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Perceived trustworthiness of faces drives trust behaviour in children.

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Facial appearances modulate trust behaviour by 5 years of age

Like adults, children explicitly value access to faces during economic trust games

Children have a capacity for sophisticated social cognition

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Keywords: face perception, development, trustworthiness, economic trust game

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Abstract

Facial appearances can powerfully influence adults' trust behaviour, despite limited evidence that these cues constitute honest signals of trustworthiness. It is not clear, however, whether the same is also true for children. The current study investigated whether like adults, 5 year olds and 10 year olds are more likely to place their trust in partners that look trustworthy, than those that look untrustworthy. A second, closely related question was whether children also explicitly value the information from face cues when making trust decisions. We investigated these questions using Token Quest: an economic trust game that gave participants the opportunity to make investments with a series of partners who might (or might not) repay their trust with large returns. These interactions occurred under different conditions, including one in which participants were shown the face of each partner and another in which they could 'purchase' access to faces with a portion of their investment capital. Results indicated that like adults, 10 year-old children selectively placed their trust in those partners they perceived look trustworthy and many were willing to 'pay' to purchase access to these face cues during the trust game. We observed a similar profile of trust behaviour in 5 year-olds, with no significant group difference in the impact of face cues on behaviour across the three age groups. Together, these findings indicate that the influence of face cues on trust behaviour emerges early, and highlight a capacity for sophisticated social cognition in young children.

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Trust is critical for healthy political, economic and social systems (Ben-Ner & Halldorsson, 2010). Yet making the decision to trust another can be daunting because, by a commonly used definition, the act involves making oneself vulnerable to the actions of others (Rousseau, Sitkin, Burt, & Camerer, 1998). Humans are motivated to evaluate the likely trustworthiness of others wherever possible, drawing upon a range of information sources, including their past behaviour (e.g., Clément, Koenig, & Harris, 2004; King-Casas et al., 2005), integrity or moral character (Delgado, Frank, & Phelps, 2005) and demographic self-similarity (McPherson, Smith-Lovin, & Cook, 2001). Perhaps the most surprising influence upon judgments of perceived trustworthiness is an individual's facial appearance, which can reliably influence trait impressions after very brief exposure (Todorov, Pakrashi, & Oosterhof, 2009; Willis & Todorov, 2006).

Few studies have investigated the predictive validity of these trustworthiness judgments based on face cues, with mixed findings. Some studies report that participants can make accurate inferences about an individual's trustworthiness, e.g., they rate criminals as being less trustworthy than lauded humanitarians (Porter, England, Juodis, ten Brinke, & Wilson, 2008) and are sensitive to a face cue that predicts cooperation and trustworthiness in economic games (width to height ratio, Stirrat & Perrett, 2010). However, a recent multi-experimental study investigating participants' ability to read faces to predict past criminal and non-criminal untrustworthy behaviours, found no evidence to support accurate appearance-based inferences of trustworthiness (e.g., Rule, Krendl, Ivcevic, & Ambady, 2013). On balance, there is currently only

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limited empirical support for the validity of inferences about trustworthiness from individuals' faces.

Nevertheless facial appearances can powerfully influence trust behaviour (Todorov, Mende-Siedlecki, & Dotsch, 2013). This influence has been elegantly quantified in a controlled experimental setting using the economic trust game (Berg, Dickhaut, & McCabe, 1995). In this game, Player A is given a sum of money to invest with Player B, who receives triple whatever is given to her/him and then decides how much (if any) to return to Player A. Willingness to invest/reciprocate in each role serves as a behavioural index of participants' trust/trustworthiness respectively. Importantly, when Player A has access to (bogus) photographs of Player B, participants make significantly larger investments in trustworthy-looking partners than untrustworthy-looking partners (Chang, Doll, van't Wout, Frank, & Sanfey, 2010; van't Wout & Sanfey, 2008). Furthermore this modulation of investments by facial trustworthiness can persist even in the presence of conflicting 'reputation' information, e.g., reports of a good/bad behavioural history (Rezlescu, Duchaine, Olivola, & Chater, 2012), though not repeated personal experiences of untrustworthy behaviour (Chang et al., 2010).

More generally, people seem quite willing to use appearance cues to guide their trust perception and behaviour. One poll indicated that approximately 75% of people believe that character information can be inferred from the face (Hassin & Trope, 2000). Participants also explicitly perceive faces to be of economic value when making investment decisions during the trust game (Eckel & Petrie, 2011). When asked whether they would give up part of their investment capital in order to purchase access to their partners' faces before

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making investment decisions, many (though not all) participants were willing to do so, with the likelihood of each 'purchase' inversely related to the cost of the photograph. Crucially, the fact that *anyone* sacrificed funds in exchange for access to face cues suggests that these participants believed the images provided meaningful information to guide their trust behaviour.

Together the findings to date, all with adult participants, strongly indicate that facial appearances influence trust behaviour. But it is not clear when this effect emerges. Despite the broad importance of trust in society, as well as for the specific development of language and cognition, self-concept, and social relationships (see Bernath & Feshback, 1995) few studies have investigated the modulation of behaviour based on cues to trustworthiness in children. Trust games conducted with multiple age groups provide some evidence of quantitative increases in trusting behaviour generally with age (Evans, Athenstaedt, & Krueger, 2013; Sutter & Kocher, 2007). To our knowledge however, no one has yet investigated whether facial cues influence trustworthiness behaviour in children.

In the current study, we investigated the influence of facial appearances on trust behaviour across development. In a customized trust game, Token Quest, participants interacted with different (bogus) partners under three experimental conditions: 1) when participants had no information about their partners, 2) when they had access to photographs of their partners (who appeared either very trustworthy or untrustworthy), and 3) when they had access to reputation information about their partners (a history of past behaviour that made them sound very trustworthy or untrustworthy).

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Our central question was whether facial appearance cues influence trust behaviour in children aged 5 years and 10 years, as they do for adults. Specifically, we asked whether all three age groups would be more likely to invest their tokens with partners who looked trustworthy than those who looked untrustworthy. We also investigated behaviour with partners accompanied by a non-face cue to trustworthiness, reputation information, to address the possibility that children's ability to make strategic investments might differ broadly from that of adults.

A closely related question was whether children explicitly value the information from face cues when making trust decisions. On a subset of trials, participants were given the opportunity to purchase access to photographs of their partners using a portion of their investment capital. Willingness to purchase would indicate that they, like adults (Eckel & Petrie, 2011), perceive access to face cues to be of economic value. We also included a parallel condition in which participants had the option to purchase reputation information, to investigate whether children might differ from adults in their appraisal of the value of access to *any* cues about Player B, i.e., even those that are highly diagnostic about partner trustworthiness.

Methods

Participants

Participants were 24 adults (17 - 35 years, M = 22.3, SD = 5.6, 11 males), 24 children aged 9.5 to 11.8 years (M = 10.3, SD = 0.6; 13 males), hereafter referred to as 10 year-old children, and 24 children aged 4.8 to 6.0 years (M = 5.5, SD = 0.4; 13 males), hereafter referred to as 5 year-old children. The adults were undergraduate psychology students who participated for course credit.

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The children were recruited from three local metropolitan schools. An additional 11 adult participants (21 - 26 years, M = 23.1, SD = 1.5, 1 male) rated face stimuli for trustworthiness during task development.

Stimuli

Stimuli were colour photographs of 5 trustworthy-looking faces (3 male) and 5 untrustworthy-looking faces (3 male). These images were selected from a larger set of 218 Caucasian face images sourced from the Internet and pre-rated for perceived trustworthiness by adults using a 9-point Likert scale (1=not at all trustworthy, 9=extremely trustworthy). We chose faces for each gender that were assigned high (M= 7.1, SD=0.5) and low trustworthiness scores (M= 1.5, SD=0.2), $t(7) = 47.1$, $p < .001$.

Procedure

Token Quest provided a measure of each participant's willingness to trust others in an economic investment paradigm. In each of five rounds, participants were given the opportunity to invest 6 tokens, which looked like pieces of pirate treasure, with different (bogus) partners. These partners were described as staff and students from our University that had previously told us how they would play the game (see Brandts & Charness, 2011). We emphasized that some interactions might result in better returns than others and that to avoid risking losses, participants could choose to not share many, or any, of their tokens with their partners. Importantly, however, the aim of the game was to finish with as many tokens in their treasure chest as possible and this 'risk-free' approach would prevent them from collecting additional tokens.

The children and adults played 3 'standard' rounds with 8 partners/trials and 2 'bonus' rounds with 2 partners/trials. On each trial, a representation of

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each partner appeared alongside the text "How many tokens would you like to give this partner?" (Figure 1) and remained on screen until the participant gave the desired number of their tokens to the experimenter. In the first standard round, a partners were represented with a blank identity (Figure 1A). In the second standard round, a photograph of a trustworthy or untrustworthy face appeared for each partner (Figure 1B). In the third standard round, rather than viewing faces, participants were given information about each partner's previous returns when playing Token Quest (Figure 1C). These reputation "hints" appeared on the screen as text and were read aloud by the experimenter.

After the second and third rounds, participants also completed two short bonus rounds. In each, they were told that if they would like to see the faces of two additional partners (after round 2) or access hints about their past behaviour (after round 3), it would cost them 3 of their 6 tokens for that round (Figure 1D and E). If they chose not to pay, they saw only blank identities (Figure 1A).

Token Quest began with an extended explanation of the paradigm, during which time participants were encouraged to ask any questions they had about how the game worked. They then completed two blank-identity practice trials. After each of these trials, a feedback screen revealed how many tokens the partner chose to return to them. This feedback was pre-determined to give participants one high token return (7 tokens) and one low token return (0 tokens), to highlight the different outcomes possible when playing with 'fair' and 'unfair' partners. In the main game, participants received feedback only at the end of each round, which ensured that token returns could not be associated with specific partners and that the validity of the trustworthiness cues provided

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remained unclear. In all cases, the number of tokens collected on each round was contingent only upon the number of tokens invested. All investments were rewarded, regardless of any characteristics of specific partners. Feedback was presented on the computer screen and transferred to a personalized paper progress chart so that participants could keep track of the tokens in their treasure chest across rounds.

After completing Token Quest, participants were given a brief description of interpersonal trustworthiness that focused on three key elements: honesty, reliability and emotional trust (Rotenberg, 1994; Rotenberg et al., 2005). They then rated the trustworthiness of characters in six brief vignettes (3 trustworthy, 3 untrustworthy) to confirm they understood our operationalization of trustworthiness, e.g. "Terry always tells the truth. How trustworthy is Terry?" They made these ratings with the keyboard, using a 7-point scale consisting of numbered cups (1 = not very trustworthy, 7 = very trustworthy) (see Cooper, Geldart, Mondloch, & Maurer, 2006). They then used the same rating scale to rate the trustworthiness of the 5 trustworthy and 5 untrustworthy faces presented during the game[1], which appeared on the screen individually (order randomized) until participants offered a rating. By including these two rating tasks, we could investigate whether any immature trust behaviour we observed in children might reflect immature trust perception.

Results

Participants entered into the spirit of Token Quest, with 75% of adults, 62.5% of 10 year olds and 62.5% of 5 year olds investing all 6 of their tokens in

[1] Participants might have only viewed 8 faces, if they chose not to reveal the faces of the identities in the face identity bonus round.

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every round. Across participant groups, the median number of tokens invested in each round was 6.0 (blank identity SD = 0.8; faces SD = 0.7; reputation SD = 0.3). This ceiling effect suggests that participants were motivated to try to maximize their outcomes by investing tokens with different partners.

Influence of facial cues on trust behaviour

To see whether face cues influenced trust behaviour in children aged 5 and 10 years, as they do for adults, we examined the number of tokens that each age group invested in partners that looked trustworthy and untrustworthy (Table 1). The mean difference between these values (i.e., tokens invested in trustworthy-looking partners minus untrustworthy-looking partners), served as our index of the influence of face cues on trust behaviour (Figure 2). There were no outliers (mean +/- 3SD) and the skew and kurtosis of the distributions (z score < +/- 1.96) indicated that these data were appropriate for parametric analysis (Field, 2009).

As we expected, one-sample t-tests (comparing means to zero) confirmed that adults selectively invested tokens in trustworthy-looking partners rather than untrustworthy-looking partners, $t(23) = 4.94$, $p < .001$, $d = 2.06$. Furthermore critically, this effect emerged early. Facial trustworthiness significantly influenced trust behaviour in 10 year-olds, $t(23) = 3.47$, $p < .01$, $d = 1.44$, and there was also a large, marginally significant effect in 5 year-olds $t(23) = 1.93$, $p = .06$, $d = 0.80$ (Cohen, 1988). Figure 2 suggests that this strategic trust behaviour might increase across development. However a one-way ANOVA indicated that participants' trust behaviour was not significantly influenced by age group, $F(2, 71) = 2.35$, $p = .10$, partial $\eta^2 = .06$.

Perceived value of facial cues to trustworthiness

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Responses in the face bonus round revealed that the perceived value of face cues differed across the three age groups. When we calculated the percentage of participants in each age group that purchased access to faces, we found that 87% of 5 year olds, but only 58% of 10 year olds and 37% of adults sacrificed investment capital to buy them. Chi-squared analysis revealed that this constituted a significant developmental difference, χ^2 (2) = 4.98, p <.05. Based on the odds ratio, 5 year olds were 5.0 times more likely than 10 year olds, and 11.6 times more likely than adults to purchase face cues – an intriguing result, given that the youngest group were the least likely to use these trustworthiness cues strategically.

Trust behaviour based on reputation cues

Results in the reputation condition confirmed that all participants invested their tokens strategically when provided with highly-diagnostic non-face cues to partner trustworthiness. Again, we examined the number of tokens that each age group invested in partners with trustworthy and untrustworthy reputations (Table 1) and calculated the mean difference between these values (i.e., tokens invested in trustworthy-sounding partners minus untrustworthy-sounding partners). This difference score indexed the influence of reputation cues on trust behaviour (Figure 3). There were no outliers (mean +/- 3SD) but the skew and kurtosis of the distributions still necessitated non-parametric analyses.

One-sample comparisons to zero indicated that all age groups selectively invested in partners with a trustworthy reputation rather than an untrustworthy reputation, all zs > 3.79, ps < .001, r > .15 (Wilcoxon signed ranks tests). Participant age significantly influenced this effect, H(2) = 18.62, p < .001

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(Independent-Samples Kruskal-Wallis Test), with reputation cues influencing behaviour less in five year-old children than 10 year-olds U = 159.0, z = -2.77, p < .001, r = 0.39 and adults U = 112.0, z = -3.97, p < .001, r = 0.57, who also differed significantly from each other U = 199.0, z = -2.17, p < .05, r = 0.31 (Mann-Whitney Tests).

Perceived value of reputation cues to trustworthiness

Responses in the reputation bonus round confirmed that participants in all three age groups valued these trustworthiness cues. More than half of all participants willing to sacrifice investment capital in order to access them: 83% of 5 year olds, 58% of 10 year olds and 71% of adults. Here also, the effect of participant age was significant, χ^2 (2) = 5.96, p <.05. Again, odds ratios indicated that the five year-old children were more likely to purchase reputation cues than both the other age groups. Here, the youngest group were 3.5 times more likely than 10 year olds and 2.0 times more likely than adults to purchase "hints" before making investment decisions.

Trustworthiness Perception.

Behavioural vignettes. We examined participants' ratings of the characters described in these vignettes to confirm that they understood our operationalization of trustworthiness (Table 2). A two-way ANOVA measuring the effects of age group (5 year olds, 10 year olds, adults) and stimulus type (trustworthy, untrustworthy) on trustworthiness ratings confirmed a significant main effect of stimulus type, F(1, 69) = 2056.59, p <.001, partial η^2 = .96, which was qualified by a significant interaction, F(2, 69) = 15.69, p < .001, partial η^2 = .31. Critically, the interaction did not reflect immature understanding of the concept of trustworthiness in 5 or 10 year olds, relative to adults. All three age

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groups differentiated significantly between the two stimulus types (see Table 2). Relative to 10 year-old children and adults, 5 year-old children gave significantly higher trustworthiness ratings to characters in the trustworthy vignettes, *t*s > 2.21, *p*s < .05, *d*s > .64, and lower trustworthy ratings to characters in the untrustworthy vignettes, *t*s > 4.60, *p*s < .05, *d*s > .1.31. Ratings in the adults and 10 year-olds did not differ in either case, *t*s < .63, *p*s > .52, *d*s < 0.18 and the main effect of age group was only marginally significant, $F(2, 69) = 2.98$, $p = .06$, partial $\eta^2 = .08$.

Face stimuli. We used the same analysis to investigate the effects of age and stimulus type on trustworthiness ratings of the face stimuli presented during Token Quest. A significant effect of stimulus type, $F(1, 69) = 271.89$, $p < .001$, partial $\eta^2 = .79$ confirmed that all three age groups significantly discriminated between these trustworthy and untrustworthy faces (see also Table 2). There was no significant effect of age group $F(2, 69) = .81$, $p = .44$, partial $\eta^2 = .02$ or interaction $F(2, 69) = .33$, $p = .71$, partial $\eta^2 = .01$. These results are consistent with mature perception of trustworthiness from faces by 5 years.

Discussion

This study demonstrates that the intriguing influence of facial appearance cues on trust behaviour observed in adults (Chang et al., 2010; Rezlescu et al., 2012; van't Wout & Sanfey, 2008) extends to young children. Like adults, 10 year-old children selectively placed their trust (investments) in those partners they perceived to have trustworthy-looking faces rather than untrustworthy-looking faces. Many of these children were also willing to sacrifice investment capital to purchase access to these stimuli, which is consistent with face cues to

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trustworthiness holding perceived economic value in the trust game (as in Eckel & Petrie, 2011). Together these results support rational and possibly mature trust behaviour in children by 10 years of age, which is powerfully influenced by facial appearance cues.

We observed a similar profile of trust behaviour in the 5 year olds. Perceived facial trustworthiness had a large, albeit marginally significant, effect on investments during Token Quest and there was no significant difference in the impact of these cues on trust behaviour across the three age groups. Like the older participants, 5 year olds were highly sensitive to the perceptual differences between trustworthy and untrustworthy faces and these children were *more* motivated than 10 year olds or adults to purchase access to these cues. Moreover, inspection of Figure 2 indicates that very few 5 year olds actually preferred to invest with untrustworthy looking partners over trustworthy looking partners. Together, these findings constitute converging support for largely adultlike trust behaviour, based on facial cues to trustworthiness, by 5 years of age.

Children and adults' rational responses in the reputation condition validated Token Quest as an index of trust perception and behaviour. Five year-olds, 10 year-olds and adults all modulated their investments in line with non-face information about each partner's past behaviour, giving significantly more tokens to trustworthy-sounding partners than untrustworthy-sounding partners. Furthermore, at least half of the participants in each age group were also willing to sacrifice funds to purchase access to these reputation cues. This bias to invest with the people that participants believed were previously the least likely to abuse the trust of others, signals that participants understood how

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the game worked and were motivated to collect as many tokens as possible. These results support Token Quest as a measure of the real-world behavioural consequences of different cues to trustworthiness, in children and adults.

One limitation of the current paradigm is our indirect measure of stimulus valuation: participants' decision to purchase (or not to purchase) access to additional information about their partners during the bonus rounds. We interpreted this variable as an index of how children and adults valued face and non-face stimuli as cues to partner trustworthiness. However they might have valued access to these stimuli for other reasons. For example, participants might have simply enjoyed the additional token exchange with the experimenter that purchasing stimuli entailed. Such an interpretation could account for the high percentage of purchases across conditions in the 5 year-old group, which particularly enjoyed this aspect of the game. Nevertheless, participants' investments during interactions with partners in Token Quest provided clear evidence of early maturing trust behaviour in children.

The facial characteristics underpinning the perceived trustworthiness of these stimuli also remain unspecified. Given that our goal was to provide the strongest possible test for effects in our young participants, Token Quest featured face stimuli pre-rated to look highly trustworthy and untrustworthy. No effort was made to control for characteristics such as attractiveness, which may contribute to trustworthiness judgments (e.g., Surawski & Ossoff, 2006; Todorov, Said, Engell, & Oosterhof, 2008) and behaviour (Bascandziev & Harris, 2013). Having demonstrated the influence of appearance cues on children's trust behaviour with these stimuli, a fascinating direction for future research will be to determine whether more subtle variability in facial trustworthiness also

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modulates behaviour in young children. If this is the case, then our paradigm could provide an elegant means to assess children's sensitivity to facial characteristics associated with trustworthiness perception in adults, e.g., attractiveness and resemblance to happy/angry emotional expressions (see Oosterhof & Todorov, 2008).

Together, the results of the current study provide important new insights into the development of human trust behaviour. Our ecologically valid measure revealed that facial trustworthiness cues influenced trust behaviour in children as young as 5 years of age, with adult-like effects observed by 10 years. These findings, like those of a recent study that reported reliable facial competence judgments in children (Antonakis & Dalgas, 2009) highlight a capacity for sophisticated social cognition in young children. Additional studies are now needed to investigate just how early in development face cues come to influence trust behaviour. Developmentally appropriate economic paradigms like ours, which require little explicit understanding of concepts like trustworthiness, will be of great utility for investigating the early emergence of these effects.

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Figure Captions

Figure 1. Examples of stimuli presented during the different rounds of Token Quest: A) blank identity, B) face identity (note – this identity was not used in the task), C) reputation information. We show also the screens from the two bonus rounds introducing participants to the notion of paying for access to D) faces and E) reputation information "hints".

Figure 2. Mean (SEM) difference between token investments in partners with trustworthy faces and untrustworthy faces (i.e., investments to trustworthy minus untrustworthy faces) by 5 year-olds, 10 year-olds and adults.

Figure 3. Mean (SEM) difference between token investments in partners with trustworthy and untrustworthy reputations by 5 year-olds, 10 year-olds and adults (i.e., investments to trustworthy minus untrustworthy reputations).

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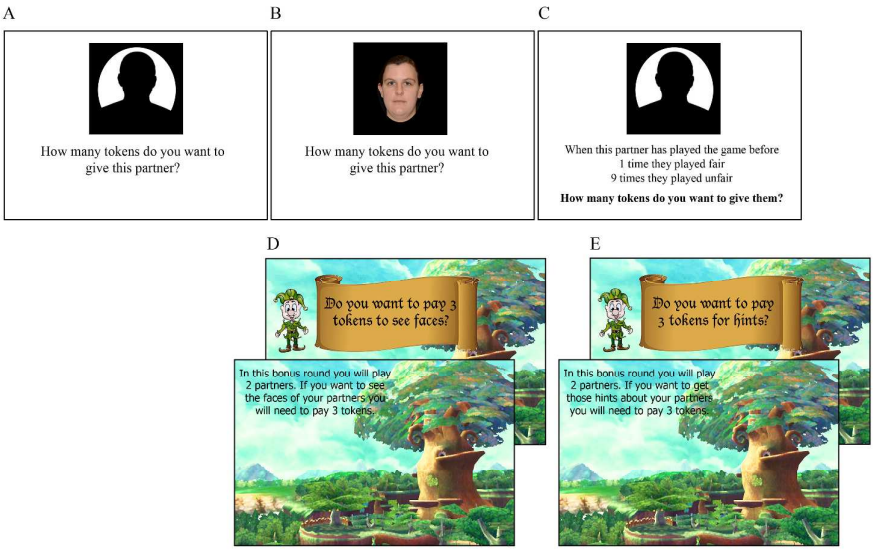

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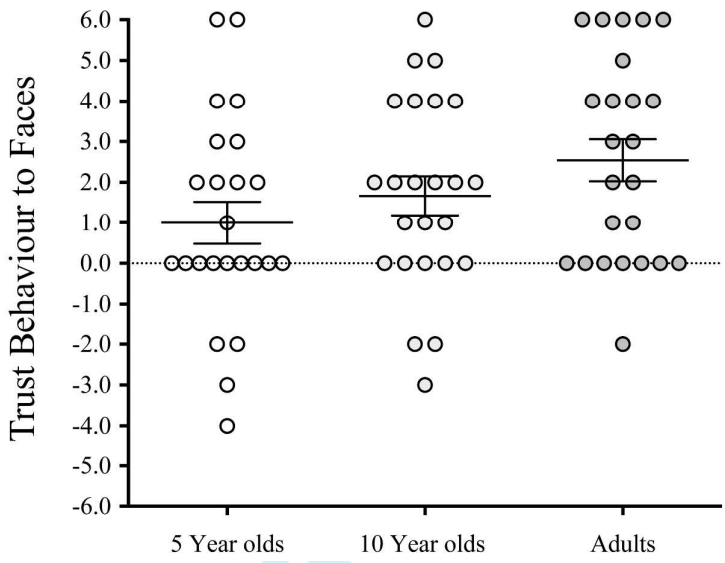

Figure 2.
Mean (SEM) difference between token investments in partners with trustworthy faces and untrustworthy faces (i.e., investments to trustworthy minus untrustworthy faces) by 5 year-olds, 10 year-olds and adults.

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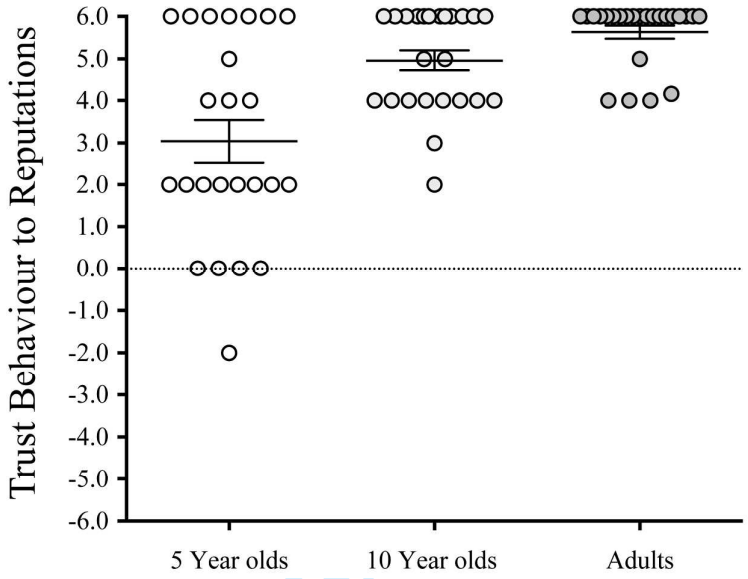

Figure 3.
Mean (SEM) difference between token investments in partners with trustworthy and untrustworthy reputations by 5 year-olds, 10 year-olds and adults (i.e., investments to trustworthy minus untrustworthy reputations).

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Table 1. *Mean (SD) tokens invested in partners with trustworthy and untrustworthy faces and reputations by 5 year-olds, 10 year-olds and adults (Maximum possible tokens invested in Trustworthy + Untrustworthy partners = 6).*

	Trustworthy	Untrustworthy
Faces	M (SD)	M (SD)
5 year-olds	3.4 (1.3)	2.4 (1.3)
10 year-olds	3.6 (1.2)	2.0 (1.1)
Adults	4.0 (1.4)	1.5 (1.1)
Reputation		
5 year-olds	4.5 (1.2)	1.5 (1.2)
10 year-olds	5.4 (0.6)	0.5 (0.6)
Adults	5.7 (0.5)	0.1 (0.3)

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Table 2. *Mean (SD) trustworthiness ratings (1 = not very trustworthy, 7 = very trustworthy) assigned to the trustworthy and untrustworthy stimuli by each age group.*

	Trustworthy	Untrustworthy	
Vignettes	M (SD)	M (SD)	
5 year-olds	6.6 (0.5)	1.3 (0.5)	t(23) = 36.0, p<.001
10 year-olds	6.3 (0.5)	2.0 (0.7)	t(23) = 25.0, p<.001
Adults	6.2 (0.6)	2.1 (0.6)	t(23) = 20.4, p<.001
Faces			
5 year-olds	5.3 (0.9)	2.8 (1.2)	t(23) = 9.1, p<.001
10 year-olds	5.1 (0.7)	2.6 (0.9)	t(23) = 12.7, p<.001
Adults	5.2 (0.8)	2.4 (1.1)	t(23) = 8.4, p<.001

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Dr Melissa Koenig
Associate Editor
Developmental Science

Dear Dr Koenig,

RE: DS-01-14-0036-SR entitled "Perceived trustworthiness of faces drives trust behaviour in children."

Thank you for your positive comments regarding the manuscript. We appreciate the very helpful points raised by yourself and the three reviewers. In light of these comments we have made several minor revisions to the manuscript. We outline these changes below.

EDITOR'S COMMENTS

Along with Reviewer 1, I would be interested in seeing comparisons of children's and adults' interest in buying reputation versus face information.

We present this comparison below, and suggest there is little evidence to support any tradeoff between participants being interested in face or reputation cues.

Also, on the top of p. 13, it would be interesting to see the means (and SDs) for participants' trustworthiness ratings in the behavioral vignettes for verbal descriptions and for faces.

In the rating phase of the task, participants rated the trustworthiness of characters described in behavioural vignettes and the face stimuli presented during Token Quest. The means and SDs of these judgments are all already presented in Table 2.

Finally, the findings are typically discussed concisely as indicating children's use of face cues to in their decisions to trust. However, in a few places, you describe the findings as reflecting 'mature trust behavior in children' or 'by 5 years of age.' (e.g., p. 2, middle of p. 5). Given that trust behavior covers a great deal of territory, you might aim to consistently state your conclusions more specifically.

We thank the reviewer for highlighting this occasional lack of specificity in our

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expression. We have looked through the manuscript carefully and made minor revisions to address this critique.
E.g.,

- On, p. 2 we originally stated – "Together, these results provide converging support for largely mature trust behaviour by 5 years of age. Our findings indicate that the influence of face cues on trust behaviour emerges early, and highlight a capacity for sophisticated social cognition in young children"
  This now reads – "Together, these findings indicate that the influence of face cues on trust behaviour emerges early, and highlight a capacity for sophisticated social cognition in young children".

- On p. 5 we originally stated - "Few studies have investigated the development of trust behavour in children".
  This now reads - "Few studies have investigated the modulation of behaviour based on cues to trustworthiness in children"

- On p. 13 we originally stated – "These results are consistent with mature trust perception from faces by 5 years"
  This now reads – "These results are consistent with mature perception of trustworthiness from faces by 5 years"

- On p. 14 we originally stated – "Together these results support mature trust behaviour in children by 10 years of age, which is powerfully influenced by facial appearance cues."
  This now reads - "Together these results support rational and possibly mature trust behaviour in children by 10 years of age, which is powerfully influenced by facial appearance cues."

- On p. 14 we originally stated - "Together, these findings constitute converging support for largely mature trust behaviour by 5 years of age."
  This now reads - "Together, these findings constitute converging support for largely adultlike trust behaviour, based on facial cues to trustworthiness, by 5 years of age".

REVIEWER 1 COMMENTS

This is well written paper addressing a novel developmental problem - whether children are influenced in similar ways to adults by facial appearance. The results are quite clear. Incidentally, a paper just came out in Psychological Science (Cogsdill et all.) showing that even 3-to-4 year-olds show consensus in trustworthiness judgments from faces and this consensus is similar to adults' one. This is not taking anything away from the current work as the authors use an economic exchange paradigm and these are the only 2 studies I am aware of that investigate this problem in children. There is a nice convergence. Cogsdill et al. show that children do make attributions of trustworthiness from faces and the current authors show that these attributions have

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specific behavioral consequences. That is, these attributions do matter.

Just curious about one point. Do children and adults who are willing to purchase "face" info are also willing to purchase reputation info. One can make different predictions. The correlation could be positive or negative if one assumes that people who care about reputation are less concerned with appearance cues.

We thank the reviewer for this potentially interesting suggestion. We can report that when examining purchasing behavior across the conditions, among all those participants who elected to purchase access to cues during the bonus rounds, most (58.3%) sacrificed tokens to access both face and reputation cues. Fewer chose to access only faces (15.0%) or only reputation information (26.7%). In the absence of any clear indication of a tradeoff between participants being interested in one cue or the other we have elected to not include this new comparison in the manuscript. As we already acknowledge in the Discussion, clear interpretation of this purchasing behaviour variable is difficult. We highlight that participants could have valued access to faces, reputation cues, or both, for any number of reasons. They might have genuinely valued the trustworthiness cues present in each/both categories, or been predisposed to purchase anything in order to ensure as many possible opportunities to exchange tokens with the experimenter (p. 15). These new data do not add clarity regarding this issue.

REVIEWER 2 COMMENTS

This was an excellent paper. Well written and presenting a clear rationale for the study conducted. The methodology used was valid and rigorous and the use of a computer game framing of the experiment adds both to the novelty of the paper and the naturalism of the study. The results are clearly presented and of significant value to the field and the discussion is clear and covers the key findings and limitations of the research in a concise manner.

In short I have no hesitation in recommending this paper for publication and would like to thank the authors for producing such a well designed and well written paper. I do have a couple of very minor points that it would be good if the authors could address.

1) Page 7, line 39: The authors say that they told participants the people in the photos were staff and students at the university and that they had previously told the exerimenters what there choices were. It would be nice to have a reference for this use of the strategy method of the trust game. One good paper on this is Brandts & Charness, 2011, Experimental Economics.

We have added the suggested reference.

2) Page 9, line 48: It would be nice if the authors could give the percentage of each group that sent all 6 tokens across the 8 identities in brackets. At the moment the "at

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least 69%" statement is slightly ambiguous (Does it mean at least 69% in all three groups or at least at least 69% of adults and 69% of children.)

Upon reflection, the phrasing of this passage was indeed unclear. We have revised it to make it now clear that 75% of adults, 62.5% of 10 year olds and 62.5% of 5 year olds invested all 6 of their tokens in every round (see page 9)

We believe that this paper is now even stronger, thanks to the helpful suggestions provided by the journal's feedback. We greatly appreciate the opportunity to undertake these revisions and hope that you will find this version suitable for publication in *Developmental Science.*

Yours sincerely

Louise Ewing

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