Development of face-based trustworthiness impressions in childhood: A systematic review and metaanalysis

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Abstract

Adults form highly influential impressions about how trustworthy someone is from a mere glance at their face. Given their social and adaptive influence, the question emerges of how trust impressions develop. Following renewed interest, some mixed findings, and debate around their origins, this paper systematically reviews and meta-analyses research on the maturity of children's face-based trust impressions. Results from 10 studies (representing 1325 children aged 3-12, and 851 adults aged 17-81, across White, Asian, and Black ethnicities, and both sexes) suggest beginnings of a mature trust impression system exist in 3- to 5-year-olds. Meta-analysis reveals trust impressions develop across childhood and show adult-like patterns between 10 and 13 years. Outstanding questions in the field are identified.

Keywords: facial first impressions, trustworthiness, development, systematic review, meta-analysis

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Trustworthiness is a primary dimension of facial first impressions (Oosterhof & Todorov, 2008; Sutherland et al., 2013), and adults are able to make judgements about the trustworthiness of a face after just 33 ms of exposure (Todorov, Pakrashi, & Oosterhof, 2009). Accordingly, when we see a face, we quickly and efficiently form an impression about whether that person's intentions toward us are cooperative or aggressive (Li, Zhang, Heyman, Compton, & Lee, 2020; Oosterhof & Todorov, 2008). Regardless of their accuracy, our trust impressions can strongly influence real–life behaviour. For example, people are more likely to rent an Airbnb from a host whose face appears trustworthy in their profile picture (Ert, Fleischer, & Magen, 2016). On the other hand, untrustworthy-looking individuals are more likely to be judged as guilty in court, and receive harsher criminal sentences, even when there is little evidence of their guilt (Porter, ten Brinke, & Gustaw, 2010). Given how readily adults form these impressions, and how influential they can be, important questions emerge as to how and when these impressions develop. Specifically, are face-based trust impressions commonly formed and influential from a young age? Or do they require age-related development to resemble those of adults?

The development of face-based impression formation has received substantial recent research interest (Cook & Over, 2020; Ewing, Sutherland, & Willis, 2019; Mondloch, Gerada, Proietti, & Nelson, 2019; Over & Cook, 2018; Sutherland, Collova, et al., 2020), but the findings have not been consistent. Therefore, it is an ideal time to synthesise the current knowledge and identify avenues for future research. This study is the first attempt to systematically review and meta-analyse the evidence on the emergence and development of trust impressions in childhood. In addition to the theoretical importance of understanding the development of trust, it is also critical from a practical point of view: as one of society's most

vulnerable groups, it is essential that children seek comfort, protection, and social connection from trustworthy people (Ma, Xu, & Luo, 2015). Moreover, as children grow older, develop independence from their parents, and have greater opportunities to engage in social activities by themselves, there is an increasingly greater demand on them to make complex social decisions (Smith & Hart, 2007). Adults' face-based trust impressions can bias adult behaviour in both helpful and unhelpful ways (Dumas & Testé, 2006; Ert et al., 2016). Therefore, it is important to understand if children share similar biases as adults when forming impressions of trustworthiness. Such biases could place children in dangerous situations (e.g., trusting someone who looks deceptively trustworthy), or alternatively, could limit their chances of valuable social relationships if they distrust potential friends based only on their looks. On the other hand, if children's impressions differ greatly from those of adults, then understanding the immature trust impression system is crucial for understanding who children may choose to trust, especially given the many impressions children are likely to make using very scant information, such as when using social media or playing video games online. This understanding can assist in guiding and protecting children in a complex social world.

Why might mature trust impressions emerge early?

Face-based impressions of trustworthiness are functionally important (Collova, Sutherland, & Rhodes, 2019; Oosterhof & Todorov, 2008). Using visual cues to guide social decisions, such as whether to approach someone based on their facial appearance, reduces cognitive load and may facilitate social interaction and self-protection (Hassin & Trope, 2000; Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015). The cognitive efficiency that face-based trait impressions afford may be why trust impressions are ubiquitous across adults (Todorov et al., 2015), across cultures (Sutherland et al., 2018), and why these judgements are made extremely quickly (Willis & Todorov, 2006). Similar to stereotyping more

generally (Bordalo, Coffman, Gennaioli, & Shleifer, 2016; Judd, 1993), face-based impressions can be overgeneralised or over-exaggerated assumptions. They can be useful to the extent that they help us structure our expectations while minimising cognitive resources (Collova et al., 2019; Foo, Sutherland, Burton, Nakagawa, & Rhodes, 2021). The rapid processing benefits that impression formation affords may outweigh the cost of forming inaccurate impressions, as long as impressions still show a small kernel of truth (Foo et al., 2021). This functional importance suggests that, like stereotypes (Reis & Wright, 1982), face-based impressions may mature early in development (e.g., during the preschool years).

Another related reason why face-based trust impressions may mature early in development is that our impression formation system is likely built from processes that are evolutionarily adaptive. Face-based trait impressions may have allowed us to rapidly recognise potentially threatening or helpful facial appearances in our evolutionary past, thus increasing chances of survival and reproduction (Öhman et al., 2001; Zebrowitz & Collins, 1997). While trust impressions may not always be accurate (Foo et al., 2021; Porter et al., 2010), they could reflect an overgeneralised tendency to attend to facial cues that reflect by-products of other, more accurate face-based impressions, such as physical cues related to aggression (Boshyan, Zebrowitz, Franklin, McCormick, & Carré, 2014), sexual unfaithfulness (Leivers, Simmons, & Rhodes, 2015), or emotional expression recognition (Zebrowitz, 2017). For example, adults usually judge happy faces as being trustworthy and approachable, whereas angry faces are seen as more untrustworthy and better avoided (Sutherland, Young, & Rhodes, 2017). Even a hint of an expression on an emotionally neutral face (e.g., happiness in the form of slightly upturned lips) can be overgeneralised into an impression of trustworthiness (Zebrowitz, 2017). The faster processing benefits that trustworthiness impressions based on emotional expressions afford may outweigh the cost of forming inaccurate impressions. This benefit may be why adults are oversensitive to

untrustworthy facial appearances (Falvello, Vinson, Ferrari, & Todorov, 2015), since protection from threat is so vital to our survival. It is possible that the adaptive benefits of forming trustworthiness impressions based on facial cues have already prepared children with a biological tendency to infer traits when they see a person's face (Li et al., 2020; Ma, Xu, & Luo, 2016; Zebrowitz & Collins, 1997), although we note that not all adaptive processes necessarily emerge early in development (e.g., the social changes that occur in puberty; Picci & Scherf, 2016).

Why might trust impressions require development across childhood?

In contrast to the idea that impression formation emerges early in development, research on other critical aspects of face perception, including facial identity and emotional expression recognition, suggests that these processes require prolonged development across childhood before they show adult-like maturity (Lawrence et al., 2008; Nelson & Mondloch, 2019). Critically, there is evidence that some of these aspects, such as emotional expression recognition, share underlying processes with trust impressions from faces (Zebrowitz & Collins, 1997). Indeed, as emotional expression recognition abilities develop across childhood, the influence of emotional expressions on children's trust impressions also increases (Caulfield, Ewing, Bank, & Rhodes, 2016). This overlap between face-based trust impressions and other face perception abilities suggests that trustworthiness impressions might also undergo development across childhood, in conjunction with these face perception skills, particularly emotion recognition.

Social experience that accumulates throughout development has also been highlighted as being particularly key to the maturation of trust impressions (Over & Cook, 2018). Social learning accounts posit that children (and adults) must learn to associate certain facial appearances with particular traits or behaviours in order to demonstrate commonly observed

trustworthiness impressions from faces (Over & Cook, 2018; Verosky & Todorov, 2013). Indeed, there is good evidence that individual social encounters throughout development and adulthood shape the associations we form between particular facial appearances and traits (Feldmanhall et al., 2018; Hassin & Trope, 2000; Sutherland, Burton, et al., 2020; Verosky & Todorov, 2013). It is also possible that face-trait links are strengthened with social experience, especially during the primary school years, when there is a proliferation of social interaction (Klimes-Dougan & Zeman, 2007; Smith & Hart, 2007). Children's impressions of trustworthiness from faces may therefore not show maturity until they have gained sufficient social, cognitive, or perceptual experience to associate certain types of facial appearances with trustworthy or untrustworthy traits (Caulfield et al., 2016; Ewing, Caulfield, Read, & Rhodes, 2015a , 2015b; Ewing et al., 2019; Over & Cook, 2018; Verosky & Todorov, 2010).

We note that social learning and evolutionary accounts are not necessarily mutually exclusive. Indeed, the evolutionary and functional benefits of trust impressions likely biologically prepare us for relevant social or cultural learning (Sutherland, Collova, et al., 2020). Critically, determining when during development children's face-based trust impressions become adult-like can provide insight into *how much* social learning (in addition to perceptual and cognitive development) is required for trust impressions to appear mature. Understanding the development of trust impressions is key to developing theoretical accounts that accurately depict the origins of these important social judgements.

Synthesis and meta-analytic approach

Following more than a decade of renewed interest in the topic of children's impressions of trustworthiness from faces, some mixed findings, and recent debate on the origin of face-based trust impressions (Cook & Over, 2020; Sutherland, Collova, et al., 2020), it is now necessary to systematically review our knowledge thus far. Such synthesis

will allow us to form stronger conclusions about whether trust impressions are indeed mature from an early age, or whether prolonged development is required for children's impressions to resemble adult-like patterns. The current study systematically reviews and meta-analyses the findings from studies that have investigated whether children's impressions of trustworthiness from faces are adult-like. Therefore, we focus on studies that include an adult control group with which children's performance is quantitatively compared. In this review, we use "adult-like" to refer to a non-significant difference between child and adult participants' performance on measures of trust impressions.

In the reviewed literature, childhood was commonly divided into age groups including younger children, in the early preschool and school years (3-to-5-year-olds) and older children, aged 10 years and older. We classified children aged between these two groups (6-to-9-year-olds) as "middle childhood" in this review, and compared these three age groups (early, middle and late childhood) to adults to examine the developmental trend across childhood. Our meta-analysis results suggest that, while children show a remarkably early sensitivity to variations in facial trustworthiness from early childhood, age-related development is required for their trust impressions to become fully mature, in late childhood.

Methods

Literature search

The formal literature search was conducted on April 3rd, 2020. We searched two online databases: *Web of Science* and *PsycINFO,* in keeping with best practices (Foo, O'Dea, Koricheva, Nakagawa, & Lagisz, 2021; Nakagawa, Noble, Senior, & Lagisz, 2017). *Table 1* includes all search terms that were used. Also searched were papers cited by these initial papers. *Figure 1* outlines the literature searching process, which followed PRISMA guidelines (Moher et al., 2009).

Table 1

Terms used in literature search.

((face or facial) AND (trust) AND (perce* or impress* or judg* or decision* or process* or evaluat*) AND (child* or adolescen*) AND (adult-like or 'adult like' or mature* or develop*))*

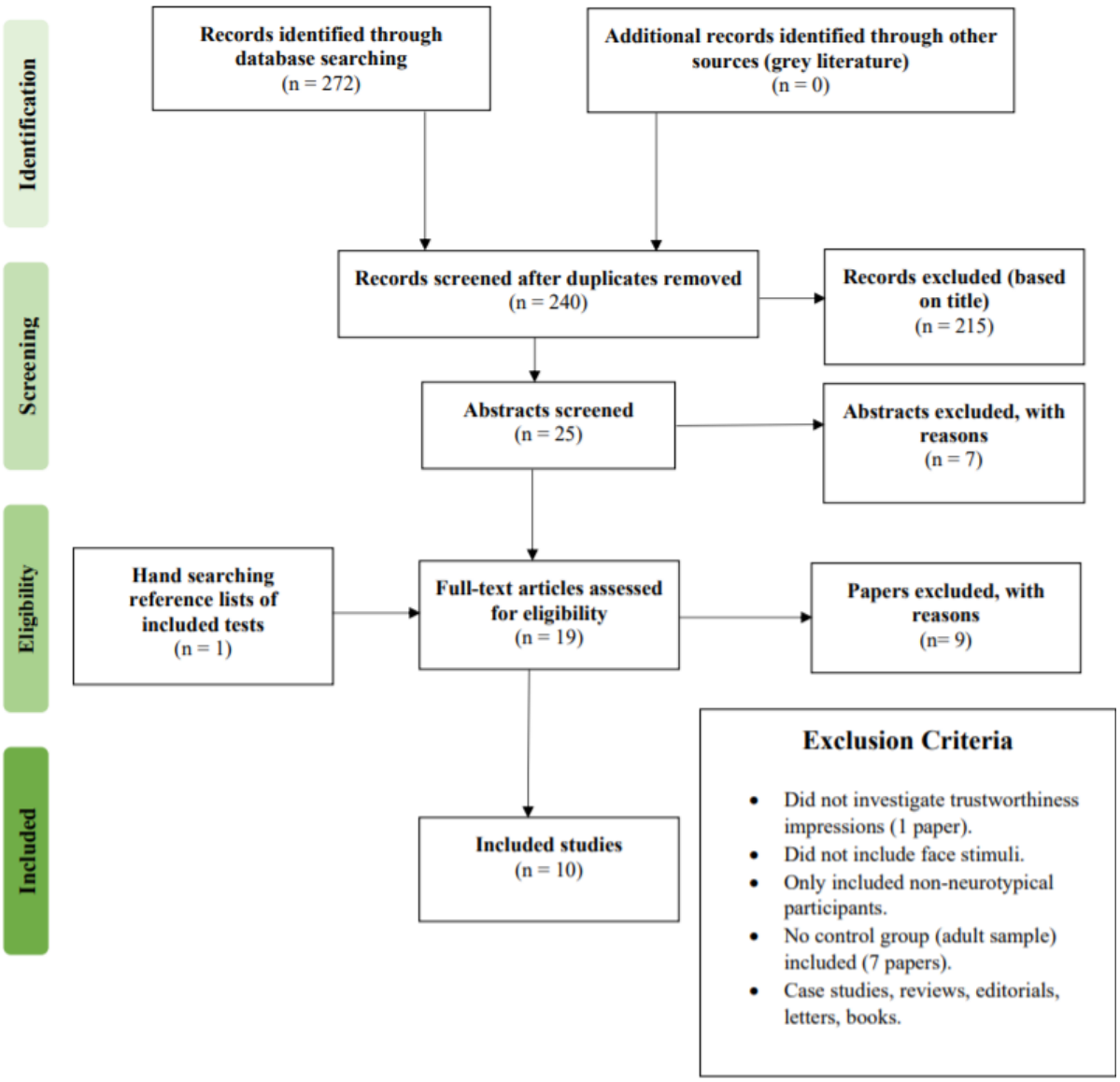

Figure 1. PRISMA flow chart (based on Moher et al., 2009). Final paper sample size was 10, representing 1325 child, and 851 adult participants. *Note*. The results of the seven studies excluded because they did not include an adult control group did not show any great inconsistency with the conclusions of the current review.

Inclusion criteria

To be included in this review, studies were required to investigate impressions of facial trustworthiness, defined as judgements relating to good and bad social intentions (following the field: see Todorov et al., 2015). We considered trustworthiness-related behaviour as including trustworthiness, niceness, and meanness, with the aim to be inclusive. "Impressions" were defined as made by human observers from unfamiliar face images only, though face stimuli could be computer-generated, composites, morphs, or photographs, as we were also interested to see whether findings generalised across different types of face stimuli. Participants included in the studies had to be children, aged between zero and 16 years of age and the study needed to compare the results found in children to those of adults in the same experimental design. Participants and stimuli could be of any race. We only included studies that assessed typically developing individuals. All experimental designs were included, as long as they directly compared children's data to a control group of adults. These inclusion criteria were set a-priori, before literature searching commenced.

Title and abstract screening

Initial title and abstract screening was done using Rayyan online tool for systematic literature review (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016). Screening was conducted to remove the papers that were obviously irrelevant.

Full-text assessment

The first author assessed all the papers for inclusion (*Figure 1*). A second author then assessed Abstracts of 25% of the papers for possible inclusion. For these, agreement between authors was high (96%), in that there was only one paper the authors disagreed about. The second author included this paper based on the abstract alone. However, full-text assessment revealed that this paper did not include an adult comparison group, and both authors agreed

the paper needed to be excluded. We expect that this high level of agreement would extend to the other papers, but note there was a small bias built for papers that were discussed by two authors. Neither author had published any of the papers reviewed, as recommended by best practice guidelines (Bastian, Doust, Clarke, & Glasziou, 2019).

Results and Discussion

Included papers

Ten papers met our inclusion criteria. All of these studies were published within the last six years and examined whether children's impressions of trustworthiness from faces were adult-like with various paradigms. Study characteristics are outlined in *Tables 2* and *3*.

Population characteristics

Sample characteristics are reported in *Table 2*. Total sample sizes of the included studies ranged from N = 72-600. The ages of children tested ranged between 3- and 13-years-old; while adult samples were between 17 and 81 years of age. Participants were predominantly of European descent (White), although two studies included only Asian participants and four studies did not report participant ethnicity. All studies used mixed sex samples.

Table 2

Sample characteristics of included studies

Study	Authors	N children	N Adults	Child participant age range	Adult participant age range	% Female in child sample	% Female in adult sample	Research location
1	Baccolo & Macchi Cassia, 2019	60	34	4-7	19-28	43%	74%	Italy
2	Caulfield et al., 2016	87	44	4-11	17-48	47%	73%	Australia

3	Charlesworth & Banaji, 2019	293	193	5-13	20-81	53%	53%	USA
4	Charlesworth et al., 2019	99	50	3-10	19-66	57%	52%	USA
5	Cogsdill & Banaji, 2015	300	300	3-13	18-61	56%	56%	USA
6	Cogsdill et al., 2014	141	99	3-10	18-67	48%	55%	USA
7	Ewing et al., 2015	48	24	4-11	17-35	46%	54%	Australia
8	Ewing et al., 2019	103	40	5-12	18-36	49%	65%	UK
9	Ma, Xu & Luo, 2016	138	37	8-12	*	63%	57%	China
10	Mondloch et al., 2019	56	30	4-12	18-24	57%	83%	Canada

Note * = not reported.

Table 3

Task characteristics of included studies

Study	Authors	Implicit or explicit task	Task design	Face stimuli type	Faces varying on	Judgements made on	Emotion expressed	Strength of emotional expression	Face race	Face gender	Face age
1	Baccolo & Macchi Cassia, 2019	Both	Odd-man-out task & forced choice task	Real face composite	Trustworthiness	Trustworthiness	Emotionally neutral	-	White	Female	Adult faces
2	Caulfield et al., 2016	Explicit	Likert scale rating	Real face composite	Trustworthiness	Trustworthiness	Happy, angry, neutral	25% & 50% intensity	White	Both male and female	Adult faces
3	Charlesworth & Banaji, 2019	Implicit	Forced choice	CGI	Trustworthiness, (& dominance, competence)	Niceness	Emotionally neutral	-	White & Black	Male	Adult faces
4	Charlesworth et al., 2019	Implicit	Forced choice	CGI	Trustworthiness (& dominance, competence)	Niceness, likelihood of performing dominant/competent behaviour	Emotionally neutral	-	White	*	Adult faces
5	Cogsdill & Banaji, 2015	Explicit	Forced choice	Standardised real faces & monkey faces	Niceness	Niceness/meanness	Emotionally neutral	-	White	Male	Adult faces
6	Cogsdill et al., 2014	Explicit	Forced choice	CGI	Trustworthiness	Trustworthiness (niceness/meanness), Dominance (strength),	Emotionally neutral	-	White	*	Both adult & child faces

						competence (smartness)					
7	Ewing et al., 2015	Both	Economic trust game	Ambient	Trustworthiness	Trustworthiness	Emotionally neutral	-	White	Both male & female	Adult faces
8	Ewing et al., 2019	Both	Economic trust game	Real face composite	Emotional Expression	Trustworthiness	Happy, angry, neutral	Subtle & overt	White	Male & female morphs	Both adult & child faces
9	Ma, Xu & Luo, 2016	Explicit	Likert scale rating	CGI	*	Trustworthiness, Attractiveness	Emotionally neutral	-	Asian	Male	Adult faces
10	Mondloch et al., 2019	Both	Forced choice	Standardised real faces	Emotional expression	Trustworthiness, Dominance	Happy, angry, fear, neutral	Subtle & intense	White	Female	Adult faces

Note *= not reported; CGI = computer generated images

Primary conclusions

Collectively, the findings of this review suggested that children's impressions of trustworthiness from faces are adult-like by late childhood (10-13 years of age). Some studies even found children's trust impressions did not differ significantly from those of adults at 3 or 4 years of age (Baccolo & Cassia, 2019; Charlesworth, Hudson, Cogsdill, Spelke, & Banaji, 2019; Cogsdill, Todorov, Spelke, & Banaji, 2014; Ewing et al., 2019). However, although children can show remarkably early sensitivity to variations in facial trustworthiness, most of the studies reviewed here also suggested that trust impressions evince age-related development across childhood before they consistently show quantitatively adult-like patterns.

The majority of studies (all except Ewing et al., 2019 and Mondloch et al., 2019) observed a developmental trend in face-based trust impressions across childhood, suggesting that children's impressions of trustworthiness from faces becomes more adult-like with age. That is, as children grew older, their impressions became more fine-grained, nuanced, and consistent. Though two studies (Charlesworth et al., 2019; Ewing et al., 2015b) found non-significant effects of age (possibly due to low sample size and power), even these studies observed an age-related upward trend. Overall, the reviewed literature indicated that the developmental trend of face-based trust impressions is not a single, discontinuous shift from immature to mature impressions, but rather that each age-group is successively more mature than the preceding one.

The observed effect of trust impressions developing with age is in line with previous research suggesting that neural regions that underlie face processing, such as the occipital and temporal cortices, and the amygdala undergo development throughout childhood and adolescence (Picci & Scherf, 2016), and is consistent with the influence of more general age-

related cognitive development (e.g., attention, concentration) on face processing (McKone, Crookes, Jeffery, & Dilks, 2012).

There were only two studies that did not observe age-related development of trustworthiness impressions (Ewing et al., 2019; Mondloch et al., 2019). However, the reasons for their findings differed. Ewing et al. (2019) did not observe developmental shift because they found adult-like trust impressions in even their youngest group (5-to-8-year-olds) in an economic trust game task. In contrast, Mondloch et al. (2019) did not observe a developmental trend in trust impressions across childhood, and indeed did not find adult-like patterns of impressions at any age in their child sample (4-12 years). These differences are further discussed in later sections.

Meta-analysis of extracted effects

To further corroborate the findings on the development of trust impressions, we conducted a meta-analysis of the extractable effect sizes that tested the difference between face-based trust impressions in child and adult age groups. We used the *metafor* package (Viechtbauer, 2010) in R version 4.0.5 (R Core Team, 2017) to run multilevel meta-analyses using linear mixed models. We were only interested in whether there was any difference between adults and children, rather than the direction of this difference. Therefore, we conducted the meta-analysis on the mean absolute difference. We did so by first converting the effect sizes and variances into absolute values using the formulas in Morrissey (2016). We then proceeded to meta-analyse the effect sizes using multilevel mixed effect models with paper identity and effect size identity as the random effects, which allowed us to control for non-independence in the data due to multiple effect sizes being extracted from the same studies. We tested the overall effect across age (comparing all children to adults) first. The restricted maximum likelihood method was used to estimate average effect sizes and their

confidence intervals. Overall, when comparing adults and children across all three age groups, there was a medium to large, positive, and significant effect, with a 95% confidence interval that excluded zero ($d_{overall}$ = 0.79, 95% CI = 0.22 – 1.36, $p < 0.01$).

To examine whether there was a developmental trend across the three age groups, (early, middle, and late childhood), we compared the three subgroups to adults by running meta-regression models using the *rma.mv* function in *metafor*. The ombibus Qm test of the effect of age group was Qm(3) = 12.1697, $p <.001$. There was a large significant effect between young children (3-to-5-year-olds) and adults ($d_{early\ childhood}$ = 0.94, 95% CI = 0.30 – 1.58, $p < 0.01$). The comparison between middle childhood (6-to-9-year-olds) and adults was also large and significant ($d_{middle\ childhood}$ = 0.85, 95% CI = 0.21 – 1.48, $p < 0.01$). The comparison between older children (10-to-13-year-olds) and adults was medium-to-large but not significant ($d_{late\ childhood}$ = 0.63, 95% CI = -0.01 – 1.26, $p = 0.05$). *Figure 2* and *Table 4* display these results. The results of the regression model testing for subgroup differences with effects averaged within papers are included in the supplementary materials. Also included in the supplementary materials are the effect sizes for the difference between evaluations of trustworthy- and untrustworthy-looking faces extracted from the reviewed papers; as well as the overall effect sizes for each (early, middle, and late childhood, and adults) age group.

Table 4

Regression model testing for subgroup differences

	Estimate	Standard error	p value	95% CIs
Early childhood	0.94	0.33	0.00**	0.30-1.58
Middle childhood	0.85	0.33	0.01**	0.21-1.48
Late childhood	0.63	0.33	0.05	-0.01-1.26

Note. **<0.001

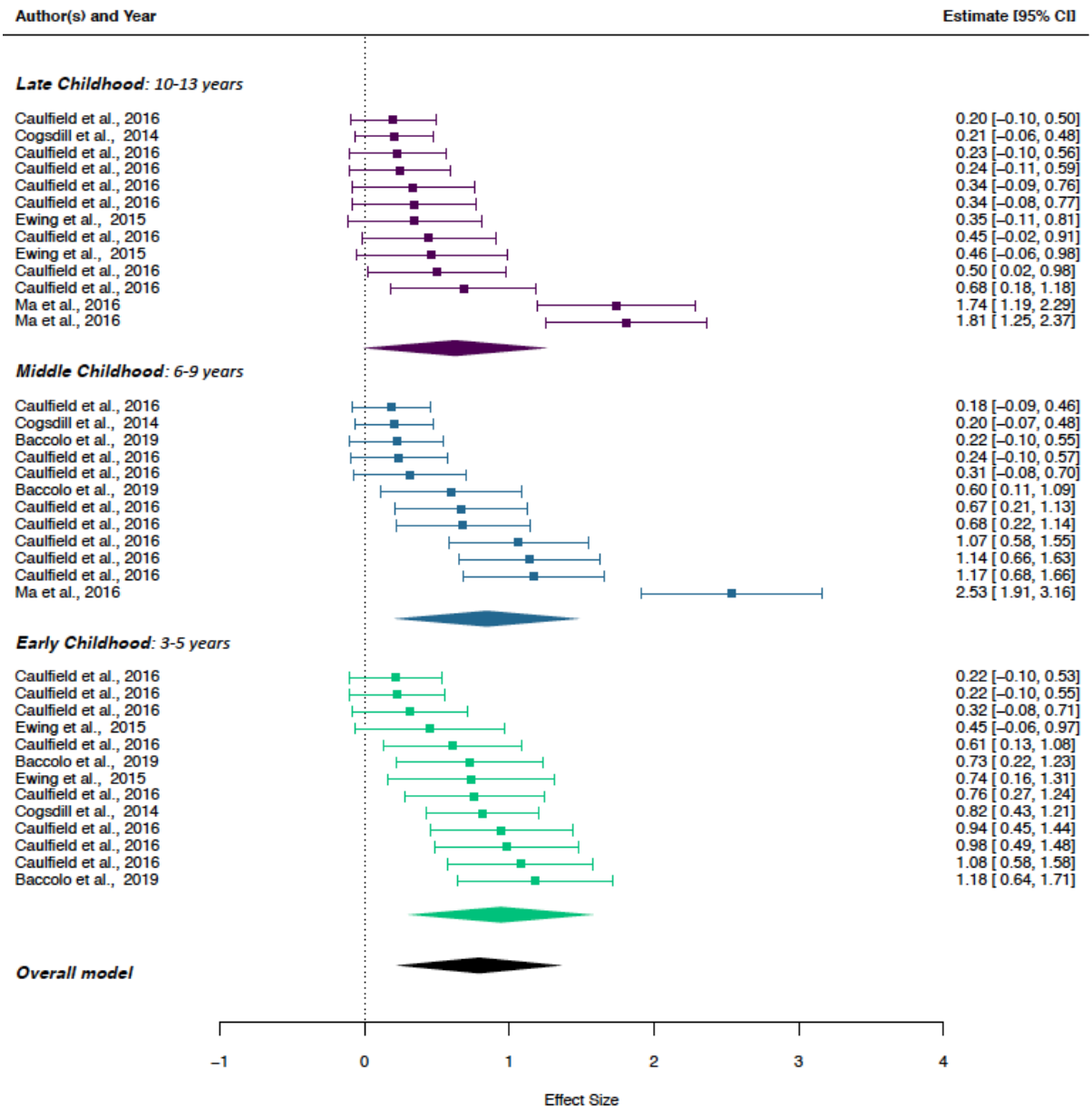

Figure 2. Parameter estimates (effect size and 95% confidence intervals) for comparisons between child and adult groups from effect sizes that could be extracted from the reviewed papers (five out of ten papers, early childhood N = 90, middle childhood N = 148, late childhood N = 137).

Children's trust impressions in early childhood (3-to-5-year-olds)

The majority of the literature reviewed suggests that young children are sensitive to variations in facial trustworthiness and can form trust impressions. For example, young children's trust judgements are often in-line with adult-consensus judgements (Baccolo & Cassia, 2019; Charlesworth & Banaji, 2019; Charlesworth et al., 2019; Cogsdill & Banaji, 2015; Cogsdill et al., 2014), suggesting they are able to discriminate between trustworthy-looking, and untrustworthy-looking faces. However, although they can discriminate between trustworthy and untrustworthy faces, at the group level, young children's impressions are less consistent and less differentiated than those of adults. For example, the difference between children's mean ratings or mean investment amounts towards trustworthy and untrustworthy faces is not as large as it is when adults make these judgements (Baccolo & Cassia, 2019; Caulfield et al., 2016; Charlesworth & Banaji, 2019; Cogsdill et al., 2014; Ewing et al., 2015b). Younger children's trust impressions are also commonly inflated relative to older children's and adults. That is, they are more trusting overall (Caulfield et al., 2016). Young children are completely dependent on their parents and carers. While their dependence does not confirm trust – indeed even young children show evidence of discrimination between trustworthy and untrustworthy persons (Jaswal, Carrington Croft, Setia, & Cole, 2010) – some degree of innate trust in carers is likely necessary for their nourishment and survival (Baier, 1986). For example, even an untrustworthy parent may meet a young child's basic needs for food and shelter. Higher levels of dependence in young children may explain the observed greater levels of trust in this age group. This tendency to trust may decrease as

children grow older, however, as they accumulate social experience and become more independent.

Children's trust impressions in middle childhood (6-to-9-year-olds)

Collectively, the reviewed literature suggests that middle childhood (6-9 years) is a key period for the development of face-based trust impressions. The meta-analysis results show a slight decrease in effect size from early to middle childhood, suggesting that children's impressions become more adult-like at this age. However, there appears to be variation in the effects found in this age group. While some studies have found that children's impressions matched adult-like patterns by 7 years of age (Baccolo & Cassia, 2019; Cogsdill & Banaji, 2015; Cogsdill et al., 2014), others have found trust impressions during middle childhood are still inflated relative to older children's and adults', indicating immature trust impressions (Caulfield et al., 2016; Charlesworth & Banaji, 2019; Charlesworth et al., 2019; Ma et al., 2016).

One possible reason for the variation in findings during the middle childhood period is that trust impressions are less commonly systematically assessed in this age range. While impressions of trustworthiness during the early and late childhood periods are well investigated, children in what we define here as the middle childhood period (6-to-9-year-olds), are sometimes grouped with either younger or older age groups. Therefore, there is comparatively less data on impressions in this age range alone, and consequently likely lower power to address changes in this age range. Further, age may be a weak proxy for development during this period. It is possible that some children in this age range mature earlier and display adult-like patterns of trust impressions during middle childhood – by 7 or 8 years of age for example, whereas others may not evince adult-like impressions until the

end of childhood (discussed in the *Children's trust impressions in late childhood* section below).

While the middle childhood period is one generally characterised by increase in social functioning and experience (Catalano, Haggerty, Oesterle, Fleming, & Hawkins, 2004), there are individual differences in social experience within this age group as well (Battaglia et al., 2005). For example, socially anxious or shy children, who actively seek less social interaction, may accrue less experience with diverse faces, or trustworthy behaviour in the people they meet. In contrast, extroverted children, children who have been to preschool, or children with siblings, have arguably more social experience (Blakemore & Choudhury, 2006), and therefore more exposure to the range of trustworthiness displayed in others' faces and behaviour. In addition, for some children, early maltreatment or abuse may bias them toward believing that adults are untrustworthy because they have more exposure to untrustworthy people. In contrast, children in caring and supportive family environments may have a bias toward expecting trustworthy behaviour from most people. While these sources of variation are unlikely to explain all of the discrepancy between results of the reviewed studies as to the maturity of trust impressions in middle childhood, they suggest fruitful lines of enquiry for further research.

Children's trust impressions in late childhood (10-to-13-year-olds)

The majority of the reviewed literature indicates that children's impressions of trustworthiness from faces are adult-like by late childhood (Caulfield et al., 2016; Charlesworth & Banaji, 2019; Charlesworth et al., 2019; Cogsdill & Banaji, 2015; Cogsdill et al., 2014; Ewing et al., 2015b, 2019). That is, by about 10 years of age, children's impressions do not differ significantly from those of adults. By the end of childhood,

impressions are fine-grained and consistent, and often show a ceiling effect in the tests used to assess them.

Of interest, one study included in this review did not find evidence of adult-like trust impressions at any point during childhood, including in 11- to 12-year-olds. Mondloch and colleagues (2019) investigated the effects of emotional expressions on children's trust behaviour and asked children which partner (represented by emotionally expressive faces) they would select to help them in hypothetical tasks. They found that children's selection of partners based on facial appearance was not moderated by trait and there was no evidence of trait-by-emotional expression interaction. That is, children did not select a happy (and therefore trustworthy-looking) face over angry or fearful (and therefore untrustworthy-looking) face to be their partner, when the task demanded a trustworthy partner. While manipulation checks indicated that children understood which activities demanded a trustworthy partner, even the oldest children in the sample did not show a preference for happy faces over angry and fearful faces. This pattern held even when the intensity of the emotional expression stimuli was increased to 50%. In contrast, adults consistently selected faces with happy emotional expressions when the task demanded a trustworthy partner. Given these findings, Mondloch and colleagues concluded that for children, happy facial expressions are not a cue to trustworthiness as they are in adults, and that children, even in late childhood, do not rely on emotional expressions when selecting social partners (Mondloch et al., 2019).

Ewing et al. (2019) investigated a very similar question to Mondloch et al. (2019) but used an economic trust game paradigm in which children were asked how much of their endowed capital they would share with partners represented by face images that were selected to appear trustworthy or untrustworthy. In contrast to Mondloch et al. (2019)'s findings, Ewing et al. (2019) found that children's face-based trust impressions *were*

influenced by the emotional expression displayed on the face. Their child participants were more likely to invest capital with happy (and therefore trustworthy-looking) faces, and less with angry (and therefore untrustworthy-looking) faces. Interestingly, like Mondloch et al. (2019), Ewing et al. (2019) did not observe any age-related change in children's performance either, but in their study, the youngest children's face-based trust behaviour was already adult-like. Ewing et al. (2019) noted that the disparity between their and Mondloch et al. (2019)'s findings may suggest that children's trust decisions are context-dependent. Specifically, in Ewing et al.'s (2019) task, children were asked to predict game partners' behaviour based on facial emotion cues in a single economic interaction. In contrast, in Mondloch et al.'s (2019) storybook task, children were required to generalise emotion cues from faces to a range of trustworthy or dominant behaviours, which is arguably a more complex task. Therefore, children's impressions (as tested in the lab, as well as in everyday life) may depend on the alignment between task demands, the child's age, how much life experience they have garnered, and their cognitive and perceptual abilities. This explanation is in line with previous research in face processing that has observed different developmental patterns for different tasks (Mondloch, Geldart, Maurer, & Le Grand, 2003).

While emotional-expression based trust impressions are mature early in childhood (Ewing et al., 2019), it is possible that age-related development is required for adult-like trust impressions to be formed from emotionally neutral faces (Ewing et al., 2015b). Ewing et al. (2019) did not observe any age-related development in their economic trust game study investigating the influence of emotional expressions on children's impressions of trustworthiness. However, they *did* observe a developmental trend in their previous trust game study with emotionally neutral face stimuli (Ewing et al., 2015). In the 2019 study, Ewing et al. suggested that extensive cultural learning and perceptual and cognitive development were not required to associate certain types of facial appearance with certain

traits (e.g., emotional expression with trustworthiness). Rather, they argued that selection pressures have evolutionarily prepared humans to use overt facial expressions (as opposed to structural cues merely resembling expressions) to distinguish between those intending to help or harm us from very early in life (Ewing et al., 2019). In contrast, Ewing et al. (2015) found that children's impressions of trustworthiness from emotionally neutral faces showed an adult-like pattern at 5 years of age, but these impressions matured with age, became more fine-grained, and more closely represented adults at 10 years of age. Therefore, the maturity of children's trust impressions may depend on whether the faces express an overt emotional expression or not.

Explicit versus implicit task designs

Mondloch et al. (2019) suggested that explicit task designs might underestimate children's sensitivity to variations in facial trustworthiness. For example, children might not necessarily select the expected face in a laboratory experiment when they are asked which looks trustworthy but might form mature trust impressions in the "real world", such as when deciding whom to approach or avoid in their daily interactions. Explicit task designs require participants to rate the trustworthiness of a face on a multi-point scale or select the trustworthy face from a range of options. Implicit designs, on the other hand, require participants to make trust judgements without being aware that this is the study's variable of interest. Implicit study designs used in the reviewed studies included an odd-man-out and perceived dissimilarity task (Baccolo & Cassia, 2019), determining peoples' likelihood of performing certain behaviours (Charlesworth & Banaji, 2019; Charlesworth et al., 2019), economic trust game paradigms (Ewing et al., 2015b, 2019), and a storybook design (Mondloch et al., 2019). The different kinds of task designs used in the reviewed studies are also presented in *Table 3* and *Figure 3A*. Of the reviewed studies, four employed purely explicit methods, two employed only implicit study designs, and four used an implicit design

as their primary task but included an explicit rating condition as a manipulation check (see *Figure 3B*). However, across implicit and explicit methods alike, all but one (Mondloch et al., 2019) of the reviewed studies found that children can show mature trust impressions. Therefore, despite the heterogeneity in task design amongst the included studies, the conclusions appear to be consistent, and are likely to be reliable.

While the overall developmental trends observed in children's trust impressions across explicit and implicit task designs are largely consistent, we note that the two studies that directly compare performance in these two types of tasks find a lag between performance in explicit and implicit tasks (Charlesworth et al., 2019; Ewing et al., 2019). However, there were not enough studies directly comparing explicit and implicit designs for this paper to systematically review differences in children's performance. The possible disparity between children's performance in explicit and implicit tasks should become clearer as future research probes this question.

Face stimuli used in studies

The reviewed studies employed a range of different types of face stimuli (e.g., computer generated images, real face composites, naturalistic) to assess impressions of trustworthiness (see *Figure 3C* and *Table 3*). Interestingly, the conclusions appear to be robust across variation in face stimuli. However, although no clear differences emerged from the current review, there may be other critical differences between types of stimuli and the resulting impressions formed by children (and adults). For example, the impressions measured from computer generated images (CGI) stimuli may capture facial cues to trust, as well as other, more general ideas associated with CGI face images, such as their artificiality, or their similarity to cartoon faces. However, we can conclude that children's tendency to

form impressions based on facial appearance is at least consistent across different types of face stimuli used in the reviewed studies.

Most of the reviewed studies included face stimuli varying on trustworthiness. Several experimenters had their stimuli pre-rated by a separate sample of adults and then used faces that were rated as either high in trustworthiness (e.g., 6 on a 7-point Likert scale), or low in trustworthiness (1 on a 7-point Likert scale) by that sample. Other authors used faces that fell toward the extreme ends of the continuum (e.g., 3 SD from the mean). Yet others manipulated how trustworthy faces appeared by using morphing techniques. One of the reviewed studies described their stimuli as varying on niceness (Cogsdill & Banaji, 2015). Niceness is thought to tap the same underlying construct as trustworthiness, and niceness and trustworthiness judgements are often informed by similar facial cues, like happy emotional expressions (Cogsdill & Banaji, 2015; Collova, Sutherland, & Rhodes, 2019). Two of the reviewed studies employed face stimuli that varied on the emotional expression displayed on the face – e.g., happy and angry expressions. Face stimuli also varied in terms of ethnicity, and in all the included studies, the predominant ethnicity of participant samples matched the ethnicity of the stimulus faces. Three of the included papers employed male and female faces as stimuli, while three used only male faces and two used only female faces (see *Figure 3D*). Two studies (Charlesworth et al., 2019; Cogsdill & Banaji, 2015) did not report the gender of the stimulus faces used. While most studies employed adult faces, two included child faces along with those of adults' (Cogsdill & Banaji, 2015; Ewing et al., 2019). Despite such methodological variation, the conclusions from this review appear to be consistent across studies and therefore are likely to generalise.

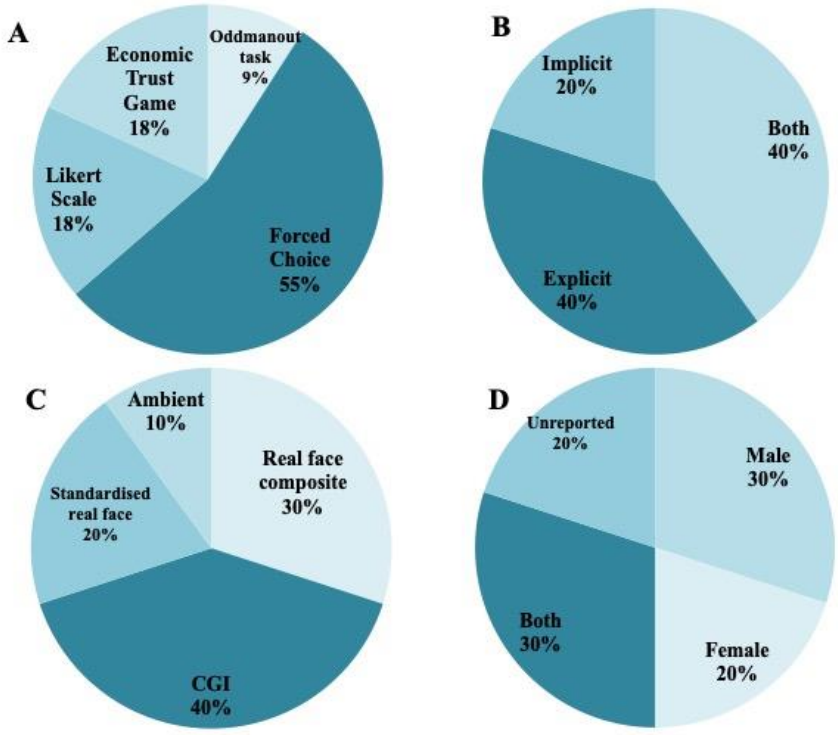

Figure 3. Pie charts showing **A)** type of task the reviewed studies used, **B)** task designs, **C)** type of face stimuli used, and **D)** gender of face stimuli used.

Comparing development of face-based trust impressions with other first impressions

Besides trustworthiness, there are several other key traits on which we evaluate faces, including competence, dominance, and attractiveness (Oosterhof & Todorov, 2008; Sutherland et al., 2013). Children can use facial appearance to form impressions about competence from early childhood (~3 years); and children's consistency in judgements of competence improves with age (Antonakis et al., 2009; Cogsdill et al., 2014). Young children can also judge dominance based on facial appearance, and like trustworthiness, impressions of dominance are thought to develop across childhood (Charlesworth et al., 2019; Cogsdill et al., 2014), although we note that some studies have not observed developmental trends (Mondloch et al., 2019). Children are also sensitive to facial attractiveness from an early age (6 months old), and as they get older, use attractiveness to guide their social decisions, as

they do with impressions of trustworthiness (Ma et al., 2016; Tang, Zhong, Xu, & Liu, 2019; Vannatta, Gartstein, Zeller, & Noll, 2009). It has been suggested that trustworthiness impressions may develop earlier than other face-based impressions however, and might even inform the formation of other impressions, because trustworthiness has been strongly correlated with general valence, and children are thought to rely global valence from an early age (Cogsdill et al., 2014; Oosterhof & Todorov, 2008). Indeed, 4- and 5-year-old children are better able to form impressions from faces varying in trustworthiness than faces varying in competence (Palmquist, Cheries, & DeAngelis, 2020). However, there is comparatively more research on impressions of trustworthiness from faces than other traits. Therefore, future research would benefit from not only further examining the development of these other traits from faces, but also comparing developmental trajectories for different traits.

Comparing development of face-based trust impressions with development of face perception, cognition, and general trust

Young children's emotional expression recognition is not adult-like (Nelson & Mondloch, 2019). It improves with age, and peaks around 11 years, though performance remains unstable throughout the early teen years (Nelson & Mondloch, 2019). This developmental trajectory is comparable to the development of trust impressions reviewed here. However, despite similar developmental trajectories, and evidence that emotional expressions may be an underlying mechanism for face-based trust impressions, emotional expression recognition does not explain trust impressions completely. In the current review, both Caulfield et al. (2016) and Ewing et al. (2019) showed that emotional expressions modulate which faces children perceived as trustworthy. Like adults, children perceive happy looking faces as more trustworthy, while angry faces are perceived as more untrustworthy (Caulfield et al., 2016; Ewing et al., 2019; Sutherland et al., 2017). Importantly however, while Ewing et al. (2019) found that the effect of emotional expressions on trust impressions

remained unchanged throughout childhood, Caulfield et al. (2015) reported significantly greater influence of emotional expressions on adults' trust impressions than on children. Moreover, this modulatory effect of emotional expressions increased as children grew older. Caulfield et al. (2015)'s conclusions could suggest that while trust impressions are adult-like by late childhood, the influence of emotional expressions on these trust impressions is not. Therefore, while emotional expression overgeneralisation likely underlies part of our trust impressions, they cannot explain these impressions completely (a conclusion which fits with the adult literature: Ewing et al., 2015b, 2019; Vernon, Sutherland, Young, & Hartley, 2014).

In contrast to the developmental trajectory of face-based trust impressions reviewed here, facial identity recognition – another prominently studied aspect of face perception – is thought to continue developing past childhood. Research suggests that face recognition memory peaks at about 32 years of age, with a steep increase in ability between ages 10 and 20 (Germine, Duchaine, & Nakayama, 2011). Although children can recognise faces from an early age, mature recognition relies on cognitive and perceptual processing strategies that are acquired through training and exposure throughout the first few decades of life (Maurer, Le Grand, & Mondloch, 2002; Mondloch et al., 2003). While trustworthiness impressions from faces are similar in that they too require a period of training and exposure, the current evidence suggests that impressions of trustworthiness seem to mature earlier than face recognition.

A question that commonly arises when investigating the development of face perception is the degree to which any age-related changes are driven by development of face specific, or more general cognitive processes (McKone, Crookes, Jeffery, & Dilks, 2012). A strong argument has been made in the face identity perception literature that most perceptual face coding abilities are mature by 5 years of age, and any improvement in task performance after this age is due to the development of cognitive abilities, such as concentration, attention,

metacognition, and general perception, all of which develop across childhood and into adolescence (McKone et al., 2012). Due to limited research however, it is less clear whether this general cognitive development theory extends to other attributes, such as face-based trait impressions. The extent to which face-selective and general cognitive and perceptual processes each contributes to age-related development of face-based trust impressions is a rich avenue for future research.

The developmental trajectory in children's face-based trust impressions reported in this paper is also comparable to a similar trajectory in more general trust perception that is not reliant on judgements about faces. Research suggests that in experimental settings, children as young as 3 years of age can make trust judgements about informants based on their traits (niceness, smartness, honesty), if presented with enough consistent evidence (Lane, Wellman, & Gelman, 2012). In fact, by 5 years of age, children modulate their trust behaviour based on reputational information about others' trustworthiness (Ewing et al., 2015b). This capacity develops with age, such that 5-to-6 year-olds' decisions to trust informants based on reputation are more consistent than younger children's (Corriveau & Harris, 2009; Lane et al., 2012); and 6-to-11-year-olds can consider even more sophisticated concepts such as informants' motives, and differentially weight information depending on the informant's intent (Fu, Heyman, Chen, Liu, & Lee, 2015).

The extent to which the developmental trajectory of trust impressions from faces reviewed here is driven by general processing related to faces, or general processing related to trust is not yet clear. This is an important question for future research, because understanding underlying processes can clarify how we process trust in faces and what mechanisms drive its development.

Influence of age-related social experience on development of face-based trust impressions

The developmental trend in children's face-based trust impressions observed in the current review could be partly explained by age-related increases in social experience. It is possible that children need to garner experience with tracking associations between behaviours directed toward targets and those targets' facial appearance, to adopt those same behaviours when they incur similar facial appearances themselves (Over & Cook, 2018). This experience is likely driven by the proliferation of social interaction during the school years, guided by an age-related increase in interest in interpersonal relationships (Denham, Salisch, Olthof, Kochanoff, & Caverly, 2004). This interpretation is supported by evidence from adult research finding past social experience strongly drives future trust impressions (Feldmanhall et al., 2018; Sutherland, Burton, et al., 2020; Verosky & Todorov, 2010).

However, it is unlikely that our tendency to form impressions is purely driven by extensive social experience. Some of the reviewed studies observe mature appearance to trait mappings in children as young as 3 (Ewing et al., 2019); and there is evidence that even seven-month-old infants show differential brain responses to faces varying in trustworthiness (Jessen & Grossmann, 2019). While trust impressions from faces are not always accurate, our impression formation system is likely built on an adaptive readiness to make judgements based on visual information gleaned from faces, which evolutionarily, revealed more proximate cues to others' intentions (Bond, Berry, & Omar, 1994; Kramer & Ward, 2010; Leivers et al., 2015). This heuristic system is especially important given environmental selection pressures that required us to quickly and efficiently determine whether those we interact with pose a threat to our survival (Oosterhof & Todorov, 2008; Zebrowitz & Zhang, 2009). An evolutionary readiness to form face-based impressions may have prepared us for relevant social learning later on in development (Sutherland, Collova, et al., 2020).

Limitations and future directions

The outstanding questions and critical gaps in the field that emerged from this review are listed in *Table 5*.

Table 5

Outstanding questions and future directions

- What does the developmental trajectory of trust impressions in adolescence and during the teen years look like? Specifically, teenagers' impressions should be compared with those of adults in the same study and with the same experimental paradigm.
- Are there idiosyncratic patterns to children's face-based trustworthiness impressions, as exists for adults (Sutherland, Burton, et al., 2020)?
- If idiosyncratic differences do exist in childhood, are they present from infancy, or do they emerge as a result of personal experience?
- How does the development of face-based trustworthiness impressions compare with development of other well-studied face perception abilities, including face identity recognition and emotional expression recognition? Investigating this kind of question would allow us to understand whether common face processing mechanisms underlie all of these facets of face perception.
- What is the relative influence of evolutionary readiness or genetics and age-related social experience on the emergence and development of children's face-based trust impressions?

A limitation of our current work is that only 10 studies met our criteria and could be included in this review. Further, the majority of the studies included in this review sampled Western children and adults. Taken together, these characteristics may limit the generalizability of the current conclusions. Future research would benefit from sampling more diverse groups and examining development of trust impressions across cultures, a

current priority for the adult literature as well (Jones, Debruine, Little, & Feinberg, 2008; Sutherland et al., 2018).

Additionally, a strong priority for future research is to investigate the development of trust impressions from faces throughout the adolescent and teenage period (14 to 18 years of age). Adolescence is a key period for social development (Choudhury, Blakemore, & Charman, 2006; Klimes-Dougan & Zeman, 2007). During this time, peers become a critical source of social support and there is an emerging focus on romantic and sexual interests (Scherf, Behrmann, & Dahl, 2012). In fact, while young children are better at recognising adults' faces than other children's faces (likely because they depend on the protection and care of adult guardians), pubertal adolescents incur a shift in recognition bias, wherein they become better at recognising faces of others who are at a similar pubertal status as themselves (Picci & Scherf, 2016). Therefore, face processing abilities self-organise as developmental tasks change (Scherf et al., 2012). While some studies have examined trust impressions during the teenage period (De Neys, Hopfensitz, & Bonnefon, 2015; Kragel, Zucker, Covington, & LaBar, 2015), these studies did not directly compare young people's impressions with those of adults, and therefore could not be included in this review. Thus, it is important for the field to examine the developmental trajectory of trust impressions post-childhood, especially given their social importance.

Understanding the developmental trajectory (if any) of trust impressions in adolescence would also be valuable for our understanding of face perception overall. Facial identity recognition and emotional expression recognition develop into adolescence (Germine et al., 2011; Nelson & Mondloch, 2019), and it would be interesting to see if face-based trust impressions show a similar developmental trend. Addressing this question would clarify whether shared processes underlie all of these face perception abilities, likely driven by the social, emotional, and neurological changes that characterise this period (Blakemore &

Choudhury, 2006; Denham et al., 2004). Future research should examine the development of trust impressions and other face perception abilities such as identity and emotional expression recognition in adolescence in the same group of participants, to allow a more direct comparison of these processes. If trust impressions do indeed reach maturity by the end of childhood as found in the current review, and do not incur any further development like other face perception abilities, then we would have convincing evidence that trust impressions are dissociable from these other processes.

The majority of the studies reviewed here determined the trustworthiness of face stimuli based on consensus judgements. That is, research on children's trust impressions to date has considered a face to be high in trustworthiness if a majority of an independent sample of adults agreed that the face looked trustworthy, and vice-versa for untrustworthy faces. Using consensus judgements is a limitation of the field, given evidence suggesting there are idiosyncratic differences in the way individuals perceive how trustworthy a face appears (Germine et al., 2015; Hehman, Sutherland, Flake, & Slepian, 2017; Hönekopp, 2006; Sutherland, Burton, et al., 2020). If children's trust impressions from faces also show strong individual differences, then our current understanding does not fully represent all aspects of children's impression formation. An intriguing question for future research is whether idiosyncratic differences exist early in life, or whether idiosyncrasy is driven by social experience across the lifespan. Moreover, it will be key to establish whether the nature of trust impressions shifts from consensus judgements to more individual variation across development. Alternatively, it is possible that very young children can form firm trust impressions, but these are not consensus-based, perhaps because they have fewer shared experiences with others, and therefore do not hold the same stereotyped face-trait assumptions that older children and adults do. The latter alternative would support our current

finding that young children's trust impressions are least adult-like compared to middle and late childhood groups.

Conclusion

Our review suggests that children show a remarkably clear sensitivity to variations in facial trustworthiness from a young age (3-years-old). However, trust impressions also develop across childhood, especially throughout the middle childhood period (6-to-9-years) until they consistently represent adult-like patterns between 10 and 13 years of age. The observed precocious appearance of trust impressions in even early and middle childhood groups highlights the functional importance of extracting social information from visual cues. Although age-related development is required before children's trust impressions are consistently adult-like, children's impression formation system already reflects the foundations of a mature one, including the (sometimes unhelpful) biases that characterise adults' trust impressions.

In addition to the theoretical interest in understanding the emergence of these fundamental social judgements, understanding this developmental pattern is critical to being able to guide and protect children in our complex social world. Trust itself has been described as the glue that holds society together (Ikenberry & Fukuyama, 1996), and as the internet transforms our trust in institutions (Sutherland, Burton, et al., 2020), it is more important than ever to consider who children are deciding to trust. For example, children are now forming impressions based on very scant social information when they play video games, or shop online, or even complete their school lessons online in this COVID-19 pandemic era. The current findings are informative for parents, educators, and anyone involved in children's lives to better understand young people's social perceptual abilities, help them survive in the face of threat, and create a society that provides opportunities for them to thrive.

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*Note: studies used in the systematic review and meta-analysis are preceded by an asterisk

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