

Original Article

Parental Investment and Resemblance: Replications, Refinements, and Revisions

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Abstract: Evolutionary theory predicts that men should be more concerned with issues of false paternity than women should be concerned with false maternity. In an earlier study (Volk and Quinsey, 2002), we studied how infant cues of resemblance influenced adults' hypothetical adoption decisions. We found that self-perceived cues of resemblance were significantly more important in men's decisions than in women's. Since that study was published, conflicting results have been reported regarding a sex-difference in the importance of cues of resemblance for adoption preference. We therefore sought to replicate our findings in three new studies. In all three studies, we replicated the initial finding of a larger correlation between ratings of resemblance and ratings of adoption preference among men than among women. We also found a trend towards slightly higher global resemblance scores in younger children, suggesting that adults view infants as more anonymous and/or less uniquely distinctive than older children. However, there was wide variance in both the global resemblance and developmental changes in resemblance amongst the different child stimuli used.

Keywords: resemblance, paternal certainty, parental investment, infant facial cues, child facial cues

Introduction

Over the last decade, there have been many studies of adult-child resemblance in the context of parental investment. According to evolutionary theory, parents should prefer to invest in children to whom they are genetically related (Trivers, 1972; Westneat and Sherman, 1993). Numerous studies of step-parental investment have shown that step-offspring receive significantly less time, financial resources, emotional resources, and social resources than genetically related offspring, (e.g. Daly and Wilson, 1999; Marlowe, 1999; Zvoch, 1999). Beyond step-parenting, men face the possibility of unknowingly raising a child that is not genetically related to them, whereas women do not. Evidence for a modest level of both modern and ancestral false paternity in humans comes from comparative primate testicular physiology (Alcock 1989 pp.529–531), behavioral information (Baker and Bellis 1995; Chagnon 1983 p.117; Eibl-Eibesfeldt 1989 pp.98, 245–249; Hart and Pilling 1960 pp.36–38), and genetic tests (Anderson, 2006; Boster, Hudson, and Gaulin, 1999; Sasse, Muller, Chakraborty, and Ott, 1994).

Because of paternal uncertainty, men are presumed to have a greater interest in cues of genetic relatedness among their putative offspring. In the face of false paternity, men are hypothesized to decrease their investment in the unrelated child (Pagel, 1997). Physical resemblance is a possible cue of genetic relatedness available to both modern and ancestral humans.

In line with the theoretical importance of paternal resemblance, researchers have found that there is a maternal family bias (compared to no paternal family bias) in attributing an infant's resemblance to the father (Daly and Wilson, 1982; McLain, Setters, Moulton, and Pratt, 2000). Burch and Gallop (2000) found that men's perceptions of their putative children's paternal resemblance predicted levels of family violence. More recent research shows that general changes in family dynamics may be linked to university students' self-perceived resemblance to their fathers (Bellard, McAuliffe, and Burch, 2006). Self-reported paternity certainty/confidence influences self-reported paternal investment (Anderson, Kaplan, and Lancaster, 2006), particularly in men who are separated from the child's mother (Apicella and Marlowe, 2004). Platek and his colleagues have found that men show a stronger preference than women for hypothetically investing in child faces that have been digitally mixed with their own faces (e.g., Platek, Burch, Panyavin, Wasserman, and Gallup, 2002; Platek et al., 2003).

However, other studies have failed to replicate some of the aforementioned findings. DeBruine (2004) and Bressan (2006) failed to replicate Platek's findings regarding desire to hypothetically adopt child faces that have been digitally mixed with a participant's face. Heijkoop, Dubas, and van Aken (2006) report preliminary data that suggest there is not a link between paternal resemblance and actual parental care in Dutch parents of older children. Thus, it is unclear whether resemblance between an adult and child face increases men's desire to invest in a particular infant or child.

To address this issue, we used the Hypothetical Adoption Paradigm (HAP). The HAP attempts to measure judgmental processes associated with parental care by asking adults to rate their desire to hypothetically adopt infants hypothetically based on pictures of the infants' faces. The paradigm is based on the hypothesis that adults have evolved cognitive mechanisms that allow them to detect important infant facial cues and respond to them in ways that would maximize their evolutionary fitness in an ancestral environment (see Volk and Quinsey 2002 for more detail). This does not imply that any such mechanisms are entirely innate, morally desirable, or unalterable with experience. In a previous study using the HAP, Volk and Quinsey (2002) found that compared to women, men's willingness to adopt a child was more influenced by cues of resemblance and less influenced by cues of infant quality. In the current study, we sought to replicate these findings in three separate studies using the HAP to determine whether our initial findings of a marked sex difference were reliable.

Another issue of reliability concerns the findings of the different studies. A major difference between many of the studies is the difference in the age of the children used in the study. Therefore, we simultaneously examined the influence of child age on measures of resemblance. Using a range of child stimulus ages, our goal was to identify whether there were significant differences in how adults perceived resemblance towards a single child at different ages, and whether the correlation between resemblance and adoption preference varied with child age. Given the ambiguity of previous theoretical predictions (e.g. Pagel, 1997), we did not have specific a priori predictions for these tests.

Methods

Participants

There were three separate studies involving 123, 63, and 75 participants, respectively. In all studies participants were roughly split between the sexes and were sampled from two different groups: Kingston, ON adult community members and Queen's University undergraduates. This recruitment strategy ensured a broad and heterogeneous sample. Compared to undergraduates, Community members were typically older, had longer relationships with a significant other, a greater number of children, lower SES, and lower education levels. Data from non-Caucasian participants were not included in the analyses.

Materials

In the first study the stimuli consisted of pictures from each of five different Caucasian children taken at ages 6, 12, 18, 24, 36, 48, 60, and 72 months (two boys and three girls). One child was missing a picture for ages 60 and 72 months, while another child was missing pictures for ages 12, 60, and 72 months (both girls). The children faced the camera in all pictures, and all but one of the pictures were in color. For each child, the images from 18 months and 48 months were digitally altered to display cues of low body weight and (separately) fluctuating asymmetry (see Volk, Lukjanczuk, and Quinsey, 2005, for details). This resulted in a total of 35 original (i.e., unaltered) images, and 20 digitally altered images, for a total of 55 images. Only the data from original, unaltered images, from children with all eight ages, were included in the analyses. This left a total of 24 faces to be analyzed (3 children x 8 ages). The faces were displayed randomly in a slide show, with two exceptions. Morphed faces of a particular child, and faces of a particular child within one age range, were not allowed to be displayed immediately after each other.

In the second study the same stimuli were used. The sole difference was that the fluctuating asymmetry images were replaced by high body weight images (see Volk and Quinsey, 2006 for details).

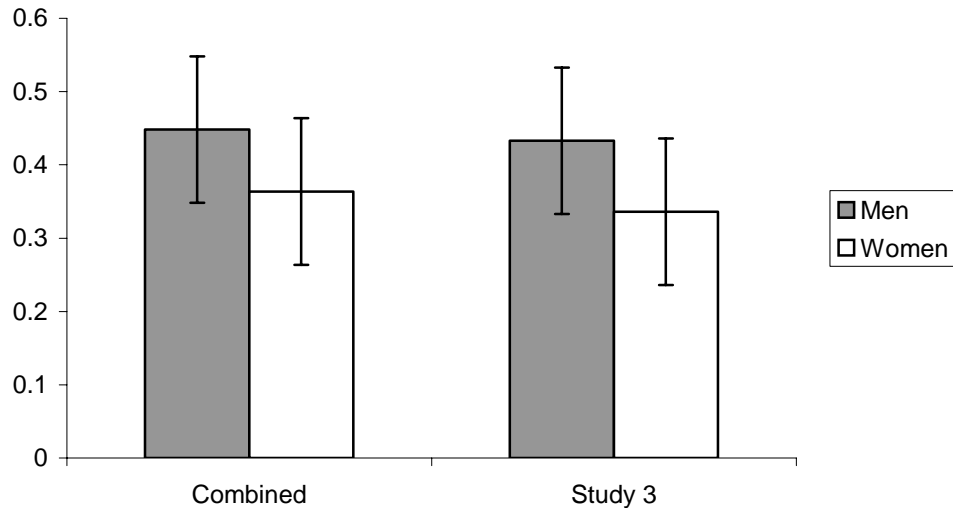
In the third study, the stimuli consisted of pictures from each of seven different Caucasian children, at ages 6, 12, 18, 24, 36, 48, 60, and 72 months (two boys, five girls). One of the female stimulus sets was missing a picture for age 48 months, leaving a total of 55 facial images. This left a total of 48 faces to be analyzed (6 children x 8 ages). The photos were similar in nature to, and presented in the same way, as those in the previous two studies (see Volk, Lukjanczuk, and Quinsey, 2006, for details). There were no altered faces in this study.

Procedure

Precise procedural details of the three studies can be found in the original references. Briefly, participants were brought into the lab to view a PowerPoint presentation of the infant and child faces. Participants were briefed and informed consent

was obtained. We asked participants to rate each child facial image carefully and independently, and to not revisit any previously viewed slides. A series of four questions followed each stimulus presentation (i.e., after each face). “How willing would you be to adopt the previous child?”, “How healthy do you think the previous child is?”, “How much do you think the previous child resembles you?”, and “How cute do you think the previous child is?” Participants answered these questions using a Likert-scale of one to seven, where a value of one represented the lowest possible score, “very unwilling/unhealthy/no resemblance/not cute”, and a value of seven represented the highest possible score, “very willing/healthy/high resemblance/very cute”. The participants recorded their ratings on a prepared printout. The slideshow presentation was self-timed. Participants were free to view a face while answering questions about it, but they were instructed to not look at any previous faces. Results from our previous studies have shown that resemblance is unlikely to be a result of strong bias in ascribing self-resemblance to healthy, happy, and cute babies because the average correlations between resemblance and the other variables are smaller than $r = .3$ (Volk and Quinsey, 2002; Volk et al., 2005). Following the slide presentation, participants completed a demographic questionnaire and then received a debriefing form and compensation for their participation (Introductory Subject Pool credits or \$5).

Figure 1. Average correlations between adoption preference and resemblance for men and women in the Combined Study and Study 3. Error bars represent standard deviation.



Results

Given that Study 1 and Study 2 shared the same 35 images, we combined the data for the two studies to present the results more parsimoniously. From here on, we refer to the combined data from Study 1 and Study 2 as Combined. We simultaneously analyzed the data individually for both Study 1 and Study 2 to determine if combining the data altered the patterns of results in the individual studies. We did not find any statistically significant differences between the Combined Study results, and the individual Study 1 and 2 results.

It should be noted that we treated the different child faces as being independent, even if they came from the same child. Based on a sample of faces from each study (5 faces from 2 children in each study), the average correlation between adoption and resemblance ratings for a particular child's faces was $r = .5$. This is only slightly larger than the average correlation between unrelated child faces $r = .3$. Nevertheless, correlations between data may alter the Type I error and/or inflate effect sizes (Glass and Hopkins, 1996; Kenny, 1995). To guard against Type I inflation, we used a stringent alpha of $p < .001$ for all t-tests and included child (Stimulus Set) as a variable in the MANOVA (Burlingame, Kircher, and Honts, 1994; Kenny and Judd, 1986). To guard against inflated effect sizes in the t-tests, we computed Cohen's d using means and standard deviations rather than t-values (Dunlap, Cortina, Vaslow, and Burke, 1996).

Table 1. Average Correlations Between Resemblance, Health, and Cuteness Ratings

| | Health | Cuteness |
|-------------|--------------|--------------|
| Resemblance | .202* | .289* |
| | <i>.188*</i> | <i>.272*</i> |
| Health | -- | .524* |
| | | <i>.552*</i> |

Note: Combined Study correlations are on top, Study 3 correlations are italicized and on bottom; * = $p < .001$

Male vs. Female Bias in Adoption-Resemblance Correlations

We first calculated the average zero-order correlation between adoption preference and resemblance for men and women. Each individual infant face (stimulus) was treated in much the same way as a separate trial in a repeated-measures design. For example, the correlation between adoption preference and resemblance for the first face in the Combined Study would be composed of 186 participants. This would then be repeated for each of the faces, yielding a total of 24 correlations in the Combined Study, and 48 correlations in Study 3. Each average correlation was therefore based on over 3,000 points of data. The average correlations were tested for homogeneity (Strube, 1988), then transformed into z' scores using Fisher's z' transformation (Silver and Dunlap, 1987). The z' scores were then averaged to yield the average, within-stimulus correlations between two variables (Dunlap, Jones and Bittner, 1983; Hays, 1962). Using Howell's recommendation for treating z' transformed correlations as data (1992), one-sample t-tests and independent sample t-tests (equal variance) were performed. These average correlations, and their standard deviations, are presented in Figure 1. The average

correlations for the Combined Study (men, $r = .448$, $t(23) = 19.1$, $p < .001$; women, $r = .370$, $t(23) = 13.6$, $p < .001$) and Study 3 (men, $r = .433$, $t(47) = 22.7$, $p < .001$; women, $r = .336$, $t(47) = 11.0$, $p < .001$) were all significant. Men had significantly higher average correlations between adoption preference and resemblance than women in both the Combined Study ($t(46) = 5.9$, $p < .001$, $d = .70$) and Study 3 ($t(94) = 7.8$, $p < .001$, $d = .71$). The correlations between resemblance and the other variables used in the studies (cuteness and health) are presented in Table 1. All correlations were significant ($p < .001$), but there were no significant differences between the correlations of the two studies or the two sexes. The correlations between resemblance and the other variables were low.

Table 2. Effects of Stimulus Set, Stimulus Age, and Participant Sex on Resemblance Ratings

| | Combined | | | Study 3 | | |
|--------------------|----------|------------------|--------|---------|------------------|--------|
| | F | partial η^2 | p | F | partial η^2 | p |
| Stimulus Set | 8.17 | .08 | < .001 | 7.32 | .36 | < .001 |
| Stimulus Set x Sex | 17.91 | .16 | < .001 | .29 | .02 | n.s. |
| Age | 3.60 | .12 | < .001 | 1.44 | .14 | n.s. |
| Stimulus Set x Age | 2.17 | .15 | < .01 | 3.6 | .78 | < .001 |

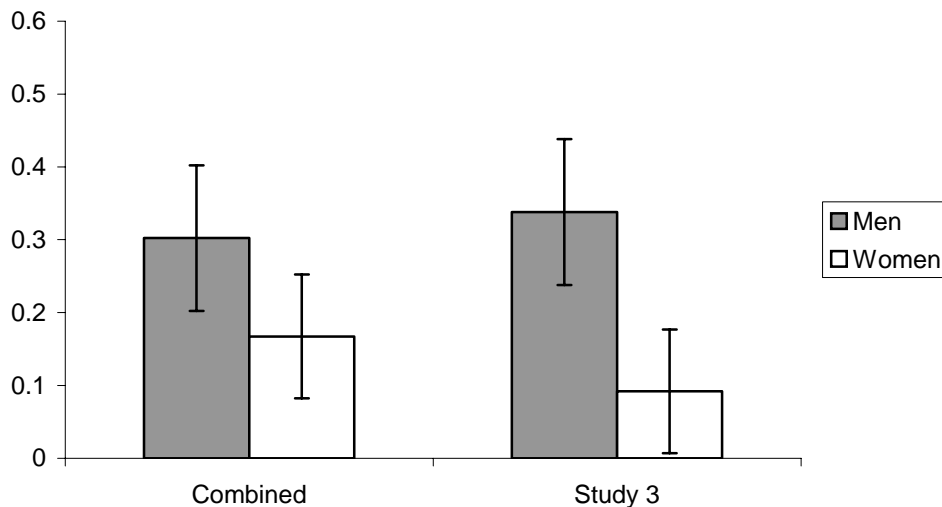
As in our earlier studies, we found relatively large correlations between cuteness and adoption preference. We therefore conducted partial correlations between adoption preference and resemblance while controlling for cuteness. The average partial correlations are presented in Figure 2 (with standard deviations). The average partial correlations for the Combined Study (men, $r = .286$, $t(23) = 11.2$, $p < .001$; women, $r = .131$, $t(23) = 5.5$, $p < .001$) and Study 3 (men, $r = .338$, $t(47) = 13.8$, $p < .001$; women, $r = .092$, $t(47) = 4.1$, $p < .001$) were all significant. Men had significantly higher average partial correlations between adoption preference and resemblance than women in both the Combined Study ($t(94) = 4.6$, $p < .001$, $d = 1.18$) and Study 3 ($t(94) = 7.6$, $p < .001$, $d = .1.55$). Indeed, the effect size of the men-women differences appeared to be larger when we controlled for cuteness ratings.

We also used a paired t-test to compare the average adoption-resemblance correlation for the youngest (6 month, $r = .41$) stimuli to the adoption-resemblance correlation for the oldest (6 year $r = .34$) stimuli and found no significant difference between the correlations of the two different stimulus ages ($t(17) = 1.8$, $p = n.s.$). The sex difference between the correlations also did not significantly change between the two stimulus ages ($t(8) = -.2$, $p = n.s.$).

Child Age-Related Changes in Resemblance Ratings

To examine the child age-related changes in resemblance ratings, we conducted a 2x3x8 and a 2x6x8 Repeated Measures ANOVA to examine whether resemblance scores changed with age in the Combined and Study 3 data respectively. The independent variables were Sex (of participants), Stimulus Set (child), and Age (of stimuli). The data were screened for missing data and violations of assumptions (Tabachnik and Fidell, 2007). There were three missing data points that we replaced with the mean value between an average value for the particular participant and the particular stimulus (Widaman, 2005). Further, in both samples the assumption of sphericity was violated, so we chose to analyze the multivariate results using the conservative Pillai's Trace (Howell, 2002). The results of the two ANOVAs are reported in Table 2. In the Combined data, we found significant effects of Stimulus Set, Stimulus Set x Sex, Age, and Stimulus Set x Age. The relationship between resemblance scores and age in the Combined Study was negative. In the Study 3 ANOVA analysis we found significant effects of Stimulus Set and Stimulus Set x Age. Age was not significant in this analysis, even though the effect size was slightly larger than the effect size for the Combined data.

Figure 2. Partial correlations between adoption preference and resemblance while controlling for cuteness for men and women in the Combined Study and Study 3. Error bars represent standard deviation.



Discussion

Male vs. Female Bias in Adoption-Resemblance

The prediction that men would have larger correlations between adoption preference and resemblance ratings was supported in the Combined Study and in Study 3. These findings replicate our earlier findings that in the HAP men place a greater

emphasis on cues of resemblance than women (Volk and Quinsey, 2002). This difference does not appear to be due to differences in how the sexes perceived resemblance with respect to cuteness and health. These findings support the hypothesis that men are more concerned with perceived cues of resemblance than women.

We believe that one important difference that could explain the disparate findings in the literature is the use of subjective versus objective cues of resemblance. Our study is an example of the former, and while the latter method has the admirable goal of seeking greater external validity (i.e., determining actual resemblance), morphing an adult's face into a child's face to generate cue of genetic resemblance may produce the ambiguous results seen in the literature if one or more morphing procedures lack ecological validity. Adults appear to be sensitive to morphed cues of resemblance in other adult faces (DeBruine, 2005), but morphing adult faces with other adult faces is more straight-forward, and poses fewer technical (e.g., the differences between morphing software algorithms) and theoretical (e.g., medically/developmentally accurate translations of adult to child features) problems than morphing adult faces into child faces.

A second challenge for the use of "objective" cues is adults' ability to reliably detect subtle facial cues of *relatedness* between adults and children. Adults are surprisingly poor at determining genetic relatedness in unfamiliar child-adult pairs when they rely solely on facial cues, performing only slightly better than chance (Brédart and French, 1999; Bressan and Grassi, 2004). The lack of a developmental advantage for detecting self-features is suggested by developmental data showing that young children show no difference in recognizing self vs. stranger facial features (Mondloch, Leis, and Maurer, 2006). Even if adults correctly attribute resemblance to genetic relatedness, environmental or social cues appear to have a larger effect on adults' ascriptions of resemblance (Bressan and Dal Martello, 2002). This potential limitation with using "objective" measures of resemblance may be compounded by possible differences in how modern and ancestral humans determine self-resemblance. Humans living in modern society have ample opportunities to study the features of their own faces through frequent exposure to mirrors, photographs, and other visual aids. Beyond looking into reflections in water (or in another's eyes), ancestral humans had no means of directly studying their own features (Burch, Hipp, and Platek, 2006). When this lack of opportunity for ancestral humans to view themselves is combined with the poor performance of modern humans in judging relatedness, and the stronger effects of social cues on judging relatedness, we believe that the available evidence currently suggests that subtle, static infant and/or child facial cues of resemblance may not represent perfectly accurate, reliable, evolved cues for determining paternity. Therefore, we believe that while facial cues of resemblance are potentially valid indicators of genetic relatedness, it could be the case that any subtle cues of resemblance are evoked differently by the different morphing techniques.

Nevertheless, we believe that the available evidence demonstrates that men's belief that a child is genetically related to themselves matters, and that any real, imagined, or suggested resemblance may contribute to that belief. The hypothesis that men's perception of resemblance is important is borne out by our findings of the male bias in adoption-resemblance correlations in four separate HAP studies, with a combined total of over 300 adult participants rating over 100 different infant and child faces, from over 30 children, and from 8 different child ages. This hypothesis is also supported by the

data on maternal, but not paternal, family biases in ascriptions of resemblance to the father and by the predictions of family dynamics, family violence, and/or self-reported paternal investment by self-reported paternal cues of resemblance. Finally, this hypothesis is also supported by differences in men and women's activation of the brain in response to perceived cues of resemblance (Platek et al., 2004).

How can this hypothesis be true if men have difficulty detecting subtle, static child facial cues of relatedness through resemblance? Men may have evolved mechanisms that are sensitive to more obvious facial cues (e.g., racial features, gross physical features) and behavioral cues (e.g., partner's behavioral traits, dynamic facial cues, social ascriptions) if those cues proved reliable enough to help men avoid unwittingly investing in unrelated offspring. If the mechanism for being concerned with resemblance operates independently of mechanisms for determining the degree of relatedness (and there is no evidence that they are dependently linked), one would expect paternal resemblance to be important to men even if they aren't perfectly reliable in interpreting relatedness from subtle, static child facial cues. The idea is that men are motivated to use whatever data they can obtain that potentially speak to their paternity, even if these data are of less than perfect quality.

Child Age-Related Changes in Resemblance Ratings

The effect of child age on resemblance ratings was negative and small in both the Combined Study and Study 3. The effect was significant only in the former study, although similar non-significant effect sizes in the individual studies suggest that this may be due to lack of statistical power in Study 3 rather than actual differences between the samples. The data suggest that infant faces have a higher resemblance to the general adult population than older child faces do. The negative correlation between age and resemblance scores is counter-intuitive when one considers that compared to older children's facial morphology, infant's facial morphology is less similar to adult's facial morphology. Given the very small effect size of the difference, we are hesitant to make strong theoretical claims regarding the significance of this effect. Concealing paternal identity is thought to be particularly relevant during infancy, and so infants should resemble a greater number of individuals (i.e., have a higher resemblance score) than children (Pagel, 1997). This possibility receives limited support from the current data.

The correlation between adoption preference and resemblance did not differ across child age. This suggests that the effects of resemblance on parental investment may continue beyond infancy into early childhood. Indeed, it is possible that the effects could continue throughout childhood and into adulthood. In either case, recursive effects of resemblance on parental perceptions could magnify the importance of perceived resemblance over time (Prentice and Hall, 1992). The lack of a sex difference associated with age and the adoption-resemblance correlations suggests that men remain more concerned with resemblance than do women as a child ages.

A final noteworthy finding in the ANOVA analyses was the significance of the individual stimuli in both influencing the individual resemblance scores as well as the interaction between resemblance scores and child age. It would appear that different children have different degrees of basic resemblance to the general adult population and that different children's resemblance to that general population change at different rates

with respect to child age. From a methodological perspective, these results suggest that studies of adult-child resemblance should consider the possibly large influence of individual child characteristics. From a theoretical perspective, our results suggest that any selection for youthful concealment of resemblance may have a smaller effect on resemblance than do individual differences in appearance.

Limitations

There are some limitations to our current study. First, the HAP is a proxy measure of parental investment. Therefore, any extensions of our results to actual parental investment must be done with a degree of caution. Second, there may be semantic ambiguities regarding the use of resemblance along with adoption preference in some cultures (see Volk and Quinsey, 2002, for further discussion). A third possible limitation is the inclusion (in two of the studies) of morphed faces. However, the null-findings of our unpublished study of fluctuating asymmetry in the HAP suggest that repeated presentations of morphed stimuli do not automatically bias participant responses towards unaltered stimuli. A final possibility is that participants' responses were dictated by demand characteristics. We believe this is unlikely for two reasons: the study "goal" was blind to participants because the resemblance ratings in these studies were included in order to reduce method variance (i.e., to give participants an item that was very different to rate than the items of primary interest in these studies), and that as in previous studies, the average correlations between resemblance and health and cuteness were small in both the current studies.

Conclusion

Evolutionary theory predicts that men should be more concerned with issues of false paternity than women should be concerned with false maternity. In particular, men considering paternal investment in a child should be more concerned with determining their relatedness to children believed to be their own than women considering maternal investment. In three separate studies using the HAP we replicated our initial findings of a positive male bias in the importance of perceived resemblance ratings in predicting adoption preference. When combined with the existing literature on resemblance and parental investment, we believe that this supports the hypothesis that men are concerned with cues of resemblance and paternity, even if subtle, static child facial cues are a poor measure of relatedness. We believe that our own use of infant and child facial stimuli to study cues of resemblance avoids the issue of objective validity of resemblance cues by directly asking participants for their perceptions of resemblance. Whether or not these resemblance perceptions are objectively accurate, they represent a more direct measure of any cognitive mechanisms that are associated with selective paternal investment.

We also found a small, negative effect of child age on resemblance. This effect was only significant in the larger sample. This negative correlation suggests that infants may have a greater resemblance to the general adult population than older children. This finding is consistent with theories of concealing relatedness. The correlation between adoption preference and resemblance was stable across child age for both sexes. The effects of resemblance on adults' perceptions and behaviors associated with parental care

may therefore be magnified over time. We also found that individual children differ markedly on their average resemblance to adults, and that different children's average resemblance changes differently with age. These results suggest caution in interpreting resemblance across different children and that any age-related effects of resemblance may be smaller in effect than age-related differences amongst individual children.

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