own race. *Psychological Science, 17,* 608-615.

Mondloch, C. J., Elms, N., Maurer, D., Rhodes, G., Hayward, W. G., Tanaka, J. W., & Zhou, G. (2010). Processes underlying the cross-race effect: An investigation of holistic, featural, and relational processing of own-race versus other-race faces. *Perception, 39,* 1065-1085.

Pelli, D. G. (1997) The VideoToolbox software for visual psychophysics: Transforming numbers into movies, *Spatial Vision 10*, 437-442.

Piepers, D. W., & Robbins, R. A. (2012). A review and clarification of the terms “holistic,” “configural,” and “relational” in the face perception literature. *Frontiers in Psychology: Perception Science, 3,* 559.

Rhodes, G., Hayward, W. G., & Winkler, C. (2006). Expert face coding: Configural and component coding of own-race and other-race faces. *Psychonomic Bulletin & Review, 13,* 499-505.

Richler, J. J., & Gauthier, I. (2013). When intuition fails to align with data: A reply to Rossion (2013). *Visual Cognition, 21*(2), 254-276. doi: 10.1080/13506285.2013.796035

Richler, J. J., Cheung, O. S., & Gauthier, I. (2011). Holistic processing predicts face recognition. *Psychological Science, 22,* 464-471.

Richler, J. J., Mack, M. L., Palmeri, T. J., & Gauthier, I. (2011). Inverted faces are (eventually) processed holistically. *Vision Research, 51,* 333-342.

Rossion, B. (2008). Picture-plane inversion leads to qualitative changes of face perception. *Acta Psychologica, 128,* 274-289.

Rossion, B. (2013). The composite face illusion: A whole window into our understanding of holistic face perception. *Visual Cognition, 21*(2), 139-253. doi: 10.1080/13506285.2013.772929

Rossion, B., & Boremanse, A (2008). Nonlinear relationship between holistic processing of individual faces and picture-plane rotation: Evidence from the face composite illusion. *Journal of Vision, 8(4):3,* 1-13.

Russell, R., Biederman, I., Nederhouser, M., & Sinha, P. (2007). The utility of surface reflectance for the recognition of upright and inverted faces. *Vision Research, 47,* 157-165.

Sekuler, A. B., Gaspar, C. M., Gold, J. M., & Bennett, P. J. (2004). Inversion leads to quantitative, not qualitative, changes in face processing. *Current Biology, 14*, 391-396.

Tanaka, J. W., & Farah, M. J. (1993). Parts and wholes in face recognition. Quarterly *Journal of Experimental Psychology, 46A,* 225-245.

Tanaka, J. W., Kiefer, M., & Bukach, C. M. (2004). A holistic account of the own-race effect in face recognition: evidence from a cross-cultural study. *Cognition, 93,* B1-B9.

Tanaka, J. W., & Sengco, J. A. (1997). Features and their configuration in face recognition. *Memory and Cognition, 25,* 583-592.

Young, A. W., Hellawell, D., & Hay, D. C. (1987). Configurational information in face perception. *Perception, 16,* 749-759.

Appendix

Here we present the data for all cells entered into the analyses of variance.

	Upright								Inverted							
	Caucasian participants				Chinese participants				Caucasian participants				Chinese participants			
	Caucasian face		Chinese face		Caucasian face		Chinese face		Caucasian face		Chinese face		Caucasian face		Chinese face	
	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis
Con	0.73	0.39	0.97	0.13	0.62	0.40	1.47	0.45	.030	0.57	0.43	0.34	0.52	.042	0.46	0.39
Inc	-.01	.039	-.67	0.10	-.17	0.34	-.79	0.05	-.10	-.39	0.11	0.17	0.39	0.34	0.42	0.24

Table A.1. Performance at discriminating configuration changes (d').

	Upright								Inverted							
	Caucasian participants				Chinese participants				Caucasian participants				Chinese participants			
	Caucasian face		Chinese face		Caucasian face		Chinese face		Caucasian face		Chinese face		Caucasian face		Chinese face	
	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis
Con	1117	1087	1124	1050	823	792	886	817	948	923	951	909	871	905	887	898
Inc	1174	1128	1160	1089	839	807	1091	821	933	921	911	929	910	919	900	916

Table A.2. Performance at discriminating configuration changes (RT, in ms).

	Upright								Inverted							
	Caucasian participants				Chinese participants				Caucasian participants				Chinese participants			
	Caucasian face		Chinese face		Caucasian face		Chinese face		Caucasian face		Chinese face		Caucasian face		Chinese face	
	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis
Con	0.57	0.25	0.68	0.22	0.57	0.19	0.65	0.43	0.21	0.17	0.21	0.15	0.32	0.12	0.33	0.2
Inc	-.29	0.27	-.38	0.04	0.11	0.35	-.12	0.19	0.23	0.34	0.05	0.28	0.22	0.27	0.24	0.16

Table A.3. Performance at discriminating component changes (d').

	Upright								Inverted							
	Caucasian participants				Chinese participants				Caucasian participants				Chinese participants			
	Caucasian face		Chinese face		Caucasian face		Chinese face		Caucasian face		Chinese face		Caucasian face		Chinese face	
	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis	Ali	Mis
Con	980	825	909	840	1033	964	1042	1107	1127	994	951	1013	919	952	950	813
Inc	985	785	901	869	1063	991	1101	1138	1177	1013	1027	838	981	921	958	999

Table A.4. Performance at discriminating component changes (RT, in ms).

Figure Captions

Figure 1. Face composites varying in configuration and component information. Participants made judgments of top halves, which always showed the same identity but might vary in the facial configuration (top of figure) or components (bottom of figure).

Figure 2. Congruency effect for configuration differences. Here and elsewhere, within-participant standard error bars are plotted.

Figure 3. Congruency effect for component differences.

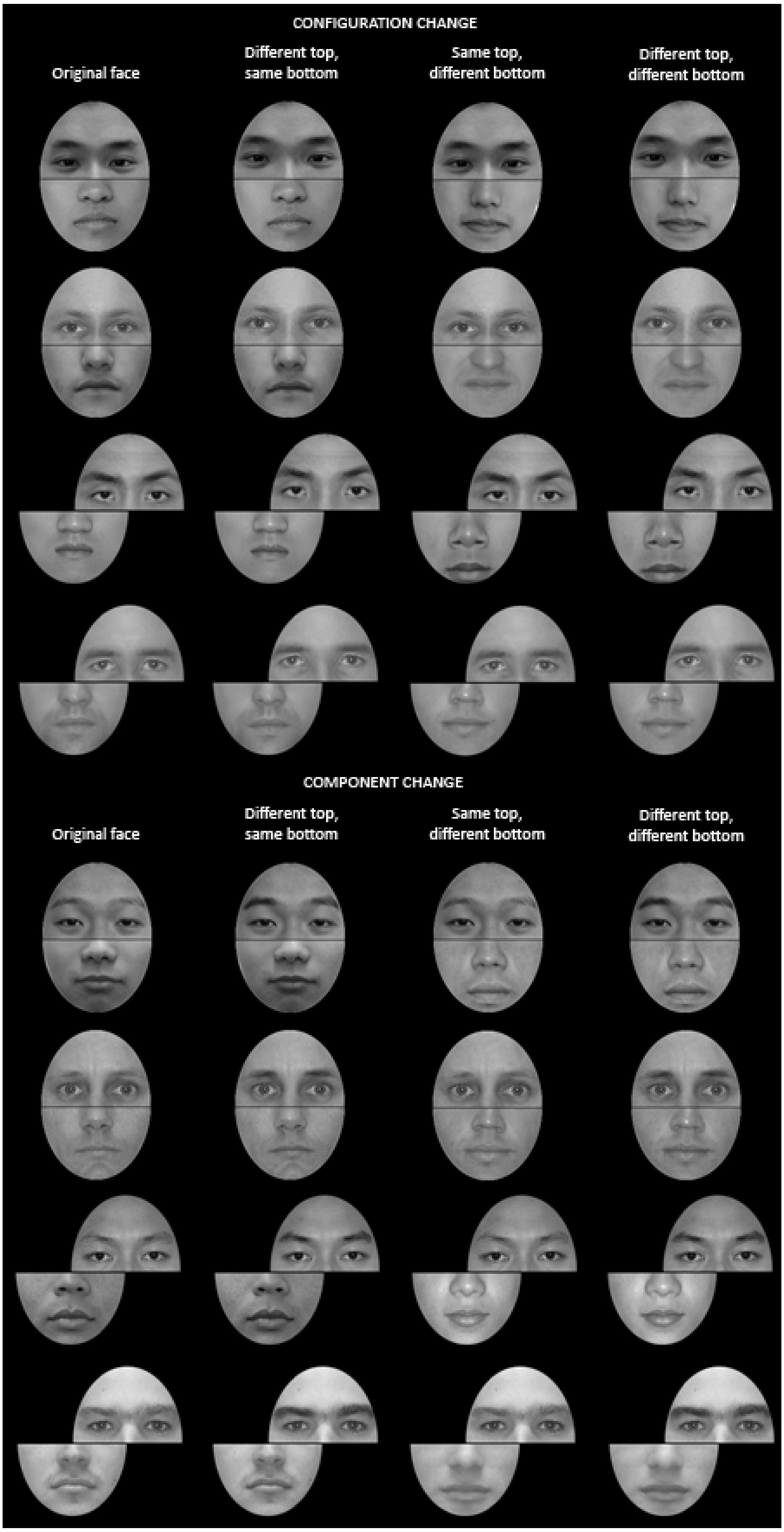
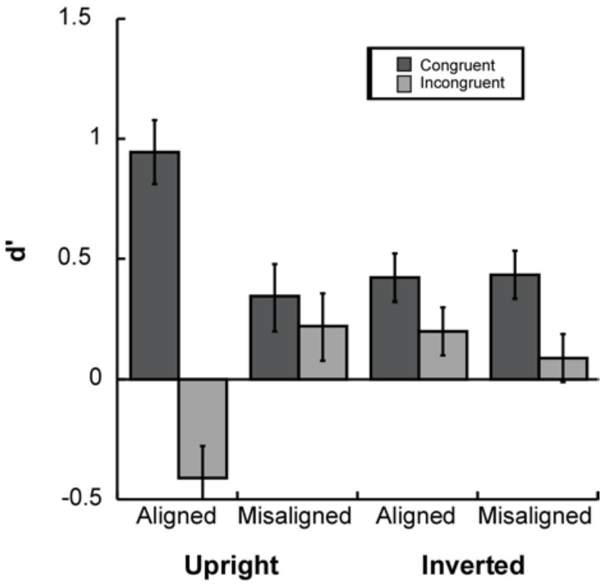

CONFIGURATION CHANGE
Original face
Different top, same bottom
Same top, different bottom
Different top, different bottom
COMPONENT CHANGE
Original face
Different top, same bottom
Same top, different bottom
Different top, different bottom

Figure 1



1.5
1
0.5
0
-0.5
d'
Congruent
Incongruent
Aligned
Misaligned
Aligned
Misaligned
Upright
Inverted

Figure 2

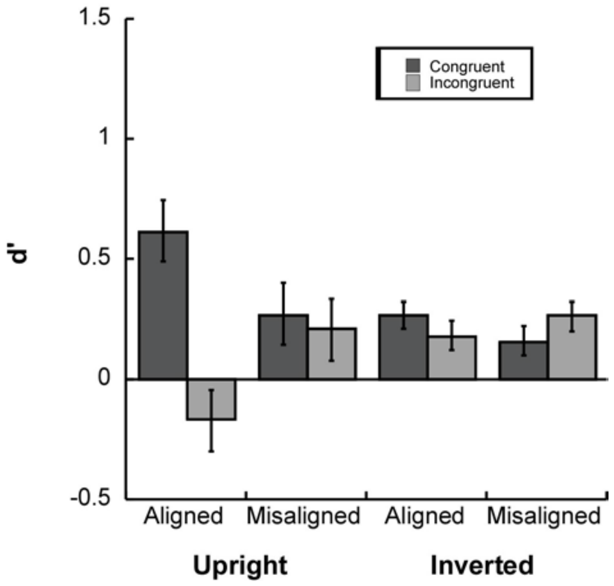

1.5
1
0.5
0
-0.5
d'
Congruent
Incongruent
Aligned
Misaligned
Aligned
Misaligned
Upright
Inverted

Figure 3