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Kin recognition signals in adult faces

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Abstract

Maloney and Dal Martello (2006) reported that similarity ratings of pairs of related and unrelated children were almost perfect predictors of the probability that those children were labeled as being siblings by a second group of observers. Surprisingly, similarity ratings were not good predictors of whether a sibling pair was same-sex or opposite-sex or how close a pair was in age, suggesting that people ignore cues that are uninformative about kinship when making similarity judgments of faces. Here we replicate this study using two sets of adult sibling pairs. In both sets, similarity ratings were very good predictors of the probability of being judged siblings. In contrast to the findings for child faces, similarity ratings for same-sex pairs were significantly higher than for opposite-sex pairs, suggesting that similarity judgments of adult faces are not entirely synonymous with kinship judgments. Additionally, Dal Martello and Maloney (2006) found that the kinship information observable in either the upper and lower halves of the face alone predicted the information observable in the full face. They concluded that the spatial relationship between features in the upper and lower halves of the face (configural information) is not used in kinship judgments. However, here we find evidence suggesting that redundant kinship information exists in the upper and lower halves of the face, calling this previous interpretation into question.

Introduction

Large amounts of socially-relevant information are available in the human face, such as sex, age, and emotional state (Burt & Perrett, 1997; Ekman, 1993; Perrett et al., 1998). One less well-studied signal available in the human face is genetic relatedness. Research on the ability to match the faces of children to their parents has shown that people are somewhat accurate at detecting genetic relatedness in the faces of strangers (Alvergne,

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Faurie, & Raymond, 2006; Brédart & French, 1999; Bressan & Grassi, 2004; Bressan & Dal Martello, 2002; McLain, Setters, Moulton, & Pratt, 2000; Nesse, Silverman, & Bortz, 1990; Oda, Matsumoto-Oda, & Kurashima, 2002). More recently, research using computer-generated cues of facial resemblance to self has shown that people respond to facial self-resemblance in ways that are consistent with resemblance being cue of kinship. For example, self-resemblance affects behavior in economic games (DeBruine, 2002; Krupp, DeBruine, & Barclay, invited revision), attributions of attractiveness and trustworthiness (DeBruine, 2004b, 2005; DeBruine, Jones, & Perrett, 2005; Penton-Voak, Perrett, & Peirce, 1999), and attitudes towards children (DeBruine, 2004a; Platek, Burch, Panyavin, Wasserman, & Gallup, 2002; Platek et al., 2004).

In light of this, Maloney and Dal Martello (2006) investigated the extent to which similarity judgments of pairs of faces correspond to genetic relatedness judgments and compared the accuracy with which the two types of judgment captured actual genetic relatedness. They reported that similarity ratings of pairs of related and unrelated children were surprisingly good predictors of the probability that those children were labeled as being siblings or not siblings by a second group of observers. However, similarity ratings were not good predictors of whether the sibling pair was same-sex or opposite-sex or how close the pair was in age.

Using the same child face pairs, Dal Martello and Maloney (2006) reported that correct categorization of kinship was affected more when the upper half of the face was masked than when the lower half was masked. They interpreted this as confirmation that the lower half of children's faces conveys less useful information about genetic kinship because the extent of growth through childhood an puberty is greater than in the upper half of the face. However, the question remains, "would the observer continue to use the same features with the same weighting in judging kinship, age, gender, or similarity between adults" (Maloney & Dal Martello, 2006, p. 1054).

Dal Martello and Maloney (2006) also determined that the ability to detect kinship using only the upper or lower halves of children's faces predicted the ability to detect kinship using the full face, suggesting that configural information that is disrupted by masking half of the face is unimportant for kin detection. If kinship detection was significantly greater for the full face than for the sum of the upper and lower halves separately, this would have been evidence that configural information that is disrupted by splitting the face horizontally (e.g. spacing between the eyes and mouth) is used in kinship judgments.

We argue, however, that the results shown by Dal Martello and Maloney (2006) are not sufficient to conclude that configural information is not used in kinship judgments. First, masking the upper or lower halves of faces disrupts some, but not all, configural information. For example, the spacing between the eyes, a common experimental manipulation to test for configural processing ability (Mondloch, Le Grand, & Maurer, 2002; Maurer, Le Grand, & Mondloch, 2002; Le Grand, Mondloch, Maurer, & Brent, 2003), is not disrupted by this masking. Second, redundant kinship information in the upper and lower halves of the face may obscure any decrease in kinship detection ability caused by the disruption of configural processing.

Much previous research on the ability to detect genetic relatedness through facial resemblance has been done on parent-child pairs (Alvergne et al., 2006; Brédart & French, 1999; Bressan & Grassi, 2004; Bressan & Dal Martello, 2002; Christenfeld & Hill, 1995; McLain et al., 2000; Nesse et al., 1990; Oda et al., 2002; Parr & Waal, 1999; Vokey, Rendall, Tangen, Parr, & Waal, 2003). The two studies of child sibling facial resemblance (Maloney & Dal Martello, 2006; Dal Martello & Maloney, 2006) would be complemented by analogous studies of adult sibling facial resemblance. Indeed, Maloney and Dal Martello (2006) qualify the finding that similarity judgments of child faces utilize the same information as kinship judgment by stating, "It remains to be seen whether this same bias is specific to children's faces or whether it is present in judgments of the similarity of adults' faces" (p. 1053).

Here, we replicate these studies using two different sets of adult sibling pairs and control pairs. The first set is comprised of all-female, dizygotic (non-identical) twin sibling pairs. In this set, age and sex are the same for both faces in each pair, so similarity judgments will not be affected by these factors. The second set is comprised of half same-sex sibling pairs and half opposite-sex sibling pairs who differed in age by one to seven years. For this set, sex and age differences are available to influence similarity judgments.

Methods

Stimuli

Stimuli for the twin image set were all 16 pairs of dizygotic (DZ) twins (from a larger set including 32 pairs of DZ twins) for whom control pairs matching in age, sex and ethnicity could be found. All faces were female, of European ethnicity, and ranged in age from 28 to 46 years ($mean = 37.9, SD = 4.7$). The sixteen control pairs were selected from the 55 pairs of monozygotic (MZ) female twins in the larger set (only one face from each pair was used). Control pairs were selected by randomly assigning to each DZ pair the first and second MZ twins matching in age. The larger image set included only two pairs of male DZ twins and no opposite-sex DZ twins, so male and opposite-sex pairs were excluded from the twin image set. Twins were recruited from the TwinsUK adult twin registry (www.twinsuk.ac.uk). Zygosity was determined by a standard questionnaire and by genotyping in cases of uncertainty (Martin & Martin, 1975), as is standard for other twin studies (e.g. Mohammed, Cherkas, Riley, Spector, & Trudgill, 2005; Roberts et al., 2005).

Stimuli for the sibling image set were 5 pairs of same-sex female siblings and 5 pairs of opposite-sex siblings from a larger image set consisting of pairs of twins, siblings, cousins, and friends. All opposite-sex sibling pairs in the larger set were used and same-sex pairs were chosen based on the availability of age-, sex- and ethnicity-matched controls. Three of the same-sex pairs were of European ethnicity and two were of East Asian ethnicity, while three of the opposite-sex pairs were of European ethnicity and two were of West Asian ethnicity. The faces ranged in age from 16 to 26 years ($mean = 19.5, SD = 2.3$) and the age difference between the pairs ranged from 0 to 7 years. Ten pairs of age-matched (to within 1 year), sex-matched and ethnicity-matched unrelated control images were also selected from the same image set (only one image from twin pairs was used). Only one same-sex male sibling pair existed in the larger set, so we excluded male-male pairs from the sibling image set.

Within image set, images were all taken against a standard background with the same camera using standard lighting. Images were standardized for interpupillary distance and

Figure 1. Examples of manipulations to stimuli. Participants judged the kinship of pairs with full face (FF), upper half masked (UHM), lower half masked (LHM), hair and clothing masked (HCM), and face masked (FM).

each image was cropped to a standard size where the pupils were aligned to the same place in each image.

Four different masked versions of each image were also made (Figure 1). Following Dal Martello and Maloney (2006), we masked the upper half of the face (UHM) by covering the image with a solid grey block above a horizontal line passing through the tip of the nose. We masked the lower half of the face (LHM) by covering the image below this same line. We masked the hair and clothing (HCM) by marking a continuous line around the chin and hairline and covering the background with solid grey. We masked the face (FM) by covering the area inside this line.

Participants and Procedure

All participants were undergraduate psychology students naive to the purposes of the experiment. Participants completed the task at individual computers in a large computer lab. Each participant completed one of two tasks. In the kinship judgment task, participants were told that half the pairs were siblings and were asked to judge whether each pictured pair was “siblings” or “not siblings”. In the similarity judgment task, participants were not given any information about kinship and were simply asked to “rate each pair for similarity on a scale from 0 (not very similar) to 10 (very similar)”. Each participant completed the same task for both the twin and sibling image sets, which were shown in separate blocks.

Each participant completed only one type of task and viewed only one type of masking (full face, lower half masked, upper half masked, hair and clothing masked, or face masked).

30 participants (17 female, mean age $= 20.6, SD = 4.5$) completed the kinship judgment task with face pairs with no masking (FF) and 34 different participants (27 female, mean age $= 22.2, SD = 6.7$) completed the similarity judgment task with the same face pairs. 27 participants (23 female, mean age $= 20.8, SD = 3.9$) completed the kinship judgment task with face pairs with hair and clothing masked (HCM) and 27 different participants (24 female, mean age $= 20.5, SD = 4.4$) completed the similarity judgment task with the same face pairs. 31 participants (23 female, mean age $= 21.3, SD = 5.9$) completed the kinship judgment task with face pairs with upper half masked (UHM), 32 different participants (24 female, mean age $= 19.4, SD = 1.4$) completed the kinship judgment task with face pairs with lower half masked (LHM) and 34 different participants (23 female, mean age $= 20.1, SD = 3.2$) completed the kinship judgment task with face pairs with the face masked (FM).

Results

Similarity and kinship judgments were compared for two masking conditions: unmasked full face images (FF) and images with the hair and clothing masked (HCM). The Pearson's product-moment correlations between mean rated similarity and the proportion of observers who judged the pair to be siblings were comparable to the figure of .92 reported in Maloney and Dal Martello (2006) for the twin image set ($R_{FF} = .890, p < .001; R_{HCM} = .922, p < .001$) and somewhat lower for the sibling image set ($R_{FF} = .717, p < .001; R_{HCM} = .504, p = .023$).

Likelihood Analyses

The estimated likelihood functions for similarity ratings were calculated as the probability that each level of similarity judgment was given to related ($P[s|R]$) and unrelated ($P[s|\bar{R}]$) pairs (Figure 3). These likelihood function were then used to calculate the log posterior odds (i.e., the natural logarithms of the ratios of $P[s|R]$ to $P[s|\bar{R}]$) for each similarity rating (Figure 4). See Maloney and Dal Martello (2006) for details of these analyses.

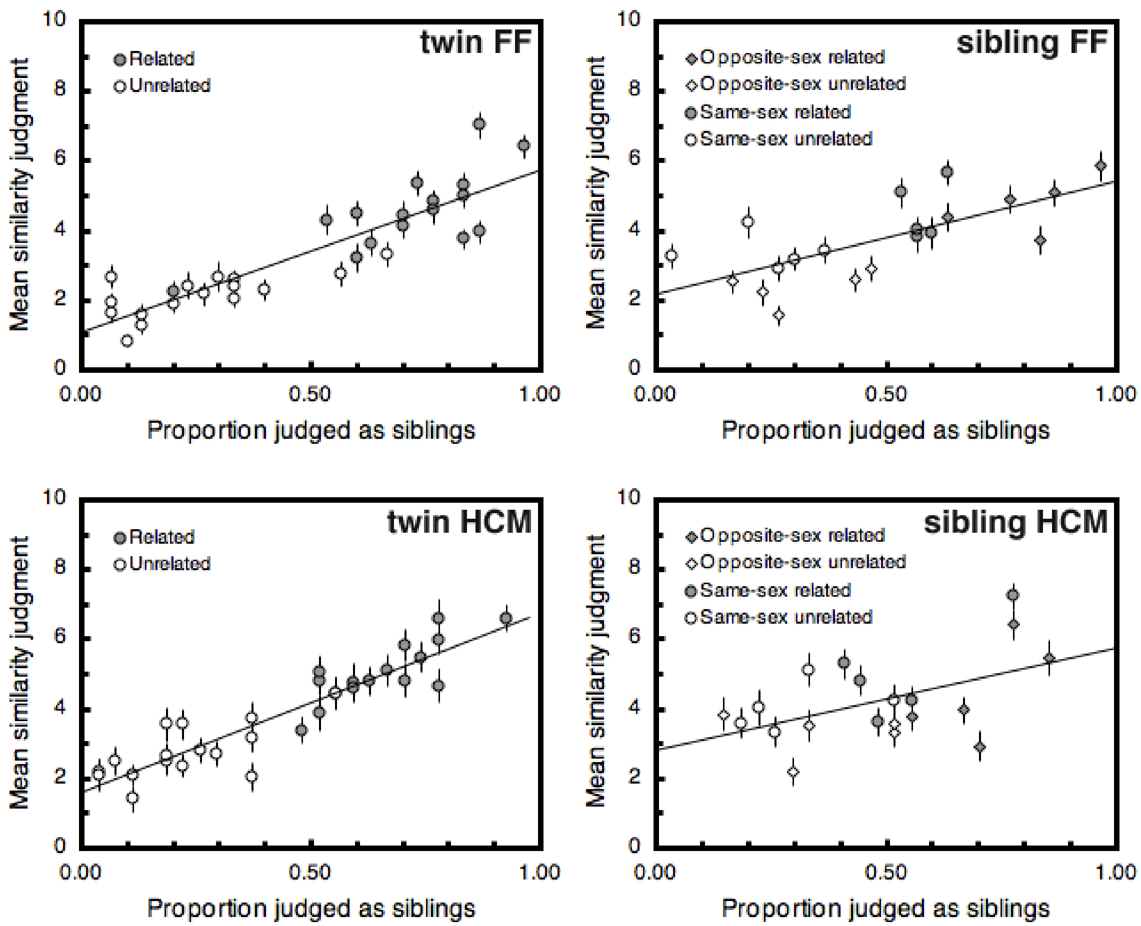


Figure 2. Mean rated similarity of each pair versus the proportion of observers who judged the pair to be siblings. Closed markers plot related pairs, while open markers plot unrelated control pairs. Same-sex pairs are plotted by circles, while opposite-sex pars are plotted by diamonds. Stimuli were from the twin or sibling image set and displayed the full face (FF) or had hair and clothing masked (HCM). Error bars represent SEM.

The proportions of variance accounted for by the maximum likelihood regression fit for the twin image set are comparable to the value of $R^2 = .96$ found by Maloney and Dal Martello (2006), also suggesting that similarity judgments primarily convey information about kinship. However, the pairs in the twin image set are all the same sex and age. The R^2s for the sibling image set are significantly lower for the unmasked (FF) condition ($z = 3.02, p = .003$), but not for the masked (HCM) condition ($z = 0.89, p = .374$), suggesting that similarity judgments of adults of varying sex and age may convey some information of the than kinship.

Signal Detection Analyses

Following Maloney and Dal Martello (2006), we computed signal detection measures of performance for kinship judgments (Figure). For masked and unmasked images in both image sets, the d' values were significantly greater than zero, indicating that participants were somewhat accurate in their judgments.

Also following Maloney and Dal Martello (2006), we computed signal detection measures of performance for similarity judgments using a *thresholded similarity observer* (TSO). This was done by converting similarity scores into "siblings" or "not siblings" judgments using thresholds as estimated by the linear regressions in Figure 4. Thus, similarity scores below the threshold were treated as "not siblings" judgments and scores above the threshold were treated as "siblings" judgments. As in the signal detection analysis for kinship judgments, the d' values were significantly greater than 0 for both image sets, indicating that similarity judgments are somewhat effective at discriminating related from unrelated pairs.

Maloney and Dal Martello (2006) reported a sightly (but not significantly) larger d' for their TSO than their kinship condition (1.057 ± 0.084 versus 0.999 ± 0.084) and concluded that kinship and similarity judgments are equally effective at discriminating related and unrelated pairs. However, here we find that the d' for the TSO is *smaller* than that for kinship judgments for both the twin and sibling image sets in both the unmasked and masked conditions. This difference was significant only for the sibling image set in the unmasked condition ($z = 2.562, p = .010$; all other $z < 1.27, p > .20$). This suggests that

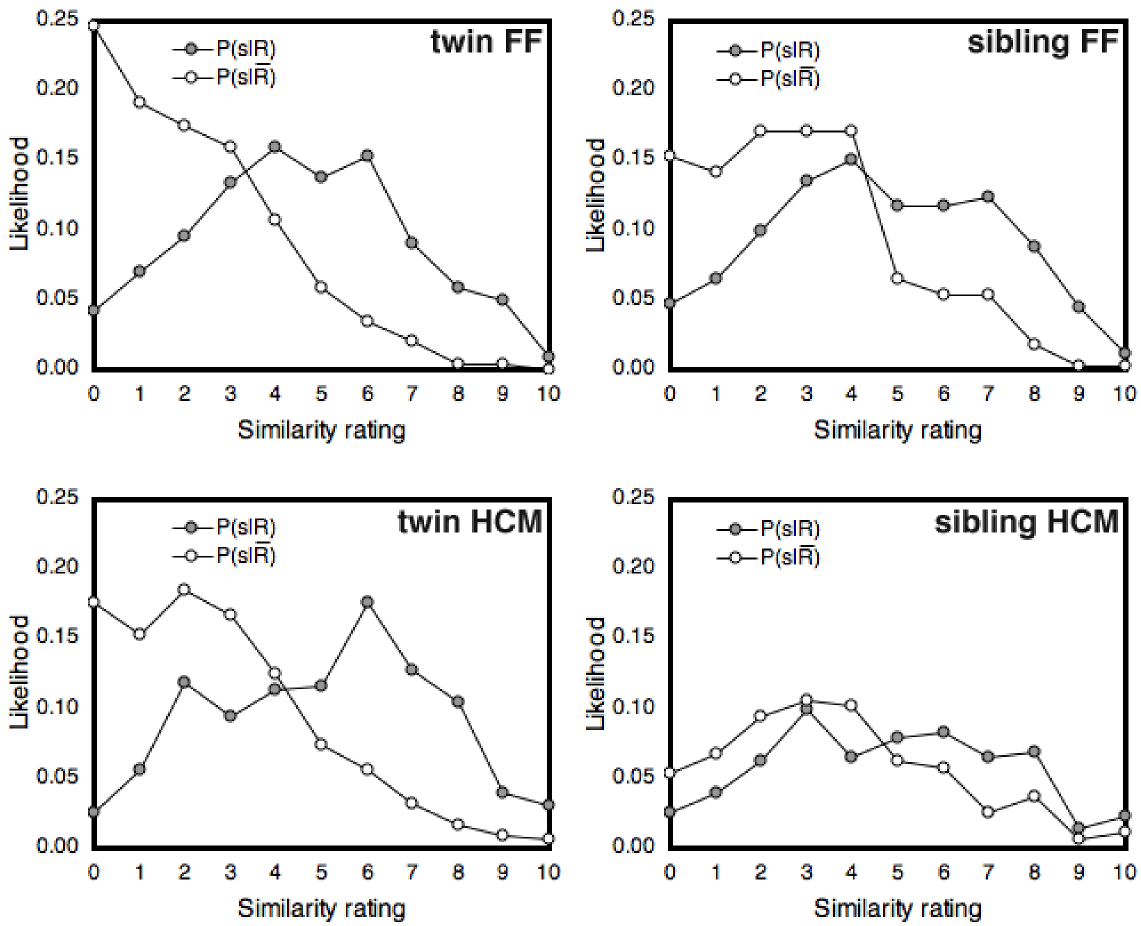


Figure 3. The estimated likelihood functions for similarity ratings of related pairs ($P[s|R]$) and unrelated control pairs ($P[s|\bar{R}]$) Stimuli were from the twin or sibling image set and displayed the full face (FF) or had hair and clothing masked (HCM).

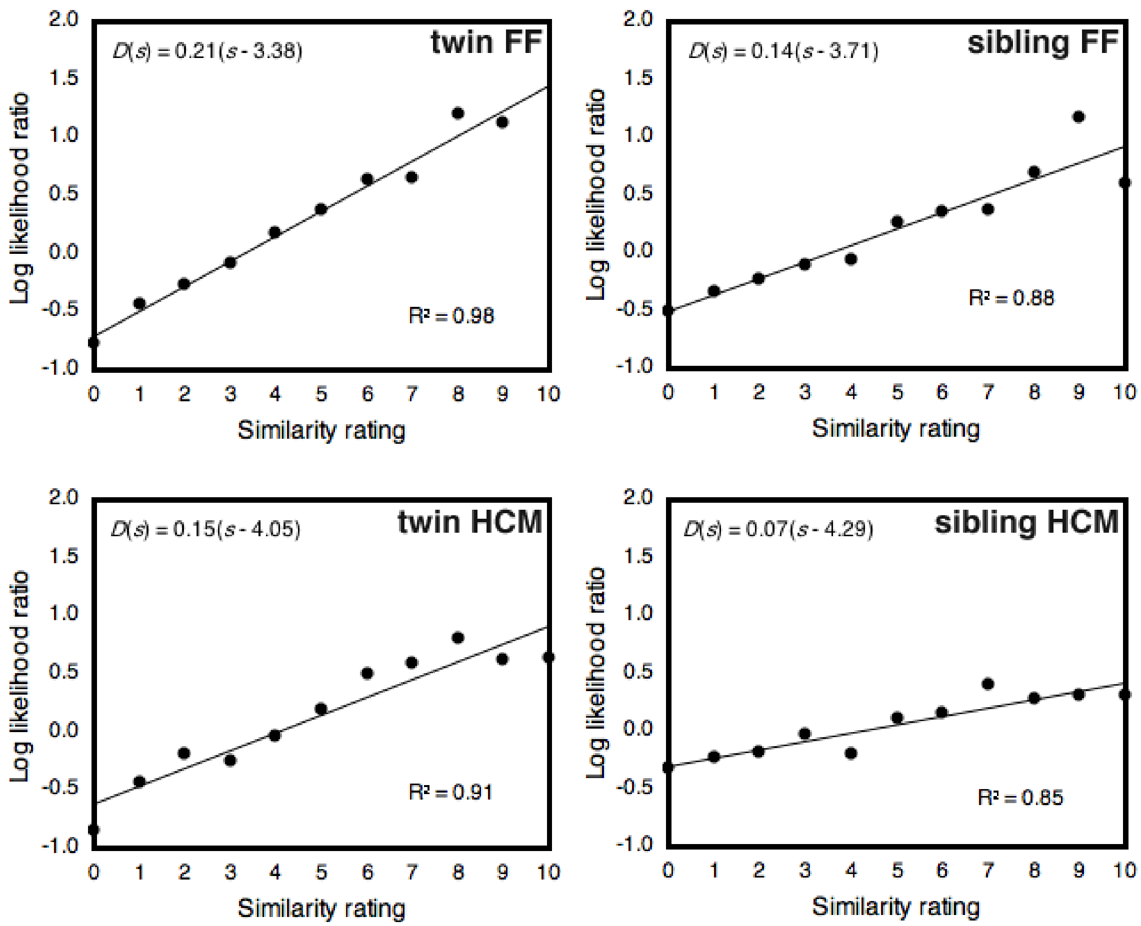
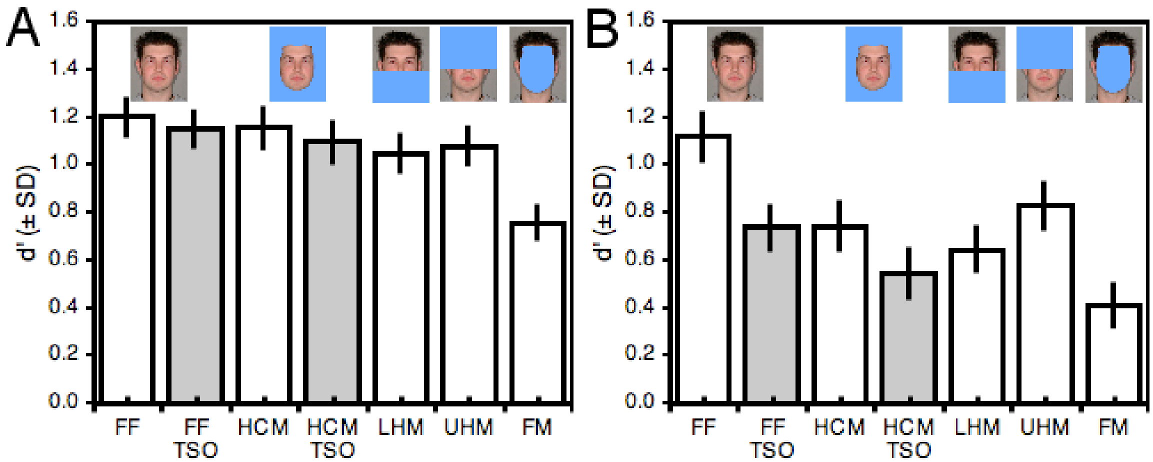


Figure 4. The natural logarithms of the ratios of $P[s|R]$ to $P[s|\bar{R}]$ for each similarity rating (log posterior odds; $\hat{D}(s)$). The solid line is the maximum likelihood regression fit to the log posterior odds and the equation for this line is given in the upper left corner of each graph. The proportion of variance accounted for (R^2) is given in the lower right corner of each graph. Stimuli were from the twin or sibling image set and displayed the full face (FF) or had hair and clothing masked (HCM).



The d's for the twin (A) and sibling (B) image sets. White bars show d's for kinship judgments for all masking conditions, while grey bars show d's for similarity judgment TSOs. Error bars show standard deviation as calculated by 10,000 bootstrap iterations. Stimuli showed the full face (FF), or had hair and clothing masked (HCM), lower half masked (LHM), upper half masked (UHM) or the face masked (FM).

similarity judgments may not be as effective as kinship judgments at discriminating related and unrelated pairs of adults, at least when the pairs are not all the same age and sex.

Sex Differences

In light of the significantly smaller d' for the similarity TSO than the kinship judgments for the sibling image set, we used the TSO to try to predict sex differences in the sibling image set, again following Maloney and Dal Martello (2006). Same-sex pairs were designated as the signal and we used a threshold of 3.5, which was chosen so that "the likelihood criterion β was as close as possible to 1" (following Maloney & Dal Martello, 2006). This analysis produced d's that differed significantly from 0 for the masked images ($z = 2.145, p = .032$) and approached significance for the unmasked images ($z = 1.828, p = .068$).

We also analyzed similarity judgments using a repeated-measures ANOVA with relatedness (siblings or unrelated) and sex composition (same or opposite) as repeated factors. The analysis for unmasked images revealed a main effect of relatedness ($F_{1,33} = 136.715, p <$

.001), whereby related pairs were given higher similarity ratings than unrelated pairs, and a main effect of sex composition ($F_{1,33} = 4.282, p = .046$), whereby same-sex pairs were given higher similarity ratings than opposite-sex pairs. However, these main effects were qualified by an interaction between relatedness and sex composition ($F_{1,33} = 23.277, p < .001$), whereby same-sex unrelated pairs were given higher similarity ratings than opposite-sex unrelated pairs ($t_{33} = 5.543, p < .001$), but same-sex and opposite-sex unrelated pairs were not given significantly different similarity ratings ($t_{33} = -1.043, p = .305$). The analysis for masked images revealed the same main effects of relatedness ($F_{1,26} = 25.133, p < .001$) and sex composition ($F_{1,26} = 13.402, p = .001$), but no interaction between these two factors ($F_{1,26} = 0.605, p = .444$).

Masked Images

All four masking conditions included enough visual information relevant to kinship for d's to be significantly greater than zero. In contrast to the findings of Dal Martello and Maloney (2006), we did not find that the upper half of the face contained more kinship information than the lower half of the face. Although neither difference was significant, the upper half masked (UHM) condition produced higher d's than the lower half masked (LHM) condition for both the twin image set ($z = 0.244, p = .807$) and the sibling image set ($z = 1.283, p = .200$).

Following Dal Martello and Maloney (2006), we tested for statistical independence of the kinship information in different regions of the face using the equations in Table 1. In the first analysis, kinship information in the upper half of the face (LHM) and lower half of the face (UHM) were compared to kinship information available from the full face (FF). In the second analysis, kinship information in the face excluding the hair and clothing (HCM) and in only the hair and clothing (FM) were compared to kinship information available from the full face (FF).

For both comparisons, the predicted values were higher than the actual values for the twin image set, but lower than the actual values for the sibling image set. Although these differences were much larger than the difference between the predicted d' of 1.196 and the actual d' of 1.187 found by Dal Martello and Maloney (2006), none of these differences were

Table 1: Independence of kinship information in different regions

analysis	image set	predicted d'_{FF}	actual d'_{FF}	z	p
$d'_{FF} = \sqrt{(d'_{UHM})^2 + (d'_{LHM})^2}$	twin	1.506	1.202	-1.100	.271
	sibling	1.053	1.118	0.190	.849
$d'_{FF} = \sqrt{(d'_{HCM})^2 + (d'_{FM})^2}$	twin	1.382	1.202	-0.635	.525
	sibling	0.847	1.118	0.765	.444

statistically significant (all $p > .27$; see Table 1).

Discussion

For adult sibling faces, we found that similarity judgments primarily convey the same information as kinship judgments for faces of the same sex and age. This is consistent with the finding of Maloney and Dal Martello (2006) for child faces of varying age and sex. In contrast, for adult faces of varying age and sex, we found that similarity ratings conveyed some information that was not present in kinship judgments. For unmasked faces, similarity ratings were lower for opposite-sex pairs than for same-sex pairs among the unrelated pairs, but not among the related pairs. For masked faces, similarity ratings were lower for opposite-sex pairs than for same-sex pairs for both unrelated and related pairs.

Unfortunately, sex and age differences were confounded in our sample, with the average age difference between opposite-sex pairs ($m = 3.90, SD = 2.47$) being greater than the average age difference between same-sex pairs ($m = 1.50, SD = 0.71$) ($t_{18} = 2.95, p = .008$). It is unknown whether a similar confound was present in the child faces sample used by Maloney and Dal Martello (2006). However, we can still conclude that sex and/or age differences contribute to judgments of facial similarity for adult faces. This may reflect the fact that adult faces display much greater levels of sexual dimorphism than child faces (Enlow, 1990). Additionally, the task of judging child faces for similarity may cue kinship more than the task of judging adult faces for similarity. Our experience with pairs of children, especially those of different sexes or ages, is likely to be more biased towards experience with siblings than is our experience with pairs of adults.

Dal Martello and Maloney (2006) also found that the ability to detect kinship using only the upper or lower halves of children's faces predicted the ability to detect kinship using the full face, suggesting that configural information that is disrupted by masking half of the face is unimportant for kin detection. Here, we found a similar result for the sibling image set. However, for the twin image set, we found that the ability to detect kinship using the full face was less than that predicted from combining the separate abilities to detect kinship using from the upper and lower halves, although not significantly so. This suggests that redundant information exists in the upper and lower halves of the face and calls into question Dal Martello and Maloney's previous interpretation. Redundant information in the upper and lower halves of the face could mask any loss in ability to detect kinship through configural information that is disrupted by masking half of the face.

While Dal Martello and Maloney (2006) found that the upper half of the face conveyed more kinship information than the lower half of the face, here we find no significant difference and a bias in the opposite direction. This answers the question, "Would we find that observers make greater use of features in the lower face in judging kinship between adults, now that these (fully expressed) features are informative?" (Maloney & Dal Martello, 2006, p. 1054). It also strengthens the claim that the reason that the lower half of the face is relatively ignored in making kinship judgments about child faces is because this area of the face changes rapidly during childhood and may be a poor indicator of genetic relatedness (Dal Martello & Maloney, 2006). Thus, our findings are evidence that people use context-specific criteria for judging kinship in faces, using or ignoring information based on its age-dependent relevance.

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Appendix

Appendix A: Signal detection analyses

image set	analysis	masking	d'	β	z	p
twin	TSO	FF	1.153 ± 0.081	1.215 ± 0.060	14.206	$< .001$
	KR	FF	1.202 ± 0.087	1.042 ± 0.055	13.810	$< .001$
	TSO	HCM	1.096 ± 0.092	1.410 ± 0.088	11.897	$< .001$
	KR	HCM	1.156 ± 0.092	1.230 ± 0.070	12.559	$< .001$
	KR	LHM	1.050 ± 0.088	1.272 ± 0.069	11.875	$< .001$
	KR	UHM	1.080 ± 0.086	1.043 ± 0.049	12.519	$< .001$
	KR	FM	0.758 ± 0.078	1.117 ± 0.036	9.755	$< .001$
sibling	TSO	FF	0.739 ± 0.100	0.983 ± 0.037	7.427	$< .001$
	TSO sex	FF	0.177 ± 0.097	0.996 ± 0.010	1.828	0.068
	KR	FF	1.118 ± 0.109	1.050 ± 0.065	10.215	$< .001$
	TSO	HCM	0.545 ± 0.111	1.108 ± 0.043	4.931	$< .001$
	TSO sex	HCM	0.235 ± 0.110	0.964 ± 0.021	2.145	0.032
	KR	HCM	0.742 ± 0.110	1.045 ± 0.044	6.734	$< .001$
	KR	LHM	0.646 ± 0.100	0.982 ± 0.033	6.431	$< .001$
	KR	UHM	0.832 ± 0.105	1.000 ± 0.044	7.888	$< .001$
	KR	FM	0.408 ± 0.097	0.989 ± 0.020	4.213	$< .001$