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ORIGINAL RESEARCH REPORT

Birth Order Does Not Affect Ability to Detect Kin

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Previous studies suggest that birth order affects kinship detection ability. Kaminski et al. (2010) argued that firstborns use contextual cues (e.g., maternal perinatal association) to assess kinship in their own family, leading to a disadvantage in assessing kinship from facial cues alone in strangers. In contrast, laterborns do not have the contextual cue of maternal perinatal association and hence rely more on facial cues, leading to an advantage in detecting kin from facial cues alone. However, Alvergne et al. (2010) found no evidence in support of such a birthorder effect. The current study aimed to replicate previous studies with better suited methods to determine the effect of birth order on kin recognition. 109 raters viewed 132 pairs of photographs of children (aged 3–17 years), and indicated whether each pair was related or unrelated. Half of the pairs were sibling pairs and half were unrelated child pairs that were age- and gender- matched to the related pairs. No image was shown more than once, related pairs were not known to be related to any other image in the study, and individuals from unrelated pairs were not known to be related to any other image. We used binomial logistic mixed effects modelling to predict kinship judgments from relatedness and birth order (with image pair and rater as random factors). Relatedness was the main factor driving kinship judgments; related child-pairs were more than twice as likely as unrelated pairs to be judged as kin. Kinship judgment accuracy was unaffected by rater birth order. These findings indicate that laterborns did not have an advantage in detecting child sibling pairs. Pre-registration, data, code, and preprint available at osf.io/h43ep.

Keywords: Kinship; Face Perception; Allocentric Kin Recognition; Phenotypic Resemblance; Facial Similarity; Birth Order

Introduction

Kinship is crucial to biological theories of social behaviour, as kinship influences altruistic and reproductive behaviour. Inclusive fitness theory argues that pro-social behaviour is increased towards kin (Hamilton, 1964). Sexual interest, however, is decreased towards close kin to achieve optimal outbreeding (Bateson, 1983), as mating with close kin can result in increased risk of autosomal recessive genetic disorders and miscarriages (Bittles, 2001).

But how do we recognise our kin in the first place? Two main categories of cues, namely phenotypic cues such as vocal, facial and odour resemblance and contextual cues such as maternal perinatal association (intensive maternal care of a sibling after their birth) and co-residence are involved in kin recognition (reviewed in Penn & Frommen, 2010). Maternal perinatal association (Lieberman, Tooby, & Cosmides, 2007) and co-residence (Lieberman, Tooby, & Cosmides, 2003) are correlated with increased pro-social behaviour and increased incest avoidance towards that sibling. Facial resemblance has been reported to influence behaviour in similar ways (see DeBruine, Jones, Little, & Perrett, 2008 for a review), as increased facial self-resemblance increased contributions and trust in economic games (DeBruine, 2002; Krupp, DeBruine, & Barclay, 2008), and self-resembling same-sex faces were found to be more trustworthy and attractive (DeBruine, 2004, 2005). Yet, in line with incest avoidance, facial self-resemblance had a negative effect on attractiveness perceptions of opposite-sex faces in a short-term relationship context, where sexual appeal is the main incentive (DeBruine, 2005). This effect was bigger for women with brothers (especially younger brothers) than women without brothers, with an increasing number of brothers decreasing the perceived attractiveness of unknown self-resembling male faces (DeBruine et al., 2011). Perceptions of trustworthiness were, however, independent of the woman having brothers or not. This suggests that contextual cues, especially maternal perinatal association, are influential cues shaping sexual and pro-social behaviour throughout life (Lieberman et al., 2003, 2007).

Moreover, detecting kinship is not confined to one's own kin. People are also reliably able to detect kinship among

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others, which, to a certain extent, enables us to expect and modify behaviours accordingly. Research on third party kin recognition focuses on the physical information that contributes to accurate kinship detection. For instance, Maloney and Dal Martello (2006) found that perceived facial similarity serves almost exclusively as a cue to kinship. Furthermore, studies have shown that people mostly rely on facial features situated in the upper half of the face when making kinship judgments (Alvergne, Perreau, Mazur, Mueller, & Raymond, 2014; Dal Martello & Maloney, 2006). While Dal Martello and Maloney (2006) found that the lower face was still used for kinship judgments when assessing parent-child pairs, Alvergne et al. (2014) found that the lower part of the face did not contain any paternity cues specifically. Moreover, they found that the presence of specific useful information is more important than the number of cues provided and that paternity can be detected even when the features of the face are mixed up (Alvergne et al., 2014). This notion of spatially localised cues being more informative of kinship than holistic cues is supported by Dal Martello, DeBruine and Maloney's (2015) study showing that facial inversion does not affect kinship judgments. Additionally, Dal Martello and Maloney (2010) found that both the left hemi-face and the right hemi-face inform kinship judgments equally, and importantly, that information from the left and right hemi-face is redundant, meaning that given one, no additional kinship information is available from seeing a full face.

However, less research has looked at individual differences in the accuracy with which kinship is detected. Kinship detection accuracy is consistent across cultures, with participants showing no difference in the ability to identify parent-child pairs from their own or another ethnicity (Alvergne et al., 2009; Kaminski, Ravary, Graff, & Gentaz, 2010). Even 5-year-olds can accurately detect parent-child pairs, with no difference between child and adult performances for neonate comparison trials (Kaminski, Gentaz, & Mazens, 2012). At the age of 9, children are also able to distinguish between relevant and irrelevant facial features for kinship detection, i.e. same head orientation or open/closed mouth or eyes (Kaminski, Berger, Jolly, & Mazens, 2013).

A couple of studies found that men gave generally higher similarity ratings than women, but accuracy did not differ between the sexes (Bressan & Dal Martello, 2002; Bressan & Grassi, 2004). An early study by Nesse, Silverman and Bortz (1990) found that men are better at judging relatedness of sons than daughters, and women are better at judging the relatedness of daughters than sons in a similarity task. Nesse, Silverman and Bortz (1990) also looked at the number of children and the number of siblings participants had, but did not find an effect of these factors on accuracy levels. It is important to note that these studies relied on similarity ratings rather than direct kinship judgments, which are highly overlapping (Maloney & Dal Martello, 2006) but not necessarily synonymous (DeBruine et al., 2009).

Bressan and Dal Pos (2012) found that fathers report higher facial resemblance between unfamiliar face pairs than non-fathers, mothers and non-mothers, but that fathers are not more accurate at detecting relatedness than others. This suggests that facial resemblance perception could be biased in fathers, possibly to reinforce paternity beliefs and hence guarantee investment in offspring.

Kaminski, Ravary, Graff and Gentaz (2010) also found a difference in raters' ability to detect kin. In a series of experiments they asked participants to match parent-child pairs, or judge the relatedness of face pairs of varying degrees of relatedness, and found that laterborns outperform firstborns in kinship detection accuracy in both tasks. They found this effect in participants from Taiwan and France, with Taiwanese raters accurately matching Caucasian parent-child pairs, and in child and adult raters. Kaminski et al. (2010) argue that firstborns use facial cues combined with contextual cues (e.g., maternal perinatal association) to assess kinship in their own family, leading to a disadvantage in assessing kinship from facial cues only in unknown faces. In contrast, laterborns do not have the contextual cue of maternal perinatal association and hence rely more on facial cues, leading to an advantage in detecting kin from facial cues alone. However, Alvergne et al. (2010) used a near-identical experimental paradigm and did not replicate this effect of birth order when raters had to determine parent-child pairs.

In light of the above, this study aimed to clarify the role of birth order on kinship detection accuracy. In an attempt to clarify the effect of having older and younger siblings as a child on kin detection, we showed raters stimuli which consisted exclusively of unknown child siblings, as this is arguably the category of kin firstborns and laterborns use differing kin detection strategies on when growing up. In addition, we used colour pictures instead of black and white pictures, and masked images to exclude hair, ears and background to focus on facial cues alone. This avoids variation in global characteristics of the photos, such as posture, as it has been shown that such global characteristics can influence kinship recognition (Kaminski et al., 2013; Vokey, Rendall, Tangen, Parr, & Waal, 2004). Another reason for masking images was to ensure kinship judgments would be exclusively based on facial cues, rather than extraneous kinship information such as a shared hair style. Furthermore, we used a guessing rather than a matching paradigm, which means that raters saw one pair of faces for each trial, rather than a target face and multiple potential matches. This ensured that the relatedness judgments for each pair were based on a given pairs' similarity, rather than being based on comparing a number of possible matches for similarity. Moreover, the guessing task explicitly asked raters whether they thought a pair was related or not, while a matching task implies that there must be a related pair within the set of presented faces. A number of previous studies have used the same methodology as presented in this paper (Dal Martello et al., 2015; Dal Martello & Maloney, 2006; DeBruine et al., 2009; Kaminski et al., 2010; Maloney & Dal Martello, 2006; Nesse et al., 1990). Lastly, we used a binomial logistic mixed model in our analysis to predict relatedness judgments from stimulus pairs' actual relatedness, raters' birth order, and their interaction. We included rater ID and

Stimulus ID as random effects rather than fixed effects. This allowed us to account for variation among both raters and stimuli without having to aggregate over one of these groups, which can limit the generalisability of findings beyond the used stimulus/rater set and may inflate false-positive rates. This also means that our dependent variable (DV) was coded as related/unrelated choice, rather than an accuracy score aggregated over stimuli as in Kaminski et al. (2010). Consequently, the effect of interest in the current study is the interacting effect of birth order and actual relatedness on raters' kinship choices rather than a main effect of birth order on overall kinship choices independent of actual relatedness.

Following Kaminski et al. (2010), we hypothesized that

1) There would be a main effect of relatedness, whereby related pairs would be judged as related more often than unrelated pairs.
2) There would be a two-way interaction of relatedness and birth order, whereby the accuracy of relatedness judgments would be higher for laterborns than firstborns.

Methods

The methods for this study were pre-registered on the Open Science Framework. The analysis script and final data set, as well as details about hypotheses, stimuli (including examples), procedure, and exclusion criteria are all available at osf.io/h43ep.

Stimuli

Stimuli were collected from children visiting a local science centre who volunteered to take part in a study of facial cues of family relatedness. Parental consent and child assent were obtained from each child to use their face photograph in online studies of family resemblance detection (an example consent form can be found on the OSF).

Children were photographed with a neutral expression looking straight at the camera with hair pulled back and any glasses, scarves, and hats removed. The specific procedures for image collection are available at osf.io/6g7ze.

From a set of approximately 2000 images of individuals of varying ages, sex and relatedness, we algorithmically chose the maximum number of sibling pairs fitting a number of criteria. Both siblings were required to be genetically related and non-twin full siblings under the age of 18. We also required that an age-matched (within 1 year), ethnicity-matched, and sex-matched foil image was available from family units that were not represented elsewhere in the image set. Specifically, the two individuals in each sibling pair are related to each other, but are not known to be related to any other individual in the set, while all individuals in unrelated pairs, too, are not known to be related to any individuals in the set. We also required that the algorithm returned an equal number of brother pairs, sister pairs and brother-sister pairs.

This produced 66 sibling pairs and 66 matched unrelated pairs. In each group, 22 pairs were both male, 22 pairs were both female, and 22 pairs were male and female. The individuals' age ranged from 3 to 17 years (mean age = 9.51 years, SD = 2.89 years) and the age difference between individuals in a pair ranged from 0 to 7 years (mean = 2.7 years, SD = 1.56 years). All included children pairs were white.

Procedure

Recruitment of participants was done online through social media (e.g., Facebook) and social bookmarking sites. The study itself was completed by participants online at faceresearch.org using their own computer. Participants were not compensated for their participation, apart from Psychology first-year students at the University of Glasgow, who were offered participation credits for their time.

Participants were told that they would view 132 pairs of faces, some of which were siblings and some of which were unrelated. They were informed that they were to judge whether the pairs were in fact "related" or "unrelated", and that subsequently there would be a short questionnaire about their own family composition (e.g., how many siblings they have). For the actual experimental task, they were shown one pair of child faces at a time and chose their answer by clicking on buttons labelled "unrelated" or "related".

In the questionnaire, participants were asked to indicate how many full siblings they had (from the same mother and father as the participant). The answer was chosen from a drop-down menu ranging from 0 (no siblings) to 10 (10 or more siblings). Participants also provided further information on each of their siblings (e.g., the number of younger/older/same-aged brothers or sisters they have). Information about other types of siblings such as half siblings, adopted siblings and stepsiblings was also gathered but not analysed in this study.

Raters

The study was started by 288 people. Participants who did not rate all 132 stimuli (n = 60) or did not complete the questionnaire (n = 18) were excluded from analyses. After these initial exclusions, we followed a categorisation of raters implemented in Kaminski et al. (2010), i.e. we only included raters with a maximum of two full siblings. This left us with a pool of 109 raters that fit the categorisation criteria and completed all tasks. Raters with one or two younger siblings were categorised as firstborns, while raters with one or two older siblings were categorised as laterborns. Raters with both one younger and one older sibling were also categorised as laterborns.

A power calculation during pre-registration indicated that with 100 participants (50 firstborn/50 laterborn), we would have 93% power to detect an interaction between birth order and relatedness with estimate $\cong$ 0.27 (odds ratio $\cong$ 1.3) at 5% alpha. We overshot this recruitment target and included all 109 eligible raters in the main analysis. The analysis and results based on the 100 pre-registered participants can be found in the supplemental materials Text S1. There are no differences in results between the two analyses. The laterborns group was made up of 48 raters with only older siblings and 11 raters with an older and a younger sibling. Firstborns (n = 50) only had younger siblings.

In more detail, we excluded

- Participants who did not complete the sibling questionnaire;
- Participants who had more than two full siblings (Kaminski et al., 2010);
- Participants who had "non-full" siblings (e.g., half-, step-, and adopted siblings) – to ensure that the participants were not exposed to maternal perinatal association (intensive maternal care of a sibling after their birth) through "non-full" siblings, or lived with a "non-full" sibling;
- "Only" children – as they do not have siblings and we were interested in the influence of siblings on kinship judgment accuracy;
- Twins who did not have any other "full" (younger or older) siblings – as birth order in twins is not related to observation of maternal perinatal association.

After filtering, the responses from 25 laterborn men (mean age = 29.22 years; SD = 12.7 years), 33 laterborn women (mean age = 25.8 years; SD = 9.96 years) and 1 laterborn of unspecified gender (age = 23 years) were analysed along with 18 firstborn men (mean age = 26.33 years; SD = 4.24 years), 31 firstborn women (mean age = 30.25 years; SD = 14.81 years) and 1 firstborn of unspecified gender (age = 17.1 years). Raters were predominantly white (89 out of 109 raters). Data from the excluded raters can be found in the data file used for the analysis, with the exclusion criteria being clearly marked in the analysis code (both available at osf.io/h43ep).

Results

We used a binomial logistic mixed model to predict relatedness judgments from actual relatedness (effect-coded as related = +0.5 and unrelated = –0.5), birth order (effect-coded as firstborns = +0.5 and laterborns = –0.5) and the interaction between birth order and relatedness in the kinship task. We included the rater ID and stimulus ID as random effects and specified our slopes maximally (Barr, Levy, Scheepers, & Tily, 2013). Analyses were conducted in the programming software R version 3.5.0 (R Core Team, 2017) in conjunction with lme4 version 1.1.19 (Bates, Mächler, Bolker, & Walker, 2015) and lmerTest version 3.0.1 (Kuznetsova, Brockhoff, & Christensen, 2016).

The analysis revealed a main effect of relatedness (β = 1.68, *95% CI* [1.32; 2.05], *SE* = 0.19, *z* = 9.07, *p* < .001, *odds ratio* = 5.37, *95% CI* [3.74; 7.74]), whereby actual related pairs were 5.37 times more likely to be judged as related than unrelated pairs (see **Figure 1**).

There was no main effect of birth order (β = –0.07, *95% CI* [–0.33; 0.19], *SE* = 0.13, *z* = –0.54, *p* = 0.59, *odds ratio* = 0.93, *95% CI* [0.72; 1.2]) and no interaction between birth order and relatedness (β = 0.11, *95% CI* [–0.12; 0.33], *SE* = 0.12, *z* = 0.91, *p* = 0.363, *odds ratio* = 1.12, *95% CI* [0.89; 1.39]), see **Figure 2**.

In fact, when looking at the non-significant difference between firstborns and laterborns (not pre-registered), firstborns tended to be more accurate in their kinship judgments (β = 1.75, *95% CI* [1.35; 2.15], *SE* = 0.2, *z* = 8.65, *p* < .001, *odds ratio* = 5.75, *95% CI* [3.88; 8.57]) than laterborns (β = 1.62, *95% CI* [1.25; 1.99], *SE* = 0.19, *z* = 8.65, *p* < .001, *odds ratio* = 5.05, *95% CI* [3.50; 7.30]), opposite to the prediction by Kaminski et al. (2010).

Discussion

In summary, we found that raters are able to identify who is related and who is unrelated when shown only facial information of children, with no further context information. This is a robust finding in the literature. We did not find that birth order, namely whether raters were firstborns or laterborns, influenced the accuracy of kinship judgments of children. Our results are consistent with Alvergne et al. (2010) who also found no effect of birth order when matching parents and children.

Our results are inconsistent with the finding by Kaminski et al. (2010) that laterborns have an advantage in detecting parent-child pairs and kin of varying degrees of relatedness. This failure to replicate Kaminski et al.'s (2010) could be a result of using different stimuli. That is, we used exclusively child pairs while Kaminski and colleagues used pairs that differed in their degree of relatedness, with only a subset

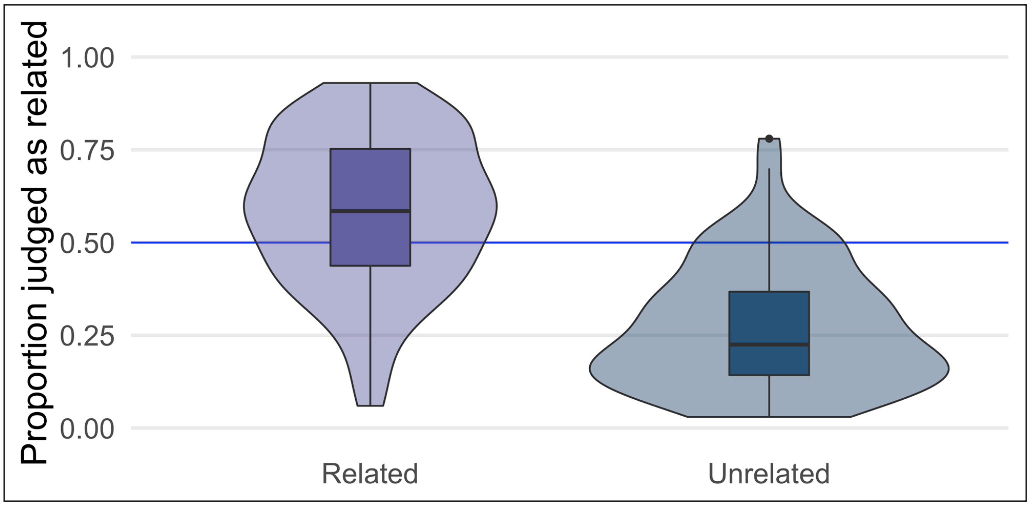

Figure 1: The main effect of relatedness on proportion of face pairs judged as related.

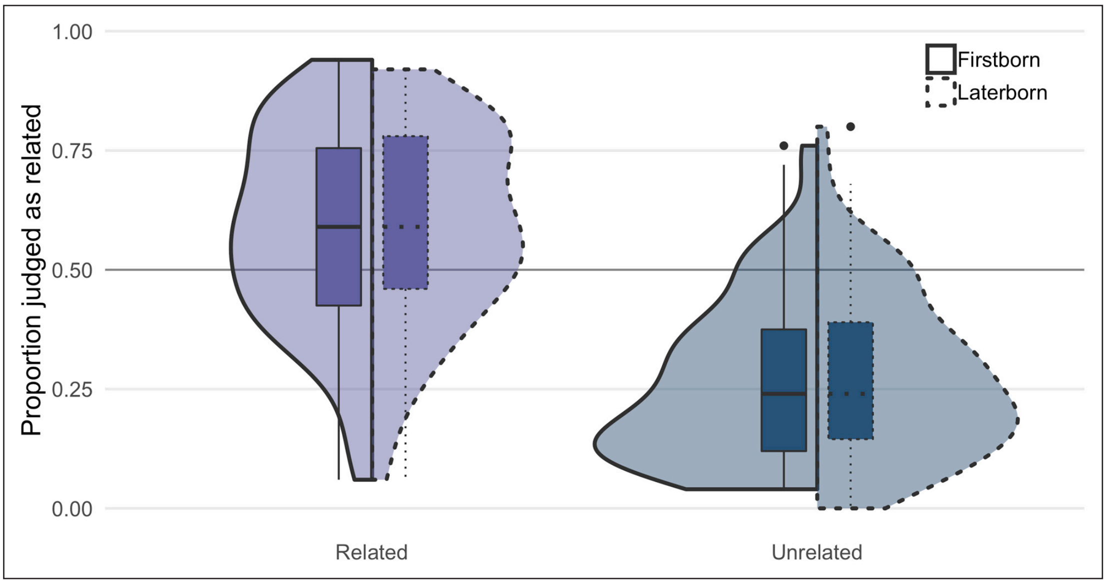

Figure 2: The interaction between relatedness and birth order on proportion of face pairs judged as related.

being siblings, of which the age was unknown. However, as Kaminski et al. (2010) argued that an advantage in kinship detection accuracy is based on birth order (i.e. having different constellations of siblings as a child), identifying child siblings is arguably a better test of this hypothesis. The current study could be repeated with other degrees of relatedness (e.g., parent-neonate pairs, grandparent-grandchild pairs, aunt/uncle-niece/nephew pairs etc.) to see whether this advantage in detecting kin is in fact limited to other kin constellations, which in turn could mean that the explanation as to why there is an advantage based on birth order has not fully been understood yet. Moreover, Kaminski et al.'s (2010) definition of laterborns included individuals who had both an older and a younger sibling, hence the laterborn might have witnessed maternal perinatal association with a younger sibling. In our data set, 11 of the 59 "laterborns" had both an older and younger sibling. This could mean that we are simply not picking up the effect of birth order due to categorisation issues. To investigate this, we conducted an exploratory analysis in which we only included laterborns with one or two older siblings, excluding raters with both an older and a younger sibling. This exclusion criterion resulted in 48 laterborns with only older siblings. Re-analysis did not change the results: birth order still had no main effect on kinship judgment accuracy ($\beta = -0.06$, $SE = 0.14$, $z = -0.44$, $p = 0.659$, *odds ratio* = 0.94) and there was no significant interaction between birth order and actual relatedness ($\beta = 0.12$, $SE = 0.12$, $z = 0.98$, $p = 0.327$, *odds ratio* = 1.13). To conclude, we find that raters are able to identify related and unrelated pairs of children, a finding consistent with the majority of research on third party kin recognition. We did not find that birth order of the rater, namely being a firstborn or a laterborn, influences kinship judgment accuracy when judging these pairs of children, which is in line with Alvergne et al. (2010) and inconsistent with Kaminski et al. (2010), who found that laterborns have an advantage when identifying kin of different degrees of relatedness.

Data Accessibility Statement
Preregistration, preprint, methods, data and code publicly available on this paper's project page on the Open Science Framework (osf.io/h43ep), preprint doi: 10.31234/osf.io/d2vy5.

Additional File
The additional file for this article can be found as follows:

- **Text S1:** Birth order does not affect ability to detect kin. DOI: https://doi.org/10.1525/collabra.235.s1

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Competing Interests
The authors have no competing interests to declare.

Author Contributions
- Contributed to conception and design: VF, LMD
- Contributed to acquisition of data: VF, IJH, AJL, KJO
- Contributed to analysis and interpretation of data: VF, LMD
- Drafted and/or revised the article: VF, IJH, AJL, KJO, LMD
- Approved the submitted version for publication: VF, IJH, AJL, KJO, LMD

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