Social information influences trust behaviour in adolescents

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ABSTRACT

Trust plays an integral role in daily interactions within adolescents' social environment. Using a trust game paradigm, this study investigated the modulating influence of social information about three interaction partners on trust behaviour in adolescents aged 12—18 ($N = 845$). After receiving information about their interaction partners prior to the task, participants were most likely to share with a 'good' partner and rate this partner as most trustworthy. Over the course of the task all interaction partners showed similar levels of trustworthy behaviour, but overall participants continued to trust and view the good partner as more trustworthy than 'bad' and 'neutral' partners throughout the game. However, with age the ability to overcome prior social information and adapt trust behaviour improved: middle and late adolescents showed a larger decrease in trust of the good partner than early adolescents, and late adolescents were more likely to reward trustworthy behaviour from the negative partner.

During adolescence social interactions become increasingly important. As they transition from childhood to adulthood, adolescents gradually spend more time with their friends than with parents or family members (Brown, 2004). Developing successful social relationships requires understanding and responding to the feelings and intentions of others, for example by trusting them. Interpersonal trust, defined as trust placed in others, plays an integral role in smooth and efficient social interactions by encouraging cooperative behaviour between individuals (King-Casas et al., 2005). Trust in others is present from an early age, and during childhood we learn not to trust all people equally (Fitneva & Dunfield, 2010; Harris & Corriveau, 2011). By the age of 3 children will place more trust in an adult who has previously given them accurate information than in an adult who has given them incorrect information (Corriveau & Harris, 2009). Experimental studies show that trust in others changes during adolescence, as adolescents become increasingly able to anticipate and interpret the behaviour of those they interact with (Derks, Lee, & Krabbendam, 2014; Fett, Gromann, Giampetro, Shergill, & Krabbendam, 2014a; Fett et al., 2014b; Sutter & Kocher, 2007; van den Bos, Westenberg, van Dijk, & Crone, 2010). Many of these interpersonal exchanges involve communication partners the individual has prior social knowledge of, or has previously interacted with. Studies in adults have shown that this social context influences levels of interpersonal trust. For example, adults are more likely to share rewards with others if they know that the other has previously shown trustworthy behaviour (Bracht & Feltovich, 2009). Studies of the development of trust behaviour during adolescence have previously mainly focused on single interactions with anonymous partners. To increase the understanding of the development of interpersonal trust during adolescence, this study

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examines the influence of social information about interaction partners on the development of interpersonal trust behaviour in repeated interactions.

Trust in dynamic social interactions

In recent years application of game-theoretical approaches has enabled the development of behavioural paradigms to study interpersonal trust behaviour (Camerer, 2003; Glaeser, Laibson, Scheinkman, & Soutter, 2000; King-Casas et al., 2005). These paradigms require participants to engage in cooperative social interactions reflecting realistic 'real-life' and emotionally charged settings (Frith & Singer, 2008). An oft-used paradigm is the trust game, during which a player (the investor) allocates an amount of money between themselves and a partner (the trustee) within an interactive setting (Berg, Dickhaut, & Mccabe, 1995). This invested amount is tripled and given to the trustee, who then decides how to share the investment between himself and the investor. Within the task trust is quantified by the amounts invested by the investor. In an iterated version of the trust game, the investor and trustee play multiple rounds together, thereby enabling examination of the effect of reputation building during the game (King-Casas et al., 2005). As the task is a direct behavioural measure of trust, it enables the manipulation of the social context within which trust occurs. This allows for more objective assessment of the effects of these manipulations on trust behaviour than traditional self-report measures. The trust game is also sensitive to behavioural changes which participants may not be able to verbalise or report (Delgado, Frank, & Phelps, 2005).

The role of social information

A number of studies have examined the development of trust in anonymous partners using the trust game. Sutter and Kocher (2007) showed that trust increased almost linearly from childhood, stabilising in late adolescence. Others have also demonstrated continued improvements in trust from early to late adolescence (van den Bos, van Dijk, Westenberg, Rombouts, & Crone, 2011; van den Bos et al., 2010), as well as finding that adolescents show greater flexibility in strategy use over of the course of a repeated trust game than children (van den Bos, van Dijk, & Crone, 2012). Little is known about the influence of prior social information on trust during adolescence. A study in a small sample of adolescents with and without externalizing behaviour problems, found that adolescents showed more trust in real-life peers they had previously described as kind than in peers they had described as mean (Sharp, Burton, & Ha, 2011). Studies in adults have shown that prior social knowledge of interaction partners influences trust game behaviour. The better an individual knows their interaction partner, the more they trust them, especially in situations with high potential losses (Goto, 1996). Initial impressions also influence trust. People invest more in partners whose face they previously rated as trustworthy (van't Wout & Sanfey, 2008), or in individuals they have been informed are trustworthy (Fett et al., 2012). Delgado et al. (2005) found that information about interaction partners influenced trust in two ways: first, prior social information about interaction partners affected the initial trust individuals placed in these partners: participants were more likely to trust a trustee who they had received positive information about than a trustee they had received negative information about. Secondly, they showed that feedback about the interaction partner during the game failed to completely alleviate these differences, despite both partners showing equal amounts of reciprocation during the game.

It seems that two types of social information can be distinguished which influence trust behaviour: prior information about interaction partners' reputation and feedback information based on behaviour during the trust game. Adolescence is a particularly interesting developmental period during which to study these effects. During adolescence, emotional responsiveness to social stimuli and socially related events is amplified, and social information becomes highly salient within decision-making contexts (Crone & Dahl, 2012; Nelson, Leibenluft, McClure, & Pine, 2005). At the same time, adolescents are often unable to self-regulate their behaviour when attention–grabbing socially and emotionally evocative events occur (Monk et al., 2003). As a result, social and emotional information strongly influence adolescent behaviour (Silk et al., 2009). During adolescence the integration of cognitive and emotional networks increases. This leads to a rise in levels of goal-directed behaviour, as the cognitive control network becomes increasingly able to overrule the heightened activation of the emotional network, thus decreasing the influence of social and emotional stimuli on behaviour (Hare & Casey, 2005; Nelson et al., 2005; Somerville & Casey, 2010). However, as the aforementioned study by Delgado et al. (2005) shows, adjusting behaviour in certain social contexts still poses difficulties for adults, for example when faced with incongruent feedback about an positively-viewed interaction partner's behaviour.

The current study

The increased salience of social and emotional stimuli during adolescence makes it likely that adolescent trust behaviour will be particularly affected by social knowledge of interaction partners. Therefore, the present study was designed to examine the influence of social knowledge of interaction partners on trust behaviour during adolescence. A group of 852 adolescents aged 12–18 years played an iterated version of the trust game against three fictitious partners who they received information about prior to playing the game. One partner was trustworthy ('good' partner), one was not trustworthy ('bad' partner) and the information about the third partner was not related to their trustworthiness ('neutral' partner). In line with previous research we expected:

1. Initial levels of trust to increase with age (Sutter & Kocher, 2007; van den Bos et al., 2010).
2. Participants would adjust their initial trust behaviour according to the information they received about their interaction partners, i.e. we expected the highest levels of trust in the good partner and the lowest levels in the bad partner.
3. The effect of the information received prior to the task would have the greatest effect in the youngest age group, as they are most sensitive to social stimuli (Silk et al., 2009).
4. Feedback received during the task would also have the least influence on subsequent trust behaviour in the youngest adolescents in our sample, as they are less able to ignore previous salient information about their interaction partners and regulate their behaviour to attend to the new and possibly incongruent information they receive about these partners during the task.

Method

Participants

Participants were recruited from years 1, 3, 5 and 6 of mainstream secondary schools in the Netherlands and had not been previously diagnosed with a neurological, psychological or learning disorder. A total of 7 participants were excluded from the analyses due to incomplete data. The remaining 845 participants were divided into three age groups: early adolescence (12–13-year-olds, year 1), middle adolescence (14–15-year-olds, year 3) and late adolescence (16–18-year-olds, years 5 and 6). Chi-square tests showed that the proportion of males and females did not differ significantly within the age groups. Demographic characteristics are presented in Table 1.

Materials

Trust game

An iterated trust game was used to measure trust behaviour. As in the design used by Delgado and colleagues (2005) participants were instructed that they would all be playing an online game against three different hypothetical partners. Participants were told that in each round of the game they would play the role of player 1, the investor and receive €2. They could either keep the entire amount, or choose to share and send the entire amount to player 2, the trustee. If they chose to invest in the trustee, the amount was tripled. The trustee could subsequently either defect and keep all the money, or cooperate and share it with the investor, with both the investor and trustee receiving €3. While we use the terms 'investor' and 'trustee' here, our protocol used the neutral terms 'player 1' and 'player 2'. The task consisted of 30 intermixed trials, 10 played against each partner. The partners were presented in a pseudorandom order which was the same for all participants. This order was designed to seem random to the participants, but was designed to ensure there were never more than 4 trials with the other partners between two trials played against the same opponent. During each trial, the participants were presented with the face and name of their partner for that trial and asked if they wished to share or keep their €2. After entering their response, they were shown a second screen with one of the three possible outcomes of the trial (the participant chose to keep; the partner reciprocated and chose to share; or the partner defected and chose to keep), as well as the amount they had earned. Participants were told they would play multiple rounds against each partner. To avoid end of game effects participants were not informed about the exact number of trials.

The task was preceded by a priming phase during which the participants read a short news story about each of the three hypothetical partners, based on those used by Delgado et al. (2005), but adapted for use in an adolescent sample. For two of the partners, the good and bad, the information in the stories related to their trustworthiness. The good partner had recently prevented an old lady from being mugged by scaring off the attackers. The bad partner had been caught by police attempting to break into a car with friends. The third neutral partner had won a flight at an air show but missed the flight because he was late. This was newsworthy because the plane crashed during the flight. The neutral story was designed to evoke a similar emotional response to the good and the bad stories, but without the social information the other two stories contained (see Appendix).

All partners were described as 16-year-old males to prevent confounding of results due to differences in age or sex between the partners. Each story was accompanied by a photograph of a neutral face (taken from Minear & Park, 2004). Three

Table 1
Demographic characteristics of participants.

	n	Age	Sex (% female)
		M (SD)	
Early adolescents	243	13.22 (.34)	56.1%
Middle adolescents	381	15.22 (.40)	49.6%
Late adolescents	221	17.53 (.75)	50.5%
Total	845	15.32 (.50)	51.6%

versions of the task were created to counterbalance the faces with the positive, negative and neutral stories. The faces were all rated as equally trustworthy by a group of adolescents during a pretesting phase. Participants were told that the stories they read would give them additional information about their partners and that their partners may or may not play the game according to the described characteristics. In reality, all three partners played according to an identical strategy, and were programmed to have the same reinforcement rate of 70% cooperate and 30% defect over the 10 trials played against each opponent.

The number of times a participant chose to share with each interaction partner was used a measure of trust. Initial trust was defined as the number of share decisions during the first five trials per condition, while post trust game trust was defined as the number of share decisions during the last five trials per condition. This decision was based on the assumption that even a participant with high levels of trust in a partner could still sometimes choose not to share. Accordingly, we felt that an average over a number of trials would be a more reliable index of how the participants viewed their partners.

Trustworthiness questionnaire

To measure how trustworthy the participants found each of their interaction partners, participants were asked to rate the trustworthiness of each of the partners on a 7-point likert scale (1 = *Not at all trustworthy*, 7 = *Extremely trustworthy*). This was measured at two time-points: directly following the stories about the interaction partners, and after completing the trust game.

Procedure

Data collection took place in participating schools under supervision of the classroom teacher and two trained psychologists. Parents were notified in writing about the project prior to testing. They were asked to inform their child's teacher if they did not wish for their child to participate, however no parents did so. During the test session all participants were seated at a computer. A short explanation of the trust game was given, followed by the participants playing three practice rounds of the trust game and receiving feedback about their answers to ensure they had understood the game. This was followed by the priming phase during which they read the stories about the interaction partners, and were asked to rate each partner's trustworthiness. Participants subsequently played the trust game against the three partners, and then give a final rating of each partner's trustworthiness.

Participants were told that a number of randomly selected rounds would be used to determine their pay out at the end of the game. In reality, participants in the youngest age group received €5 for their participation and those in the two older groups received €7.50, to ensure that all participants were rewarded equally for their participation. The local IRB approved all procedures.

Analyses

Age differences in initial levels of trustworthiness were checked using a 3 × 3 repeated measures ANOVA, with within-subjects factor Condition (good, neutral and bad partner) and between-subjects factor Age (early, middle, late adolescence) to analyse reported levels of trustworthiness after reading the stories about each of the interaction partners. To examine the initial effect of the social information on trust behaviour, another 3 (Condition) × 3 (Age) repeated measures ANOVA was used to examine the average number of share decisions made by participants on early trials.

Change scores for both trust (first five (early) trials vs last five (late) trials) and trustworthiness (pre vs post measurement) were computed to examine age differences in changes in levels of trust and trustworthiness during the task. These change scores were analysed per condition using a 2 × 3 repeated measures ANOVA with within-subjects factor Time (respectively pre and post trustworthiness and early versus late share trials) and between-subjects factor Age. The effect of feedback through interactions with each of the partners was examined in more detail by classifying participants' responses to their partners' behaviour into one of four categories (based on Fett et al., 2012): (a) *trust repairing*: the participant chose to share despite the trustee not sharing in the previous round, (b) *distrust reciprocating*: the participant chose not to share in response to a keep decision by the trustee in the previous round, (c) *trust honouring*: the participant chose to share in response to a share decision by the trustee in the previous round, and (d) *trust disruption*: the participant chose not to share despite the trustee sharing in the previous round. As the trustee only responded to trials on which the participant choose to share, only trials which were preceded by share trials could be categorised. Age group differences in frequency of these response categories were investigated using a 4 (Response categories) × 3 (Age) repeated measures ANOVA per condition.

Finally, as similar reinforcement rates were programmed in each of the three conditions, both post trust game trustworthiness ratings as well as the number of share decisions made by participants on late trials were examined to determine if participants' judgements of the partners still differed at the end of the game. A 3 (Condition) × 3 (Age) repeated measures ANOVA was used.

All effects are reported as significant at $p < .05$. In analyses where the assumption of sphericity was violated, degrees of freedom were corrected using Greenhouse–Geisser estimates of sphericity. Significant main effects were further examined using post hoc Bonferroni-adjusted pairwise comparisons where appropriate. Significant interaction effects were followed up using univariate ANOVAs. To correct for multiple comparisons a Sidak-Bonferroni corrected alpha level of $p = .017$ was applied to these post hoc ANOVAs.

Table 2
Age differences in trustworthiness: mean pre and post trust game trustworthiness ratings of each interaction partner per age group.

	Before trust game			After trust game		
	Good	Neutral	Bad	Good	Neutral	Bad
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Early adolescents	5.16 (1.9)	4.69 (1.44)	2.35 (1.53)	4.36 (1.69)	3.62 (1.71)	3.81 (1.80)
Middle adolescents	5.50 (1.52)	4.76 (1.27)	2.33 (1.48)	4.16 (1.52)	3.90 (1.45)	3.90 (1.67)
Late adolescents	5.61 (1.64)	4.67 (1.60)	2.49 (1.43)	3.94 (1.64)	3.96 (1.65)	3.94 (1.78)

Results

Age differences in initial trust and trustworthiness

Initial trustworthiness ratings indicated that the stories affected the way participants viewed their interaction partners (Table 2). Trustworthiness differed per condition (Greenhouse–Geisser $F(1.87, 1567.67) = 781.50$, $p < .001$, $\eta_p^2 = .48$). The good partner received the highest rating (good vs neutral $p < .001$; good vs bad $p < .001$), and the lowest level of trustworthiness was reported for the bad partner (bad vs neutral $p < .001$). There was a main effect of Age ($F(2, 839) = 3.81$, $p = .02$, $\eta_p^2 = .01$), with post hoc Bonferroni analyses showing that late adolescents reported higher levels of trustworthiness than early adolescents ($p = .02$), while middle adolescents did not differ from the other age groups. This effect did not differ between interaction partners.

The influence of prior information on initial trust behaviour

The prior social information participants received influenced trust behaviour towards interaction partners during initial trials (Table 3). A main effect of Condition (Greenhouse–Geisser $F(1.93, 1631.68) = 269.99$, $p < .001$, $\eta_p^2 = .24$) showed that participants shared more with the positive than the neutral ($p < .001$) or negative partners ($p < .001$) and more with the neutral than the negative partner ($p < .001$).

While the main effect of Age was not significant, the Condition $\times$ Age interaction (Greenhouse–Geisser $F(3.86, 1631.68) = 3.00$, $p = .02$, $\eta_p^2 = .01$) showed there was a difference between groups in the negative condition ($F(2, 846) = 4.61$, $p = .01$, $\eta_p^2 = .01$). This was due to late adolescents sharing on more trials than early ($p = .02$) and middle adolescents ($p = .02$). There were no age differences in the positive or neutral conditions.

The effect of reputation building: changes in trust and trustworthiness during the trust game

Over the course of the trust game, participants received feedback about the decisions made by their partners, thus enabling them to adjust their decisions in light of their increased knowledge of their partners. As Fig. 1 shows, this resulted in the trustworthiness scores for the good partner decreasing during the trust game ($F(1, 836) = 269.55$, $p < .001$, $\eta_p^2 = .24$). A similar decrease was seen in the neutral condition ($F(1, 838) = 16.37$, $p < .001$, $\eta_p^2 = .16$). In contrast, the trustworthiness rating of the bad partner increased during the trust game ($F(1, 837) = 367.24$, $p < .001$, $\eta_p^2 = .31$). Changes in the decrease in the trustworthiness rating of the good partner differed per age group, as indicated by a Time $\times$ Age interaction ($F(2, 838) = 9.29$, $p < .001$, $\eta_p^2 = .02$). Early adolescents showed a smaller decrease in their trustworthiness rating of the good partner ($F(2, 838) = 9.63$, $p < .001$, $\eta_p^2 = .02$) than middle ($p = .01$) and late adolescents ($p < .001$), indicating that their experiences lead them to adjust their trustworthiness rating less than the late adolescent group. Middle and late adolescents did not differ in their adjustment of the rating of the good partner. No age differences were found in changes in the trustworthiness rating of the bad or neutral partners.

Changes in trust behaviour generally mirrored those of trustworthiness ratings. As Fig. 2 shows, sharing increased in late trials compared to early trials when playing with the bad partner ($F(1, 844) = 70.16$, $p < .001$, $\eta_p^2 = .08$). In contrast, sharing decreased in late trials compared to early trials when playing with the good ($F(1, 843) = 75.40$, $p < .001$, $\eta_p^2 = .08$) and neutral partners ($F(1, 844) = 16.89$, $p < .001$, $\eta_p^2 = .02$). No age differences were found in changes in the number of share trials in the

Table 3
Age differences in trust: mean number of share trials per age group for early and late trials per interaction partner.

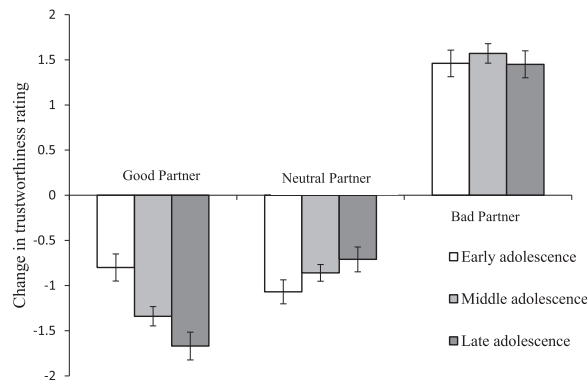|	Early share trials (trials 1–5)			Late share trials (trials 6–10)		
	Good	Neutral	Bad	Good	Neutral	Bad
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Early adolescents	3.23 (1.31)	3.05 (1.26)	1.76 (1.34)	2.98 (1.44)	2.93 (1.32)	2.24 (1.56)
Middle adolescents	3.37 (1.23)	3.09 (1.30)	1.78 (1.39)	2.77 (1.42)	2.89 (1.44)	2.34 (1.53)
Late adolescents	3.16 (1.32)	3.08 (1.28)	2.10 (1.46)	2.56 (1.45)	2.74 (1.52)	2.41 (1.69)

Fig. 1. Changes in trustworthiness ratings during the trust game per age group.

bad or neutral conditions. In the condition with the good partner, a main effect of Age was found ($F(1, 843) = 3.20$, $p = .04$, $\eta_p^2 = .01$) as well as a Time × Age interaction ($F(2, 843) = 4.13$, $p = .02$, $\eta_p^2 = .01$). This was the result of a smaller decrease in the number of share trials during the trust game ($F(2, 845) = 4.127$, $p = .016$, $\eta_p^2 = .01$) amongst early adolescents than middle ($p = .03$) or late adolescents ($p = .05$). Thus, in general, participants adapted their behaviour in each of the conditions over the course of the trust game after realising that their partners where not responding in the way they had anticipated. In the case of the good partner, the older age groups adapted their behaviour more than the early adolescent group.

More in-depth analysis of responses to feedback showed that participants differentiated their responses based on the interaction partner (see Table 4). When playing with the good (Greenhouse–Geisser $F(2.15, 1687.97) = 198.26$, $p < .001$, $\eta_p^2 = .20$) and neutral partners (Greenhouse–Geisser $F(2.35, 1843.94) = 129.33$, $p < .001$, $\eta_p^2 = .14$), participants most frequently rewarded trustworthy behaviour, as indicated by the high levels of trust honouring, but were less inclined to punish untrustworthy behaviour as indicated by the low levels of distrust reciprocating. These effects did not differ between the age groups. When playing with the bad partner (Greenhouse–Geisser $F(2.04, 1599.53) = 100.18$, $p < .001$, $\eta_p^2 = .12$), participants showed similar results, however the trust honouring behaviour differed between age groups ($F(2,784) = 6.20$, $p = .002$, $\eta_p^2 = .01$). Late adolescents showed higher levels of trust honouring than early ($p = .004$) or middle adolescents ($p = .008$), suggesting that they were more receptive than the younger participants to changes in their interactions partner's behaviour.

Trust and trustworthiness after the trust game

Trustworthiness ratings after completion of the trust game differed per Condition (Greenhouse–Geisser $F(1.97, 1644.78) = 7.66$, $p = .001$ $\eta_p^2 = .01$). Ratings of the good partner were higher than those for the neutral or bad partners (Table 2). The main effect of Age was not significant. The Condition × Age interaction (Greenhouse–Geisser $F(3.94, 1644.78) = 2.86$, $p = .02$, $\eta_p^2 = .01$) showed that the differences between conditions differed per age group. There were no age differences in the negative or neutral condition, but there was a main effect of Age in the positive condition ($F(2, 834) = 3.91$, $p = .02$, $\eta_p^2 = .01$), though this not quite reach the stringent Sidak-Bonferroni alpha level of .016. An exploratory examination of post hoc effects
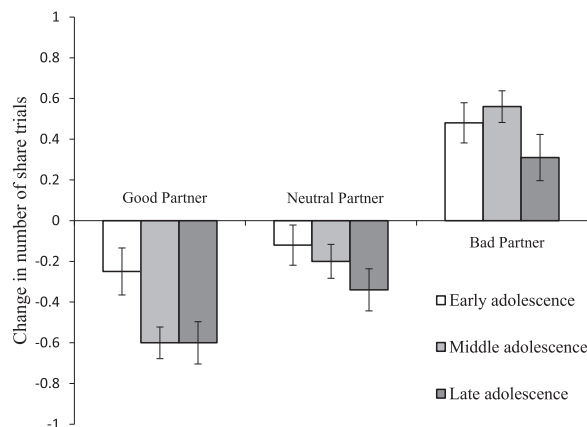

Fig. 2. Difference between number of early and late share trials per age group.

Table 4
Feedback responses per interaction partner and age group.

	Trust repairing (TR)[a]	Distrust reciprocating (DR)[b]	Trust honouring (TH)[c]		Trust disrupting (TD)[d]	Differences between conditions
	M (SD)	M (SD)	M (SD)		M (SD)	
Positive	1.39 (1.19)	0.69 (.80)	2.18 (1.47)		1.28 (0.95)	DR < TR, TD, TH (p < .001) TR < TH (p < .001) TD < TH (p < .001)
Early adolescents	1.43 (1.22)	0.70 (0.79)	2.26 (1.46)		1.25 (0.96)	
Middle adolescents	1.43 (1.16)	0.67 (0.79)	2.20 (1.47)		1.33 (0.95)	
Late adolescents	1.28 (1.21)	0.73 (0.83)	2.08 (1.49)		1.33 (0.93)	
Neutral	1.39 (1.19)	0.79 (0.79)	1.99 (1.43)		1.28 (0.99)	DR < TR, TD, TH (p < .001) TR < TH (p < .001) TD < TH (p < .001)
Early adolescents	1.36 (1.29)	0.85 (0.73)	1.95 (1.42)		1.33 (0.99)	
Middle adolescents	1.38 (1.30)	0.81 (0.82)	1.98 (1.41)		1.29 (0.99)	
Late adolescents	1.39 (1.23)	0.70 (0.80)	2.06 (1.49)		1.22 (0.98)	
Negative	0.67 (.88)	0.65 (0.68)	1.41 (1.53)	Early < Late (p = .004) Mid < Late (p = .008)	1.13 (0.95)	TR < TH, TD (p < .001) DR < TH, TD (p < .001) TD < TH (p < .001)
Early adolescents	0.59 (1.30)	0.67 (.68)	1.27 (1.43)		1.09 (0.91)	
Middle adolescents	0.67 (0.88)	0.64 (.70)	1.30 (1.50)		1.16 (0.95)	
Late adolescents	0.75 (0.90)	0.60 (.66)	1.72 (1.65)		1.11 (0.98)	

[a] Participant chose not to share despite the trustee sharing in the previous round.
[b] Participant chose not to share in response to a keep decision by the trustee in the previous round.
[c] Participant chose to share in response to a share decision by the trustee in the previous round.
[d] Participant chose not to share despite the trustee sharing in the previous round.

found that early adolescents reported higher levels of trustworthiness for the good partner than late adolescents ($p = .02$). No differences were found between middle adolescents and the early and late adolescent groups.

Behaviour on late trials showed a similar effect (Table 3). Participants shared more with the good partner and neutral partners than the bad partner (main effect condition: Greenhouse–Geisser $F (1.93, 1628.52) = 34.32$, $p < .001$, $\eta_p^2 = .04$). The main effect of Age was not significant. The Condition × Age interaction indicated that the differences between the conditions were not the same for the three age groups (Greenhouse–Geisser $F (3.86, 1628.52) = 2.90$, $p = .02$, $\eta_p^2 = .30$). There were differences between age groups in the positive condition ($F (2, 845) = 4.81$, $p = .01$, $\eta_p^2 = .01$). On trials with the good partner, early adolescents shared more than late adolescents ($p = .01$), while no differences were found between the middle adolescent group and early and late adolescents. Sharing behaviour did not differ between age groups for the other conditions.

Discussion

The present study used an economic exchange game to examine how social information about interaction partners influences trust behaviour during adolescence. While previous studies have examined the development of trust in interactions with anonymous partners (van den Bos et al., 2010; Harbaugh, Krause, Liday, & Vesterlund, 2003; Sutter & Kocher, 2007), this study focussed on the influence of social information on trust. The results showed that social information altered adolescent trust behaviour. Adolescents initially placed more trust in a partner they had been led to believe was trustworthy than in a partner they believed was not trustworthy or whose trustworthiness they knew nothing about. Furthermore, though participants incorporated the feedback they received about their partners over the course of the task in subsequent decisions, this effect differed over the conditions and between age groups.

The effects of initial impressions

Analysis of trustworthiness ratings showed that the initial task affected the way the participants viewed their interaction partners: trustworthiness differed between the three conditions before participants played the trust game. As hypothesised these ratings differed between age groups, with late adolescents reporting higher levels of initial trust in their partners than early adolescents. The manipulation also resulted in behavioural differences on early trials of the trust game. All participants shared most with the good partner and least with the bad partner. Furthermore, late adolescents shared more with the bad

partner than early or middle adolescents. These observed differential effects of the manipulation per condition are consistent with our expectations based on previous studies in adults. These have shown that individuals will modify their level of trust in a partner based on an initial impression, a small amount of prior information, or on observations of previous behaviour. For instance, adults were more likely to reject a fair offer in an ultimatum game if their partner had been described as selfish, and more likely to accept an unfair offer from a partner described as generous (Marchetti, Castelli, Harle, & Sanfey, 2011). Others have shown that adults are more likely to trust a partner who showed trustworthy behaviour during a previous trust game with other people (Bracht & Feltovich, 2009), or who they implicitly believe to be trustworthy based on their facial features (van't Wout & Sanfey, 2008). Our findings show that adolescents incorporate information they receive about interaction partners into their decision-making process in a similar ways.

Changes during the trust game

Over the course of the game participants used the feedback they received about their partner to adapt both their behaviour, and their subjective opinion of the trustworthiness of their partner. In the positive and neutral conditions, trustworthiness ratings and sharing decreased, while in the negative condition an increase was found. However, all participants continued to share most with the good partner and least with the bad partner, despite similar reinforcement rates.

The continued influence of initial levels of trust over the course of interactions has been previously demonstrated. Chang, Doll, van 't Wout, Frank, and Sanfey (2010) showed that trustworthiness following an iterated trust game was the result of an interaction between initial levels of trust and the partner's behaviour during the game. Despite behaving in a similar manner, partners that had initially been rated as untrustworthy were rated as less trustworthy after the trust game than those that had previously been rated as trustworthy. These findings suggest that though initial trustworthiness judgements can be modified by experience, they cannot be erased completely. Research in adults by Delgado et al. (2005) has suggested that this is particularly the case when a partner is initially viewed as trustworthy. This leads to decreased sensitivity to feedback following positive information about an interaction partner, as a result of reduced activation of the caudate nucleus, the area in the brain involved in reinforcement learning. Therefore, trials in which the good partner violates expectations by choosing not to reciprocate, do not lead to encoding of this evidence and subsequent learning to the same degree as in the neutral and negative conditions. This idea is strengthened by other research showing that participants continue to show increased trust in a partner who previously included them in a game, despite this partner reciprocating in a similar manner to a partner who excluded them during the game (Hillebrandt, Sebastian, & Blakemore, 2011). It seems that positive social information creates a strong prior belief which influences subsequent decision-making behaviour. Our findings support this, as the adolescents in our sample continued to place the highest level of trust in the good interaction partner throughout the course of the game, despite the identical reinforcement rates displayed by the three interaction partners.

The impact of age on changes in trust

The aforementioned influence of social information on trust behaviour was found to change with age. While the results confirm our hypothesis that young adolescents would be least receptive to information during the task, this did not hold for all interaction partners. When playing with the positive partner the older age groups showed a larger decrease in trust over the course of the task than the youngest age group, but in the negative and neutral conditions, trustworthiness and sharing changed similarly across age groups. Furthermore, when we examined the way in which participants responded to their interaction partners' decisions, we found that while adolescents are generally inclined to reward trustworthy behaviour with continued trust, late adolescents were more likely to do so in interactions with the bad partner than middle and early adolescents. Perhaps the increased flexibility in their beliefs about their interaction partners lead to an attempt to encourage trustworthy behaviour in the partner they trusted least.

Combined these findings show an increased flexibility with age in responses within social interactions. Previous work has reached similar conclusions in broader comparisons of children, adolescents and adults (Belli, Rogers, & Lau, 2012; van den Bos et al., 2012). Studies in young children show that they have a robust bias to trust verbal information given by adults even if it is incorrect (Jaswal, Croft, Setia, & Cole, 2010). Interestingly, this effect decreases when they are presented with incorrect information by an adult and concurrently receive correct information from another child. In this case they will often trust the child over the unreliable adult (Jaswal & Neely, 2006). This suggests that flexible responding to others within social interactions starts to develop at an early age. Our findings extend this work by showing that this flexibility continues to change during adolescence. Linking this finding to the increased integration of cognitive and emotional networks in the brain during adolescence (Steinberg, 2008), which may facilitate better regulation of behaviour and decrease the salience of the information participants received prior to the task, this suggests that as integration increases, adolescents become gradually more able to incorporate feedback about their interaction partners in their decision-making process. Therefore, the change in trustworthiness ratings and sharing with the good partner increases with age, as does rewarding of positive behaviour by the bad partner. However, as previous studies have shown (Delgado et al., 2005), even in adults the use of feedback to adjust behaviour in social contexts still poses difficulties, meaning that the strong bias created by emotional information continues to be influential in late adolescence and into adulthood.

Limitations and future directions

Limitations of the current study must be noted. Firstly, participants were aware that they were playing against hypothetical partners. Previous research has shown stronger reactions when participants played against a human compared to a computer (van't Wout et al., 2006). The effects found may therefore have been stronger if participants had believed their interaction partners were real. Secondly, the iterated format used for the trust game means that demands were placed on participants' working memory capacities. Over the course of the task they needed to store and track the behaviour of their interaction partners. However, our finding that participants responded differently to each of the interaction partners over the course of the game suggests that the working memory demands were not too high. Finally, all participants had 16-year-old males as their interaction partners. This was done to prevent confounding of results due to differences in perceived trustworthiness resulting from age or sex differences between the partners. Consequently, not all adolescents played with an age- and sex-matched peer. While it seems unlikely that the pattern of results reported here could have been influenced by this, future research examining the effect of age and sex differences between interaction partners on trustworthiness ratings during adolescence is needed to ascertain this. Future research could also consider examining the influence of potential earnings on the participants' behaviour. Though previous research has frequently demonstrated that moral considerations such as trust and fairness influence decision-making in economic exchange games (e.g. Derks et al., 2014; Falk & Fischbacher, 2006; Güroglu, van den Bos, Rombouts, & Crone, 2010), the interaction between these moral concerns and maximising earnings has not been examined in detail in adolescent samples. A task which included a condition where similar decisions were made without social interactions would avoid the influence of moral considerations on behaviour and enable the social and learning effects to be more clearly distinguished.

The current study shows that social information about an interaction partner influences trust behaviour and that this influence changes during adolescence. We used a large sample of adolescents consisting of three clearly delineated age groups spanning the adolescent developmental continuum. In contrast to the anonymous interactions studied in previous research, we examined the effects of social information prior to the trust game, as well as the influence of feedback during the task. Decision-making in a social context is representative of what adolescents are faced with in daily life. Therefore our results are highly applicable to real-life situations, and fit within suggestions that studying social situations is of increasing importance to the field of cognitive neuroscience (Todorov, Harris, & Fiske, 2006).

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.adolescence.2015.10.021.

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