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What's in a child's face? : effects of facial resemblance, love withdrawal, empathy and context on behavioral and neural responses
Heckendorf, E.

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Author: Heckendorf, Esther

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Chapter 3

Brain Activity and Love-withdrawal Moderate Effects of Suggested Kinship on Negative Appraisals

Esther Heckendorf, Marian J. Bakermans-Kranenburg,
Marinus H. van IJzendoorn, Alexandra Voorthuis, and
Renske Huffmeijer

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Abstract

Facial resemblance serves as an important kinship cue in humans, and, as such, facilitates kin recognition. Mechanisms to facilitate kin recognition exist in many different species and have probably evolved to promote nepotism and avoid inbreeding. Responses to facial resemblance may however be affected by a person's own (childhood) experiences with close relatives. In the present study, we investigated whether the degree of resemblance of children's faces with the participant's face was related to participants' positive and negative appraisals of the children's faces. We morphed pictures of an unfamiliar child's face with the participant's face and with the face of an unfamiliar adult, to create facial stimuli that differed in their degree of facial resemblance with the participant. We examined the effects of childhood experiences with parental love-withdrawal and participants' neural processing of facial identity (fusiform face area activity, FFA). As hypothesized, negative appraisal of the faces decreased linearly with increasing facial resemblance. In addition, love-withdrawal and FFA activity moderated the relation between facial resemblance and negative appraisal. Participants who both reported high love-withdrawal and showed greater FFA activity showed the largest decrease in negative appraisals with increasing resemblance. Positive appraisal of the faces was not associated with resemblance of the child face with the participant's face. Future research should address the effects of phenotypic kinship cues on actual parental behavior.

Introduction

How do we recognize our relatives? Various cues, like co-residence during childhood, observing your mother caring for a newborn sibling, and phenotypic cues of genetic relatedness influence our estimates of kinship (Lieberman, Tooby, & Cosmides, 2007; Porter & Moore, 1981; DeBruine, 2002; DeBruine, 2004a). An individual may use such cues to distinguish kin from non-kin (i.e. estimate whether he or she is related to another individual), and to determine the degree of genetic relatedness (i.e. determine how closely he or she is related to another individual). Many species are known to engage in kin recognition, and kin recognition mechanisms have probably evolved to promote nepotism (i.e. favor relatives) and avoid inbreeding (Hepper, 2011).

According to the inclusive fitness theory, nepotistic behavior pays off because it promotes survival and reproductive success of close relatives who share a proportion of one's genes (Hamilton, 1964), and thus enhances the chance that an individual's genes are transmitted. Inbreeding, on the other hand, is related to negative outcomes, including increased childhood mortality rates and risk of genetic abnormalities in offspring (Al-Gazali, Hamamy, & Al-Arrayad, 2006; Saha, Hamad & Mohamed, 1990). Therefore, avoiding inbreeding and promoting nepotism are highly desirable in evolutionary terms, and mechanisms to facilitate kin recognition are adaptive because they enable individuals to adjust their behavior according to their genetic relatedness with others (Lehmann & Perrin, 2002). Phenotype matching, i.e. the process of determining the degree of relatedness to another individual by comparing that individual's phenotypic cues (e.g. odor, auditory signals) to a 'kin prototype', has been identified as a crucial kinship recognition mechanism in many animals (Hauber & Sherman, 2001).

In humans, facial resemblance may play an important role in phenotype matching, as it has been shown that individuals are able to make fairly accurate judgments of others' actual relatedness based on facial similarity (Bressan & Grassi, 2004; Maloney & Dal Martello, 2006; Kaminski, Dridi, Graff, & Gentaz 2009; Alvergne, Faurie & Raymond, 2010). In addition, participants rated adults' faces that resembled themselves higher on prosocial characteristics such as trustworthiness (DeBruine, 2002, 2005), and participants were willing to show more prosocial behavior (e.g. cooperation) to adults that facially resembled themselves (Krupp, DeBruine & Barclay, 2008). Likewise, adults were more willing to invest in children whose faces resembled their own (Bressan,

Bertamini, Nalli, & Zanutto, 2009; DeBruine, 2004b; Platek, Burch, Panyavin, Wasserman, & Gallup 2002). Lastly, facial resemblance enhances the perceived attractiveness of children's faces (DeBruine, 2004b), particularly for same-sex faces (DeBruine, 2004a). Interestingly, the effects of facial resemblance of other-sex faces was found to be sensitive to the relational context: In one study, facial resemblance of other-sex faces was not related to perceived attractiveness in the context of a long-term relationship (in which both prosocial regard and sexual attraction are expected to play a role). However, when presented in the context of a short-term relationship (in which primarily sexual attraction is expected to play a major role), facial resemblance of other-sex faces was related to decreased attractiveness (DeBruine, 2005). Taken together, findings from previous studies thus fit well with the theory that kin recognition serves the dual goal of both promoting nepotism and avoiding inbreeding.

However, individual differences may exist in the way people respond to individuals that resemble themselves. It can be expected that effects of facial resemblance (and kinship cues in general) depend on an individual's own (childhood) experiences with close relatives. We recently found that young adults' experiences with parental love-withdrawal during childhood were related to face processing. Parental love-withdrawal was related to increased brain activity in face processing areas (i.e. infero-lateral occipital cortex and fusiform areas) as well as increased activity in the inferior frontal gyrus in response to children's faces that resembled their own compared to children's faces that did not resemble their own face (Heckendorf, Huffmeijer, Bakermans-Kranenburg, & Van IJzendoorn, 2016). Thus, experiences of love-withdrawal were related to enhanced neural differentiation between children's faces that resembled the participants' face and children's faces that did not. Love-withdrawal is a parental disciplinary strategy in which the parent withholds love and affection when the child misbehaves or disobeys, and is associated with long-term negative consequences, including low emotional well-being, low self-esteem, fear of failure, insecure attachment, and feelings of resentment toward the parents (Bowlby, 1973/1985, p. 243; Assor, Roth, & Deci, 2004; Goldstein & Heaven, 2000; Elliot & Thrash, 2004; Renk, McKinney, Klein, & Oliveros 2006). Previous research has also associated experiences of love-withdrawal with enhanced (neural) processing of and responding to interpersonal cues, including emotional faces, and with differential effects of experimental manipulations such as oxytocin administration on these

processes (Bakermans-Kranenburg, Van IJzendoorn, Riem, Tops, & Alink, 2012; Huffmeijer, Tops, Alink, Bakermans-Kranenburg, & Van IJzendoorn, 2011; Huffmeijer et al., 2013; Riem et al., 2013; Van IJzendoorn, Huffmeijer, Alink, Bakermans-Kranenburg, & Tops, 2011). Thus, the regular use of love-withdrawal as a parenting technique seems to have a profound impact on an individual's long-term psychological well-being and interpersonal relationships (including kinship and romantic bonds), as well as on the neural processing of relevant stimuli. Such effects may well be reflected in a different evaluation of self-resembling faces.

Individual variation in the evaluation of faces may result from individual differences in the neural processing of faces. A large body of research has robustly and consistently related face processing to activity in the fusiform face area (FFA), a brain region located on the lateral side of the middle fusiform gyrus (see Kanwisher & Yovel, 2006 for a review). Important with respect to facial resemblance as a kinship cue is that FFA activity has specifically been related to analyzing facial identity: the particular features and configuration that define an individual face (Andrews & Ewbank, 2004; Andrews & Schluppeck, 2004; Grill-Spector, Knouf, & Kanwisher, 2004; Yovel & Kanwisher, 2005). Greater FFA activity may thus be considered to reflect more extensive processing of the observed face, in particular the identifying features and configuration. This may in turn impact on the perception and differentiation of facial resemblance and thus affect subsequent evaluations.

In the present study, we examined whether the degree of self-resemblance of child faces affects participants' evaluations of the child faces. More specifically, we examined whether increasing resemblance of a child's face with the participant's face is related to more positive appraisals and less negative appraisals. In addition, we examined whether effects of facial resemblance depend on participants' neural processing of facial identity (FFA activity) and whether childhood experiences of parental love-withdrawal moderate participants' reactions to facial resemblance. As analysis of facial identity is necessary for differential responding to different individuals, we expected stronger increases in positive appraisals and more exaggerated decreases in negative appraisals with increasing facial resemblance in individuals who process faces more extensively (i.e., show greater FFA activity in response to faces in general). We also expected that individuals with more experiences of parental love-withdrawal would show larger increases for positive appraisals and

stronger decreases for negative appraisals with increasing facial resemblance. Most pronounced effects were thus expected in individuals who both process faces relatively extensively and report higher levels of love-withdrawal experiences.

Materials and methods

Participants

Forty-six female undergraduate and graduate students aged 21.81 years on average ($SD = 2.60$; range 18-28 years) completed two experimental sessions, 4-12 weeks apart ($M = 4.61$, $SD = 1.68$ weeks). Exclusion criteria were MRI contraindications, pregnancy, current psychiatric and neurological disorders, history of severe head injury, current alcohol or drug abuse, and chronic use of medication (except contraceptives). One participant provided no usable fMRI data due to excessive head movement, and three participants fell asleep during fMRI data acquisition. Thus, our final sample consisted of 42 participants aged 18 to 28 years ($M = 21.83$ years, $SD = 2.64$). The Ethics Committee of the Leiden University Medical Center approved the experiment and informed consent was obtained from all participants at the beginning of the first session. All participants were rewarded with 40€ for participation. The structural MRI scans of the final sample did not show any anomalies.

Procedure

Participants were instructed to abstain from alcohol and excessive physical activity during the last 24 hours and from caffeine during the last 12 hours before the start of each session. At the start of session 1, participants filled out questionnaires, including a measure of parental love-withdrawal. The researchers explained the MRI procedure to the participants at the beginning of each session. Inside the scanner, foam inserts were placed between the head coil and the participant's head to minimize head movements. The participants watched two types of children's faces (faces showing no resemblance and faces showing 50% resemblance with the participant), as well as scrambled faces (as a visual control) preceded by subliminal primes (for detailed information see Heckendorf et al., 2016) within the scanner. Stimuli were projected onto a screen placed outside the opening of the scanner bore. Participants viewed

the screen through a mirror fixed to the head coil. At the end of the second session, participants completed a rating task in which they evaluated both the children's faces shown in the fMRI experiment and a child's face resembling the participant for 75% on several positive and negative characteristics. Subsequently, participants were debriefed about the nature of the priming task presented in the MRI scanner.

Facial Stimuli

We created pictures of children showing no facial resemblance, 50% facial resemblance, and 75% facial resemblance with the participant by morphing the photograph of a child's face (unfamiliar to the participant) with a photograph of: (i) an unknown female face and (ii) a photograph of the participant's own face. Prior to the first session, participants provided a full-color digital photograph of themselves that met the following criteria: a light and uniform background, the picture showing their face (full frontal) and neck only, with a neutral facial expression, without piercings, make-up, or glasses. To create morphs not resembling the participant, we used full color, full frontal photographs of two female faces (both Caucasian and unfamiliar to the participant, aged 24 and 25 years, neutral facial expression, no jewelry or glasses). For half of the participants, the non-resembling morph for session 1 was created using female face 1 and the non-resembling morph for session 2 was created using female face 2, and for the other half vice versa. Full color, full frontal photographs of six 9–11 year old children (three boys and three girls, all Caucasian but slightly varying in skin color, all unfamiliar to the participants, with neutral facial expression, no jewelry or glasses) were available for morphing. For about half of the participants ($n = 21$), the morphs were created with the picture of a female child, for the other half ($n = 24$) with the picture of a male child. Within genders, we selected the child that best matched the participant's skin color and face-shape for ease of morphing. The same child was used for both the non-resembling and the 50% and 75% self-resembling morphs. We used both 50% and 75% self-resembling morphs in the rating task to investigate whether participants' ratings of the morphs would be linearly affected by self-resemblance.

Prior to morphing, all photographs were resized to 448×560 pixels and edited using Adobe Photoshop CS: External features (i.e., hair and ears) were removed and the pictures were framed on a black background. Subsequently, we performed morphing using Fantamorph 5 Deluxe. The 75%-resembling

morph consisted for 75% of the participant's face and for 25% of an unknown child face, the 50%-resembling morphs consisted for 50% of the participant's face and for 50% of the same child face, and the non-resembling morphs consisted for 50% of the unknown female face and for 50% of the same child face. The 75%- and 50%-resembling morphs thus differed only in the relative degree to which they consisted of the participant's face (50% vs. 75%). Finally, we generated a scrambled face for each participant from the 50%-resembling morph by randomly rearranging blocks of 9×9 pixels using Matlab R2012B. These scrambled stimuli were used as a visual control in fMRI recording. An example of the morphing results is shown in Figure 1.

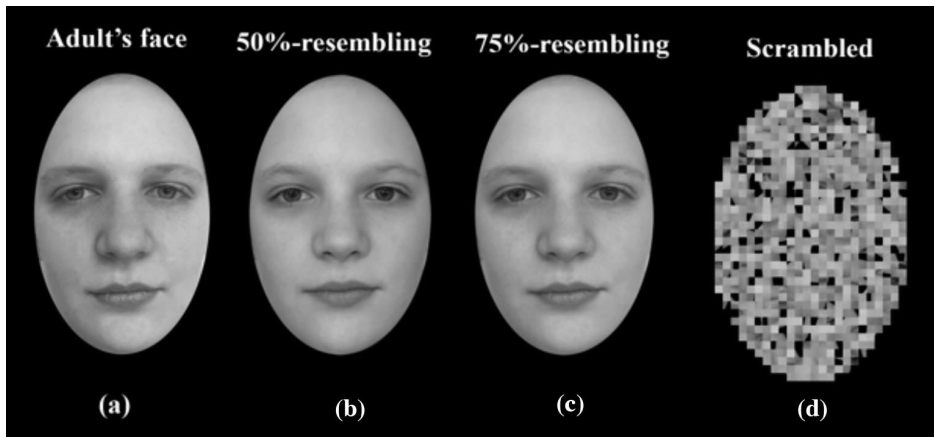


Figure 1. The 50%-resembling morph (b) consisted for 50% of the child's face and for 50% of the participant's face (a). The 75%-resembling morphs (c) consisted for 25% of the child's face and for 75% of the participant's face (a). The scrambled face (d) was generated by randomly rearranging pixels from the 50%-resembling morph (b).

An independent sample ($N=15$) rated the age of all morphed pictures used in our experiment. The estimated age of the three types of morphs (non-resembling, 50%-resembling and 75%-resembling) differed significantly ($F_{(2, 28)} = 15.72, p < .001$), as tested with a repeated measures ANOVA. Post-hoc pairwise comparisons with Bonferroni correction for multiple comparisons revealed that the 75%-resembling morph was perceived as older than both the non-resembling morph ($t_{(14)} = 2.13, p = .001$) and the 50%-resembling morph ($t_{(14)} = -1.67, p < .003$). Differences in age estimates between the 50%-resembling and the non-resembling morph ($p > .05$) were not significant.

Face Rating Task

At the end of the second session, participants completed a computerized task to evaluate the two non-resembling morphs, the 50%-resembling morph, and the 75%-resembling morph. E-Prime Software (Psychology Software Tools, 2012) was used to implement the task and to collect the participants' responses. The task consisted of three blocks during which the participants were asked to rate the morphs on several positive and negative characteristics. In the first block, participants were asked to indicate how attractive, intelligent, unreliable and worthwhile (Dutch: 'aantrekkelijk', 'slim', 'onbetrouwbaar' and 'de moeite waard') the different morphs were on a 600-point visual analog scale (VAS) ranging from 'not at all...' to 'very...' (e.g. ranging from 'not at all attractive' to 'very attractive'). In the second block, participants rated how much commitment, connectedness, distance and aversion (Dutch: 'verbondenheid', 'betrokkenheid', 'afstandelijkheid' and 'afkeer') they felt toward the morphs, again on a 600-point VAS, ranging from 'no at all' to 'a lot of ...' (e.g. ranging from 'no commitment at all' to 'a lot of commitment'). In the third block, participants evaluated how much the different morphs resembled themselves, on a 600-point VAS ranging from 0% to 100%. Each combination of morph and question was presented once. Thus, the first and the second block each consisted of 16 trials, and the third block consisted of 4 trials.

The blocks were presented in fixed order. Within a block, combinations of faces and questions were presented in quasi-random order, with the restrictions that the same face could not be presented more than two times in a row and that the 75%-resembling morph could not be presented on the very first trial of the task. On each trial, a morph (sized 6 x 9 cm) was presented in the center of the screen on a black background. A VAS was positioned below the morph. Participants used the mouse to rate the morphs by moving a slider to the position on the scale corresponding to their judgment. Participants could alter their choice until satisfied with their rating, and then moved to the next trial by clicking a button labeled 'next' that was presented in the bottom center of the screen. Only the participant's final choice on each trial was stored. Scores for the two non-resembling morphs were averaged.

Perceived self-resemblance of the morphs increased significantly with the degree of facial resemblance, with a large effect size ($F_{(2,86)} = 357.69, p < .001, \eta_p^2 = .89$). Post-hoc comparisons with Bonferroni correction for multiple comparisons revealed that all differences were significant ($p < .001$). Thus,

perceived self-resemblance of the 75%-resembling morph was significantly higher than perceived self-resemblance of the 50%-resembling morph, which in turn was significantly higher than perceived self-resemblance of the non-resembling morphs.

Face Processing: Fusiform Face Area Activity

Details concerning MRI image acquisition and fMRI processing and analysis, along with results (observed activation as well as reliability of activity) have been reported elsewhere, (Heckendorf et al., 2016). We analyzed the fMRI data with FSL (FMRIB's Software Library) FEAT (FMRI Expert Analysis Tool) version 5.0.4, part of Jenkinson, Beckmann, Behrens, Woolrich, and Smith (2012), and Smith et al. (2004). For the current study, we included FFA activity in the contrast faces (i.e., non-resembling, 50%-resembling) > scrambled stimuli during the second session as a measure of face processing. We selected this contrast to examine whether and how an individual's degree of face processing impacts on how she subsequently evaluates the morphs. We obtained significant activity for this contrast within the fusiform gyrus as well as other brain areas in the first session. Preliminary whole-brain analysis (identical to those conducted on data from the first session; see Heckendorf et al., 2016) also revealed significant activity in the fusiform gyrus for the contrast faces vs. scrambled in the second session. We chose to focus on fMRI data obtained during the second session because participants completed the Face Rating Task at the end of the second session.

We obtained each participant's maximum activity value within the FFA as our measure of face processing: As the FFA is an area within the fusiform gyrus defined by its preferential responding to faces, we first defined an anatomical mask of the fusiform gyrus using the Harvard-Oxford Cortical Structures Atlas. A binarized, anatomical mask including only voxels belonging to the right or left fusiform gyrus with a probability of at least 25% was created in 2 mm isotropic MNI-152 standard space (Jenkinson, Bannister, Brady & Smith, 2002). Next, we created a functional mask of face processing areas using the probability map obtained for a localizer task in an earlier study (N=124) for the contrast faces vs. scenes (Engell & McCarthy, 2013). We binarized and thresholded this contrast image (only voxels with at least a 25% probability to be significantly activated in the faces vs. scenes contrast included) in 2 mm isotropic MNI-152 standard space (Jenkinson et al., 2002). Finally, we

multiplied the functional and anatomical masks to obtain a mask including only voxels that both respond specifically to faces and are part of the fusiform gyrus: thus a mask of the FFA. Featquery was used to export each participant's maximum activity value (contrast parameter) within the FFA mask to IBM SPSS Statistics 23 for further analysis. Our decision to include maximum activity values was based on the reliability of FFA activity obtained for the priming task, which was higher for maximum activity values than for mean and median activity values (Heckendorf, Bakermans-Kranenburg, Van IJzendoorn, & Huffmeijer, manuscript submitted for publication).

To ensure that excluding the three participants who fell asleep during the fMRI data acquisition did not significantly influence the results, we reran the analyses with these three participants included. For two of the participants that fell asleep during fMRI data acquisition, fMRI data of session 1 was available, and we included this participants' maximum activity value (contrast parameter) within the FFA mask during session 1 in the analyses. For the third participant, fMRI data of the first 156 trials (67% of the task) of session 2 was available. As we obtained similar reliability of FFA activity in the contrast faces vs. scrambled stimuli in previous analyses (Heckendorf et al., manuscript submitted for publication), we included this participant's FFA activity during the available trials in the analyses.

Love-withdrawal Experiences

At the beginning of the first session, participants completed a modified version of the 30-item Children's Report of Parental Behavior Inventory (CRPBI-30, Schludermann & Schludermann, 1983; Beyers & Goossens, 2003), containing the items of the Acceptance and Psychological Control scales from the original questionnaire and several extra items to measure love-withdrawal. The 11-item Love-withdrawal scale consists of all five items that constitute the Withdrawal of Relations subscale of the 108-item CRPBI (3 of which are also included in the Psychological Control scale of the CRPBI-30; Schludermann & Schludermann, 1983), two items that were adapted from this same questionnaire, and four items that were adapted from the Parental Discipline Questionnaire (Patrick & Gibbs, 2007). Participants rated how well each item described their mother and father separately (e.g., "My mother was a person who if I'd hurt her feelings, stopped talking to me until I please her again") on a 5-point Likert scale, ranging from ("not at all") to ("very well"). We averaged scores for maternal

and paternal love-withdrawal. We winsorized the score of one outlier ($z = 3.61$; the new score was identical to the second-highest score of the sample plus the difference between the second-highest and next-highest score, see Tabachnick & Fidell, 2001). After winsorizing, the scores were normally distributed with an average score of 18.55 ($SD = 6.01$, $Mdn = 16.5$, range: 11.5-32.5). Earlier studies obtained adequate validity and reliability of the CRPBI and its subscales (Schludermann & Schludermann, 1983, 1988; Locke & Prinz, 2002). Internal consistency of the scale in the current sample was high (Cronbach's $\alpha = .91$). The Love-withdrawal subscale as used in this study was implemented in earlier research on the consequences of maternal love-withdrawal in young adults (e.g., Huffmeijer et al., 2011).

Statistical Analyses

Statistical analyses were conducted using SPSS software, version 23. We first conducted three principal component analyses (PCAs) with Varimax rotation, for the non-resembling, 50%-resembling, and 75%-resembling morphs, to determine which of the positive and negative ratings clustered. The PCAs yielded the same two factors for all three morphs, one containing the positive items (i.e. attractive, intelligent, worthwhile, committed and connected), and the other containing the negative items (i.e. unreliable, distant, repulsive). This two-factor solution explained 59.83% (50%-resembling morph), 61.34% (75%-resembling morph), and 61.61% (0%-resembling morph) of variance respectively. Eigenvalues were 3.36 (50%-resembling morph), 3.38 (non-resembling morph) and 3.57 (75%-resembling morph) for the first factor and 1.34 (75%-resembling morph), 1.43 (50%-resembling morph) and 1.55 (non-resembling morph) for the second factor. Loadings of the ratings on the factors were between 0.60 and 0.83. We therefore averaged across participants' ratings of attractiveness, intelligence, worthwhileness, commitment and connectedness to obtain a score for positive appraisal and across ratings of unreliability, distance, and repulsion to obtain a score for negative appraisal of each type of morph.

To examine effects of facial resemblance, experiences of love-withdrawal, and neural face processing (FFA activity) on participants' ratings, we conducted two repeated measures ANCOVAs with negative appraisals and positive appraisals respectively as dependent variables, facial resemblance (no resemblance, 50% resemblance, 75% resemblance) as within-subjects factor

and experiences of love-withdrawal and FFA activity as continuous predictors. In case of sphericity violations, we applied the Greenhouse Geisser correction. In case of a significant main effect of facial resemblance, pairwise comparisons (Bonferroni-corrected for multiple comparisons) were computed.

Results

Means and standard deviations of participants' negative and positive appraisals of unfamiliar faces and faces resembling the participant for 50% and 75% are presented in Table 1.

Table 1. Average ratings and standard deviations of the negative and the positive scale for all face stimuli: Participants rated the faces that resembled themselves more positive and less negative.

Child faces	Negative		Positive	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Unfamiliar	203.33	92.07	287.41	87.45
50% familiar	178.02	94.63	333.29	94.10
75% familiar	145.47	106.65	365.34	97.71

Negative appraisals

The repeated measures ANCOVA revealed a significant main effect of facial resemblance ($F_{(2, 76)} = 3.73, p = .03, \eta_p^2 = .09$), reflecting a linear effect of facial resemblance ($F_{(1, 38)} = 4.32, p = .045, \eta_p^2 = .10$): Faces that resembled the participants to a greater extent were evaluated less negatively. Although a clear linear decrease in negative appraisals was observed (see Table 1), post hoc comparisons revealed that the participants rated the 75%-resembling morph significantly less negatively than the non-resembling morph ($p < .01$), but participants' ratings of the 50% self-resembling morph did not differ significantly from ratings of the other two morphs ($ps > .05$).

The significant main effect of facial resemblance was qualified by a significant two-way interaction between facial resemblance and love-withdrawal ($F_{(2, 76)} = 3.92, p = .02, \eta_p^2 = .09$) as well as a significant three-way interaction between facial resemblance, love-withdrawal and FFA activity ($F_{(2, 76)} = 4.44, p = .02, \eta_p^2$

= .11). The interaction between facial resemblance and FFA activity was not significant ($F_{(2,76)} = 2.74, p = .07$).

To visualize the interaction effects we divided the participants into groups reporting fewer and more experiences of love-withdrawal using a median split ($Mdn = 16.5$), and we conducted separate repeated measures ANCOVAs with facial resemblance and FFA activity as independent variables for each group. The interaction between facial resemblance and FFA activity was significant. For participants who had experienced high levels of love-withdrawal ($F_{(2,38)} = 4.32, p = .02, \eta_p^2 = .19$), but not for participants who had experienced low levels of love-withdrawal ($p > .05$). To further explore the interaction, we therefore divided the participants that had experienced high levels of love-withdrawal into two groups with high ($N=11$) or low ($N=10$) FFA activity using a median split, and conducted repeated measures ANOVAs with facial resemblance as within-subjects factor for each group separately. A significant effect of

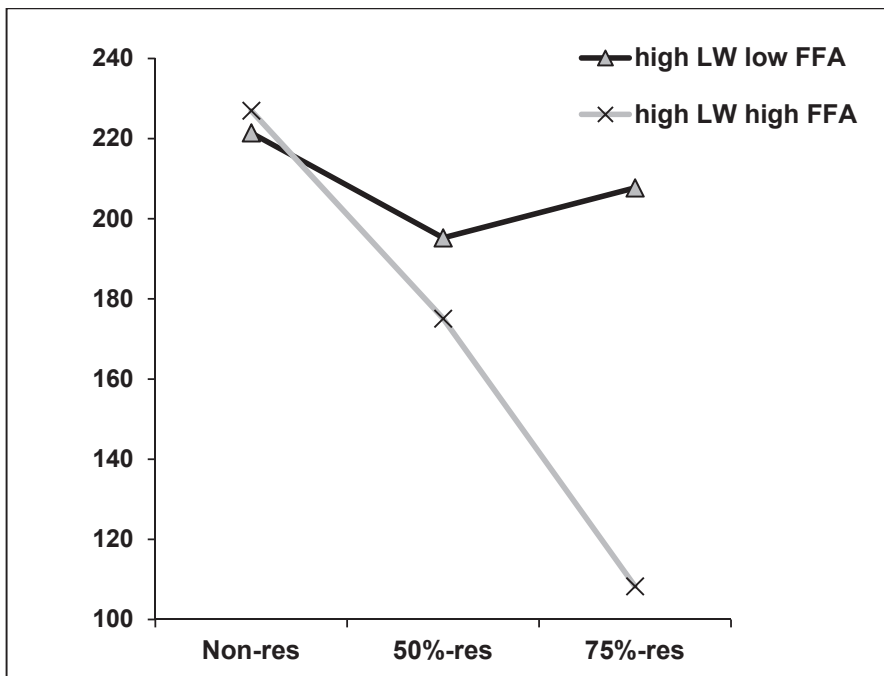


Figure 2. Interaction between facial resemblance and FFA activity in participants with high levels of reported love-withdrawal. Individuals with high levels of both FFA activity and experienced love-withdrawal showed the most pronounced decrease in negative appraisals.

facial resemblance was found only in the group showing high FFA activity ($F_{(2,20)} = 12.56, p = .00, \eta_p^2 = .56$; low FFA activity: $F_{(2,18)} = 0.27, p = .77, \eta_p^2 = .03$), reflecting a linear decrease in negative appraisals with increasing facial resemblance ($F_{(1,10)} = 19.19, p = .00, \eta_p^2 = .66$; see Figure 2). Thus, the effect of facial resemblance on negative appraisals of the morphs was most pronounced in individuals who had both experienced relatively much love-withdrawal and processed the faces to a large extent.

We reran the analyses with the bigger sample of 45 participants with incomplete fMRI data from session 2. These analyses revealed the same results as in the sample of 42 participants.

Positive Appraisals

Although, as shown in Figure 2, positive appraisals seemed to increase linearly with increasing facial resemblance, the repeated measures ANCOVA for positive appraisals revealed no significant main or interaction effects (all $F_s \leq 1.65, p_s > .20$ [42 participants]; all $F_s \leq 2.26, p_s > .11$ [45 participants]).

Discussion

We investigated young adults' appraisal of children's faces as a function of the degree of resemblance to their own face. As expected, increased self-resemblance was related to less negative appraisals of the children's faces. Furthermore, love-withdrawal and FFA activity moderated the relation between facial resemblance and negative appraisals, with more pronounced effects of facial resemblance in participants reporting high love-withdrawal and showing high FFA activity. Thus, particularly in participants who reported high levels of parental love-withdrawal, extensive face processing, as indicated by greater FFA activity, was associated with larger decreases in negative evaluations of children that resembled the participant.

The finding that participants showed less negative appraisals of child faces that resembled themselves more, implicating close kinship, makes sense from an evolutionary perspective: it may promote caregiving behaviors directed at closely related children, which in turn enhance the child's likelihood of survival and future reproductive success, thus increasing the chance that an individual's genes are transmitted to the following generation (Hamilton, 1963,

1964). The finding that children's faces that resemble the participant less are rated more negatively is also in line with the results of studies suggesting that both stepmothers and stepfathers invest less in their stepchildren than in their biological children (Anderson, Kaplan, & Lancaster, 1999; Anderson, Kaplan, Lam, & Lancaster, 1999; Evenhouse & Reilly, 2000; Hetherington & Jodl, 1994; Marlowe, 1999; Schmeeckle, 2007; Tifferet, Jorev, & Nasanovitz, 2010; Zvoch, 1999), and that stepchildren are more likely to be abused by their stepparents (Creighton & Noyes, 1989; Daly & Wilson, 1996; Van IJzendoorn, Euser, Prinzie, Juffer, & Bakermans-Kranenburg, 2009). In a Canadian study, the risk of 0-2 year-old children to be killed by a stepparent was estimated as even 70 times higher than the risk to be killed by a genetic parent (Daly & Wilson, 1988b). Similar results were obtained in a U.S. study, in which the estimated risk of fatal abuse by a stepparent in children under 3 years was about 100 times higher than the risk of fatal abuse by genetic parents (Daly & Wilson, 1988a). Stronger negative feelings towards biologically unrelated stepchildren may play a role in these increased risk rates among stepchildren, although results have not been unequivocal (Gelles & Harrop, 1991; Malkin & Lamb, 1994; Temrin, Buchmayer, & Enquist, 2000; but see Daly & Wilson, 2008).

The finding that a more pronounced decrease in negative appraisal with increasing facial resemblance was observed in participants reporting more experiences of love-withdrawal and showing greater FFA activity, indicate, first, that the extent to which individuals process faces varying in resemblance to the participant indeed affects their appraisal of these faces. The FFA analyzes face configuration in order to differentiate between individual faces (see for a review Kanwisher & Yovel, 2006), and greater FFA activity may reflect an enhanced ability to discriminate between identities and heightened sensitivity to identity cues, including facial resemblance. Individuals that process faces more extensively may therefore detect facial resemblance better, which may explain why participants showing higher FFA activity (in combination with experiences of love-withdrawal) show larger decreases of negative appraisals with increasing self-resemblance of children's faces.

The results also suggest that childhood experiences of parental love-withdrawal as a disciplinary strategy are related to changes in the neural processing of and reactions to facial resemblance in children's faces. The results are in line with previous findings relating experiences of love-withdrawal to enhanced effects of emotional expression on face processing (Huffmeijer et al.,

2011) and enhanced neural differentiation between self-resembling and non-self-resembling children (Heckendorf et al., 2016). Thus, regular experiences of parental love-withdrawal as a disciplinary strategy may not only be associated with long-term negative outcomes such as low self-esteem and reduced emotional well-being (Assor et al., 2004; Goldstein & Heaven, 2000; Renk et al., 2006), but also with changes in the neural processing of and reactions to interpersonal stimuli, including facial stimuli communicating emotions or kinship cues, that are still evident in young adulthood.

Contrary to our expectations and previous findings (DeBruine, 2002, 2003, 2004b, 2005; Krupp et al., 2008; Platek et al., 2002), effects were restricted to negative appraisals and did not extend to positive appraisals. Several factors may have contributed to such discrepancies. First, we studied female participants only and gender differences in reaction to facial resemblance may exist. In several previous studies, male, but not female, participants rated children's faces that resembled themselves as more attractive than children's faces that did not resemble themselves (Platek et al., 2002, 2003; Volk & Quinsey, 2002). In addition, facial resemblance affected hypothetical investment decisions, such as the willingness to adopt a child, more in men than in women (Platek et al., 2002, 2003; Volk & Quinsey, 2002, 2007). That males' judgements and decisions are more affected by facial resemblance than those of women may be caused by a greater need to rely on kinship cues such as facial resemblance to be certain of paternity. Contrary to women, who bear their child, throughout history, men could never be absolutely certain of paternity. Therefore, men may use their degree of facial resemblance with a child to make more accurate estimations of their likelihood of paternity, and, as a consequence, may adjust their behavior towards a child based on the degree of facial resemblance. As women do not need to rely on their degree of facial resemblance with a child to know whether or not it is their own, it makes sense that effects of facial resemblance would be more restricted in women than in men. Future studies, directly comparing females and males, could determine the extent of such gender differences, investigating for example whether gender differences extend to both small and large investment decisions and to both positive and negative judgments and behaviors.

Second, the design of our task may have contributed to differences between our and others' findings. Previous research has often used forced-choice tasks, in which participants were asked to indicate their preference for one of two

or more simultaneously presented faces varying in facial resemblance (e.g. DeBruine, 2004a, 2004b; 2005; Krupp et al., 2008; Plateket al., 2002). In our study, we presented faces one at a time. Thus, participants evaluated each of the faces separately, and could therefore assign different faces similar ratings, decreasing differences between appraisal of non-resembling and resembling faces. Compared to ratings that allow for subtle variations in the appraisal of children's faces, forced choices may exaggerate effects of facial resemblance. In addition, we created morphs using the face of a nine- to eleven-year old child, whereas other studies have often used the faces of infants and young children (up to two years old) to create morphs (Bressan et al., 2009; DeBruine, 2004b; Platek et al., 2002, 2003, 2004; Platek, Kenaan, & Mohamed, 2005). As a consequence, the morphs in our study looked older than those used in previous research, which may have yield different results. Investment decisions are most likely to be made during infancy (Daly & Wilson, 1984) and infants require a large amount of care and parental contact, and therefore, facial resemblance in infants may evoke stronger reactions compared to facial resemblance in older children. In addition, parental investment and care are crucial for the survival of infants, but parental care becomes less crucial as children age and learn to be increasingly self-reliant and independent. This too might heighten the importance of facial resemblance in infants and young children. In future research, morphs of infant and child faces of different ages could be included to examine whether and how the effects of facial resemblance are moderated by the age of the morphed face.

The present study has some limitations. First, we used a retrospective self-report questionnaire to assess participants' experiences with childhood love-withdrawal. Participants' memories might be biased by current experiences with their parents. Second, the 75%-resembling morph appeared slightly older than the 50%-resembling and the non-resembling morphs, which may have affected the results. However, participants usually rate faces of younger children higher in cuteness and attractiveness than faces of older children (Luo, Li, & Lee, 2011; Volk, Lukjanczuk, & Quinsey, 2007). Thus, our finding of a less negative appraisal of the 75%-resembling morph is unlikely to reflect an effect of perceived age. Third, it remains unclear to what extent facial resemblance created through morphing matches facial resemblance of actual genetic relatives. Genetically related faces are more similar than unrelated individuals' faces, but exactly what features individuals look at to estimate the degree of genetic relatedness has

not yet been investigated systematically, and similarity in specific features (e.g. nose width) may be more important than overall similarity (DeBruine, Jones, Little, & Perrett, 2008; Maloney & Dal Martello, 2006). Moreover, we cannot exclude the possibility that some of the participants were aware of the study's hypothesis. In future research, it is important to explicitly ask the participants during debriefing about their ideas of the study hypothesis. Finally, we only included female participants in our study, due to concerns with regard to sample size and homogeneity, and to enable comparisons with planned future studies with mothers and their children.

Future research with larger samples should also include both males and females to examine possible gender differences in response to facial resemblance. In addition, future research should investigate the influence of phenotypic kinship cues on parental behavior to examine how differences in children's facial resemblance to their parents may affect real life behavior. Facial resemblance between fathers and their offspring may be positively related to fathers' investment of resources in their offspring (Alvergne, Faurie & Raymond, 2009; Prokop, Obertová, & Fedor 2010), and fathers' emotional closeness to their offspring (Alvergne et al., 2009). In addition, reactions to facial resemblance in expectant mothers' and fathers' may be examined, as hormonal changes in expectant mothers and fathers prior to the birth of a baby (Berg & Wynne-Edwards, 2001; Storey, Walsh, Quinton, & Wynne-Edwards, 2000; Rilling, 2013) may affect their reactions to facial resemblance in infants.

Finally, earlier research has shown interference between simultaneous processing of faces and names of familiar people (Young et al., 1986; Ferreira, Marful & Bajo, 2014). In future research, it could be investigated whether individuals with more love-withdrawal experiences differ from individuals with less experiences of love-withdrawal in the degree of interference between face perception and name retrieval. Moreover, future research could examine whether individuals with more love-withdrawal experiences do not only react stronger to faces of significant others, but also to other identifying information, including names.

Conclusion

In sum, we found evidence for an association between the neural processing of children's faces and appraisal of these faces. More extensive face processing was related to stronger reactions to facial resemblance (i.e. less negative appraisal with increasing facial resemblance) in participants who reported high levels of love-withdrawal. These results illustrate the long-term effects of early love-withdrawal. Thus, children of parents who regularly use love-withdrawal as a disciplinary strategy may become vigilant for information related to significant others, including their own offspring. Such enhanced vigilance may explain the stronger reactions to facial resemblance suggesting kinship.

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