

Developmental Changes and Individual Differences in Trust and Reciprocity in Adolescence

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A Trust Game was used to examine trust and reciprocity development in 12–18-year-old-adolescents ($N = 496$), as findings have been conflicting and transitions in adolescence remain elusive. Furthermore, this study tested the roles of gender, risk, and individual differences in empathy, impulsivity, and antisocial tendencies in trust and reciprocity. Results indicate stability in trust and a decrease in reciprocity across adolescence, but also show that trust and reciprocity choices were influenced by risk, and that empathy mediated the age-related decrease in reciprocity. Males trusted more than females, but there were no gender differences in reciprocity. These findings highlight the importance of considering individual differences and adolescents' sensitivities to varying contexts in explaining trust and reciprocity development in adolescence.

Adolescence, the period between ages 10 and 22 years, is marked by pronounced changes in social orientation (Nelson, Leibenluft, McClure, & Pine, 2005). These changes help adolescents in developing social skills and mature long-term social goals (Crone & Dahl, 2012). It has been argued that adolescents show a shift from self-oriented behavior toward other-oriented behavior during this period, which helps them attain the “adult goal” of developing and maintaining stable, close relationships (Crone & Dahl, 2012; Eisenberg, Fabes, & Spinrad, 2006). Several developmental changes in adolescence, such as growth in sociocognitive functioning (e.g., moral reasoning, cognitive empathy, social problem solving) and increased social-affective influences on goals and behavior (Crone & Dahl, 2012; Eisenberg & Spinrad, 2014), make adolescence a period in which other-oriented behaviors are likely to emerge and to become more complex (Eisenberg & Spinrad, 2014).

Two important types of other-oriented behavior that enable adolescents to successfully navigate their changing social world are trust and reciprocity (Crone & Dahl, 2012; Derks, Lee, & Krabbendam, 2014; Lemmers-Jansen, Krabbendam, Veltman, & Fett, 2017). Whereas reciprocity (i.e., repaying trust) can be defined as prosocial behavior (Derks et al.,

2014; van den Bos, van Dijk, Westenberg, Rombouts, & Crone, 2011), the closely related construct of trust refers to “a voluntary transfer of a good or favor to someone else, with future reciprocation expected but not guaranteed” (Gunnthorsdottir, McCabe, & Smith, 2002, p.50). Trust encompasses multiple processes (McKnight & Chervany, 1996), including risk, taking and perspective taking (also referred to as cognitive empathy; van den Bos, Westenberg, van Dijk, & Crone, 2010). Both trust and reciprocity are considered to be crucial elements of other-oriented behavior (van den Bos et al., 2010). In social interactions, other-oriented behavior often takes the form of exchanging favors, which are sometimes separated in time (van den Bos et al., 2010). Trusting that a favor will be returned is important for initiating other-oriented behavior and is generally beneficial to others. Trust can benefit others either when it is reciprocated (e.g., it leads to cooperative interactions that are positive for both the trustor and trustee), or unreciprocated (e.g., it results in a larger share for the trustee). Reciprocity is critical for maintaining social relationships (Lahno, 1995; van den Bos et al., 2010) and increasing the chance of future prosocial interactions, both as recipient and initiator (Harbaugh, Mayr, & Burghart, 2007; Trivers, 1985).

Other-Oriented Behavior in Economic Games

One way to investigate the development of other-oriented behavior is with economic games (Gum-

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merum, Hanoch, & Keller, 2008). The Trust Game (Berg, Dickhaut, & McCabe, 1995) is of particular interest for understanding trust and reciprocity. In the Trust Game, two players are involved in dividing an amount of money or tokens (Malhotra, 2004; van den Bos et al., 2010). In the current study, we used a fixed-choice modified version of a previously developed child-friendly Trust Game (van den Bos et al., 2010; see Figure 1a). The first player, the trustor, is given two options: either to divide money (in the form of coins) between him/herself and the second player in a certain way, or to give it to the second player, who is then asked to divide the money. If the trustor chooses to give the money to the second player (trust), the number of coins he/she gives to the second player is multiplied by the experimenter. The second player, then, also has two options: he/she can equally divide the money (reciprocate), or keep most of the money and give the remainder of the stake to player one (exploit; Malhotra, 2004; van den Bos et al., 2010). The choice for the first player entails a risk: he/she may gain more money by deciding to trust the second player, but runs the risk of receiving relatively little money if the second player decides to exploit.

Studies examining trust and reciprocity behavior in Trust Games with anonymous others have shown age-related increases in both trust and reciprocity between childhood and adolescence (Sutter & Kocher, 2007; van den Bos et al., 2010). Some of these report further increases in mid-adolescence (van den Bos et al., 2010), while others report no further changes between ages 13 and 18 years (Fett et al., 2014; Güroğlu, van den Bos, & Crone, 2014) and ages 17–27-years (Lemmers-Jansen et al., 2017), or decreases between ages 14 and 16 years (Derks et al., 2014). Studies that have used other types of economic games to examine fairness considerations across child and adolescent development have reported increased other-regarding behavior over the course of childhood and adolescence (e.g., Blake & McAuliffe, 2011; Gummerum et al., 2008; Güroğlu, van den Bos, & Crone, 2009). It should be noted, though, that most of these studies focused on children or adults, and few studies have examined the trajectories of trust and reciprocity within early to mid/late adolescence (but see Derks et al., 2014; Güroğlu et al., 2014). Additionally, there is a lack of studies investigating the development of behavior in the Trust Game using a continuous age range; previous studies have compared age groups that are several years apart. Given that there is evidence that cooperative behavior does not necessarily develop linearly, an important next step is to investigate

trust and reciprocity development in adolescence using a continuous age range (Derks et al., 2014). Therefore, our first aim was to examine the development of trust and reciprocity using the Trust Game within the relatively understudied period of adolescence, using a continuous age range between 12 and 18 years. Because prior studies showed conflicting developmental patterns of trust and reciprocity across mid-adolescence, our goal was to examine this pattern in more detail.

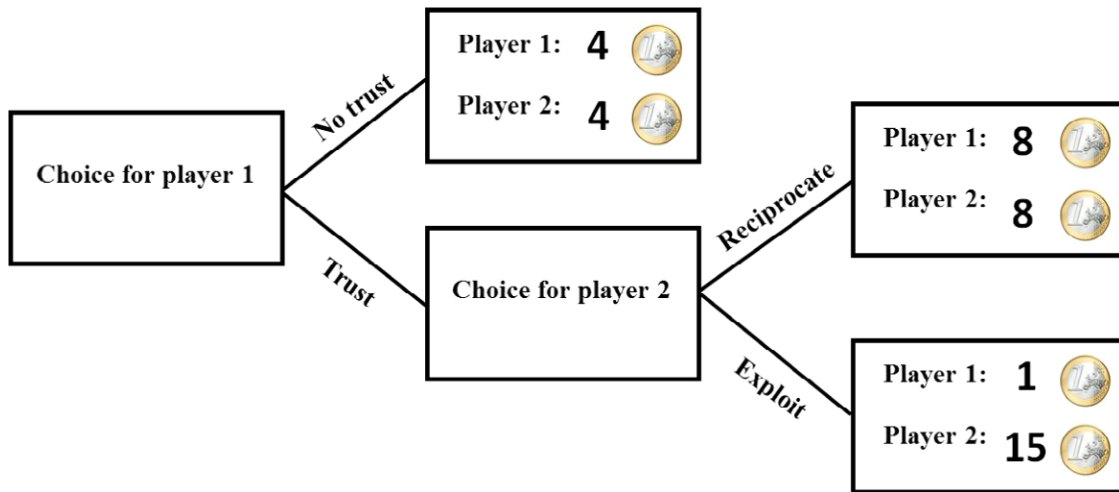
Gender Differences in Adolescents' Trust and Reciprocity

Previous studies have provided evidence that there are gender differences in adolescents' trust and reciprocity behavior. Although one study that focused on adolescence showed no gender differences in trust (van den Bos et al., 2010), other studies showed that adolescent males trust others more often than females (Derks et al., 2014; Lemmers-Jansen et al., 2017). In contrast, no gender differences in reciprocity have been found in adolescent samples (Derks et al., 2014; van den Bos et al., 2010). Likewise, most studies in adults have found that males show higher levels of trust but that males and females are equally likely to reciprocate (e.g., Ashraf, Bohnet, & Piankov, 2006; Derks et al., 2014). However, some studies with college students showed that women were more likely to reciprocate (Ben-Ner & Halldorsson, 2010; Buchan, Croson, & Solnick, 2008; Chaudhuri & Gangadharan, 2007; Croson & Buchan, 1999). In the present study, based on previous findings in adolescents, we hypothesized that males would show more trust than females and that there would be no gender differences in reciprocity (Derks et al., 2014; Lemmers-Jansen et al., 2017). No prior study has focused on how gender differences influence the development of trust and reciprocity in a sample of mid-adolescents. Therefore, we will also test the possible interaction between age and gender in trust and reciprocity in the broad age range between 12 and 18 years.

The Role of Context: How Risk Influences Adolescents' Trust and Reciprocity

The extent to which trusting someone is perceived as risky is an important factor that may influence adolescents' trust and reciprocity decisions. For instance, it was previously found that when a trustor had a lot to lose (i.e., by taking a high risk with trusting), trustees were more willing to reciprocate

(a)



(b)

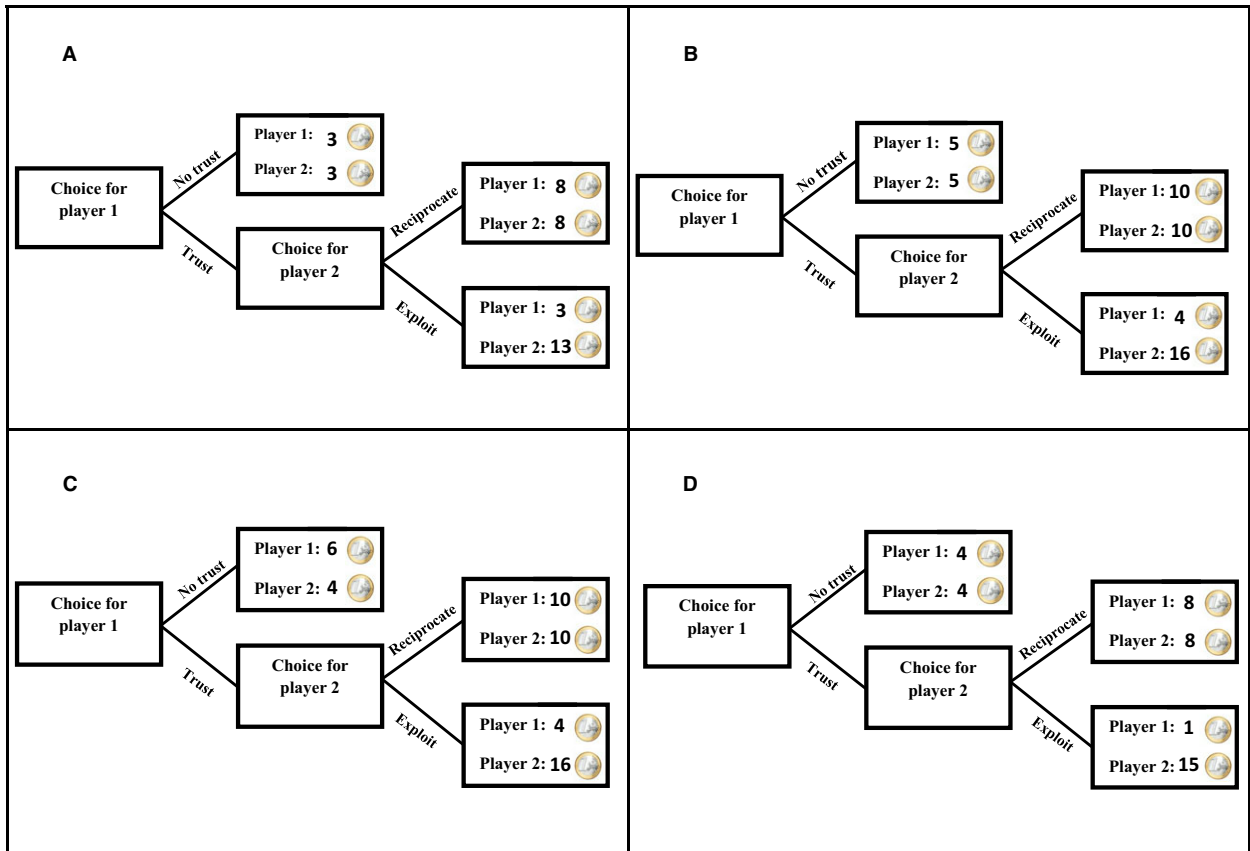


FIGURE 1 (a) Example of the visual displays that were shown in each trial. In each round, participants were assigned to the role of player 1 (the trustor) or player 2 (the trustee). The choice of the player they were assigned to was highlighted (i.e., if participants played as player 1, the choice for player 1 was highlighted and the choice for player 2 was masked by somewhat darkening that part of the screen), but the whole decision tree remained visible to participants. If participants were assigned the role of player 1 (the trustor; indicated by the text “You are now player 1”), they had to decide whether to trust player 2 or not by pressing certain keys on the keyboard. A no trust choice ended the game immediately, whereas trust decisions allowed player 2 to decide whether to reciprocate or exploit the trust shown by player 1. The stakes are represented by the numbers next to the 1-euro coins. Please note that the choice labels (trust, no-trust; reciprocate, exploit) were not visible to participants but are shown here for illustrative purposes. (b) Visual representation of the four experimental conditions: (A) No risk, potential coin loss for player 1 was 0, (B) Small risk, potential coin loss was 1, (C) Medium risk, potential coin loss was 2, and (D) High risk, potential coin loss was 3.

this trust (van den Bos et al., 2010). However, there is evidence that children take the risk of the trustor into account less than adults when making trust and reciprocity decisions (van den Bos et al., 2010). Although previous research has indicated that this context-dependency develops in adolescence (e.g., Güroğlu et al., 2009, 2014; Will, Crone, van den Bos, & Güroğlu, 2013), suggesting that older adolescents differentiate more between risk contexts than younger adolescents, more research is warranted on when this context-dependency emerges exactly. One prior study that tested other-oriented development over the whole range of adolescence using variations of Dictator Games showed that non-costly other-oriented behavior increased, but costly other-oriented behavior decreased with increasing age (Meuwese, Crone, Rooij, & Güroğlu, 2015). To learn more about when this risk-context-dependency emerges, we used a fixed-choice Trust Game in which adolescents played both as trustor and trustee with anonymous peers. The influence of context on trust and reciprocity was investigated by manipulating the amount of risk the trustor faced (defined as potential coin loss when trust was exploited) when deciding whether or not to trust (Malhotra, 2004; van den Bos et al., 2010). Based on previous research, we expected that higher risk for the trustor would be associated with fewer trust decisions and more reciprocation by the trustee (van den Bos et al., 2010). We also expected that older adolescents would differentiate more between risk contexts than young adolescents.

The Role of Individual Differences: How Personality Affects Trust and Reciprocity

Several factors may influence whether adolescents decide to trust and reciprocate. These can be distinguished into individual differences in empathic abilities, impulsivity, and antisocial tendencies (e.g., Machiavellianism and bullying). Empathy is a multi dimensional construct encompassing affective and cognitive empathy, and the intention to comfort others (Overgaauw, Rieffe, Broekhof, Crone, & Güroğlu, 2017). Affective empathy refers to feeling the emotional state of a suffering person, whereas cognitive empathy refers to understanding this suffering. Intention to comfort others refers to the inclination to act in prosocial ways in order to comfort the suffering person.

Two factors that may be negatively related to trust and reciprocity are impulsivity and antisocial tendencies. Impulsivity is often defined as “a predisposition toward rapid, unplanned reactions to

internal or external stimuli without regard to the negative consequences of these reactions to the impulsive individuals or to others” (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001. p. 1784). Machiavellianism refers to an antisocial personality trait that is characterized by a lack of empathy, as well as by a tendency to lie, deceive, manipulate, and control others (Peeters, Cillessen, & Scholte, 2010). Another type of antisocial behavior is bullying, which refers to recurrent displays of negative actions that inflict injury or discomfort on another person (Olweus, 1989).

In self-report research it was already found that individual differences in empathic abilities and impulsivity influenced trajectories of prosocial behavior in adolescence (Kanacri, Pastorelli, Eisenberg, Zuffianò, & Caprara, 2013; Padilla-Walker, Dyer, Yorgason, Fraser, & Coyne, 2015). In addition, a prior study using the Trust Game showed that individual differences in perspective taking were correlated with adolescents’ trust and reciprocity, but that the direction of the correlation depended on the situation (i.e., the trustworthiness of the other individual; Fett et al., 2014). A prior study that examined trust and reciprocity in the Trust Game in undergraduate students showed that impulsivity was positively associated with trust decisions (Ibáñez et al., 2016). Because other studies also showed associations between impulsivity and prosocial behavior, we tested whether the same holds for trust and reciprocity in an adolescent sample (McMahon et al., 2012). Machiavellianism and bullying have been shown to be negatively associated with reciprocity in children (Barnett & Thompson, 1985; Batsche & Knoff, 1994; Coleman & Byrd, 2003; Griesse, Buhs, & Lester, 2016), but it is unknown whether the same is true for adolescents. Exploration of associations with empathic abilities, impulsivity, and antisocial tendencies may give more insight into the processes underlying trust and reciprocity behavior in adolescence. However, as only few studies have looked into this, it remains unclear how trust and reciprocity relate to various forms of empathy, impulsivity, and antisocial behavior, and whether these relations change during adolescence. Therefore, to investigate the influence of individual differences on trust and reciprocity development in adolescence, we obtained self-report measures of participants’ empathic abilities, impulsivity, and antisocial tendencies. First, we expected impulsivity to be positively associated with trust (Ibáñez et al., 2016) and negatively associated with reciprocity (McMahon et al., 2012). Next, we expected that empathy would

be positively associated with reciprocity (Fett et al., 2014) and that Machiavellianism and bullying would be negatively associated with reciprocity (Barnett & Thompson, 1985; Batsche & Knoff, 1994; Coleman & Byrd, 2003; Griese et al., 2016).

Finally, studies have reported significant links between age and empathic abilities, impulsivity, and antisocial tendencies. For example, one study with an adolescent sample found that perspective taking increased with age, and that perspective taking mediated an age-related increase in non-costly prosocial behavior (Güroğlu et al., 2014). Impulsivity has been found to increase into mid-adolescence and to decline in young adulthood (Peper, Braams, Blankenstein, Bos, & Crone, 2018), and several studies have found that bullying increases in adolescence as compared to childhood (Salmivalli, 2010). As such, individual differences in empathic abilities, impulsivity, and antisocial tendencies may also mediate the age-related change in trust and reciprocity. Thus, an additional aim of this study was to explore whether age-related changes in empathy, impulsivity, and antisocial tendencies in 12–18-year-old adolescents mediate developmental changes in trust and reciprocity behavior.

Although not the main focus of the current study, it is important to keep in mind that the level of risk and individual differences in empathic abilities, impulsivity, Machiavellianism, and bullying may be interrelated. For example, various studies have suggested that impulsivity is implicated in risky decisions in adolescence (e.g., Galván, Hare, Voss, Glover, & Casey, 2007) and that different types of empathy are positively related to each other and negatively related to bullying (Overgaauw et al., 2017). Furthermore, studies have argued that adolescents' risk-taking is modulated by their ability to empathize with others (e.g., Crone, Bullens, Van der Plas, Kijkuut, & Zelazo, 2008). For instance, studies that manipulated risk levels in Trust Games have shown that adolescents are especially likely to reciprocate if they are able to take the perspective that someone took a high risk by trusting them (van den Bos et al., 2011). Therefore, in the current study associations between level of risk and individual differences in empathy, impulsivity, and antisocial tendencies will be reported and briefly discussed.

METHOD

Participants

Our initial sample included 540 participants between ages 12 and 18 years. However, some

participants were excluded due to missing data, including 37 participants who did not finish the Trust Game (i.e., they had no trust or reciprocity scores due to technical problems), and seven participants who did not report their age. The final sample ($N = 496$) consisted of 260 (52%) males and 236 females (48%). Their mean age was 14.89 ($SD = 1.45$; range 12.32–18.89). To zoom in on age-dependent changes in trust and reciprocity in early and middle adolescence, participants were grouped into five age categories: 12-year-olds ($N = 56$, M age = 12.72, $SD = .18$, 30 [54%] male, 26 [46%] female), 13-year-olds ($N = 87$, M age = 13.53, $SD = .29$, 38 [44%] male, 49 [56%] female), 14-year-olds ($N = 132$, M age = 14.43, $SD = .29$, 72 [55%] male, 60 [45%] female), 15-year-olds ($N = 107$, M age = 15.48, $SD = .27$, 57 [53%] male, 50 [47%] female), and 16–18 year-olds ($N = 114$, M age = 16.93, $SD = .65$, 63 [55%] male, 51 [45%] female). In the latter group, most participants were 16 years ($N = 67$) or 17 years ($N = 39$), and a smaller number was 18 years old ($N = 8$). The latter group was collapsed across ages 16–18 to have an approximately equal number of participants per age group. Analyses using these age groups yielded mostly similar results as analyses that did not collapse over ages 16–18 (see Appendix S1 in the online Supporting Information). Chi-square analyses showed that gender distributions did not differ between age groups. Most participants were of Dutch origin (84%), as were most of their parents (70%); other participants were of various origins around the globe (both European and non-European). No information was obtained about participants' socioeconomic status, religion, language, or family characteristics.

Procedure

Participants were recruited and data were collected in March and April 2011 from a local secondary school in a suburb of The Hague, the Netherlands. Informed consent was obtained from participants and their parents. Participants were tested in their classroom as part of a larger study, which was approved by the local ethics committee.

Classroom size ranged from 10 to 30 students. Four trained experimenters were present to supervise each test session. Test sessions lasted approximately 60 minutes. The first half of the test session consisted of questionnaires that measured various aspects of development, including empathic abilities, impulsivity, and antisocial tendencies. In the second half of the test session, participants were

presented with eight economic games (see Meuwese et al., 2015, for a report on participants' behavior on the first four economic games), of which the Trust Game, the economic game of interest in this study, was the final one. Finally, the participants completed a short cognitive capacity test. All questionnaires and tasks were administered on a computer.

Before the test session, participants were reminded that their participation was voluntary and that data would be handled in a confidential and anonymous way. With regard to the Trust Game, participants received on-screen instructions and were encouraged to ask questions to ensure that they fully understood the game. It was explained to participants that they would play one-shot Trust Games with several age-matched anonymous individuals. Participants were told that these individuals also participated in the study and could play Trust Games with them by means of a real-time connection via a computer. For this reason, they played the games in larger groups, and they all started and ended the tasks (including the Trust Games) at the same time. Note, however, that there was no actual real-time connection between Trust Game players. That is, trustor participants never received feedback on the subsequent choice of player 2, and trustee participants were always trusted by player 1; this was pre-programmed. Participants were debriefed when all tasks were completed. Before the start of the economic games, it was emphasized that participants would play the economic games with unfamiliar peers. In addition, they were reminded that they played the allocation games for real money: at the end of data collection, one participant per class was randomly selected to receive his or her earnings during one of the games (ranging from 1 to 5 euros), meaning that only one participant per classroom was rewarded for participation.

Materials

Trust game. In the present study, we used a version of the Trust Game that was suitable for a wide age range (Berg et al., 1995; Malhotra, 2004; van den Bos et al., 2010; see Figure 1). Participants always first played a block of eight trials as player 1 (the trustor), followed by a block of eight trials as player 2 (the trustee). The order in which trials were presented in each block was randomized. The order of the blocks and randomization of trials within the blocks was chosen to minimize learning effects (i.e., it was ensured that choices as player 1 would not be influenced by previous trials in which they played as player 2 and were either

trusted or not trusted). Participants were told that they would play with a different anonymous peer at each trial (i.e., they never played more than one Trust Game with each anonymous peer). As such, adolescents' percentage of trust decisions could be interpreted to reflect a general level of trust toward individuals of the same age.

Player 1: Trustor. When participants were assigned the role of player 1, their instructions read: "You are player 1. You choose to...", while they were shown the entire decision tree in which the choice for player 1 was highlighted (see Figure 1). The entire decision tree was displayed such that participants could determine the risk involved in trusting the trustee. Participants then had to indicate whether they chose the first option, resulting in the end of the current trial, or the second option, which allowed the trustee to decide the outcome of the current trial. In the latter case, the original amount was multiplied by 2 in six of the eight trials, and in the remaining trials it was multiplied by 2.50 and 2.67. Note that, while the first option can be labeled as the "no trust" and the second option as the "trust" decision, such choice labels were not visible for participants during the game. After making their choice, participants did not receive feedback on the subsequent choice of player 2 in order to avoid learning effects. As such, participants did not receive feedback on whether their trust was vindicated by reciprocation.

Player 2: Trustee. When participants were assigned the role of player 2, their instructions read: "You are player 2. The other player decided that you can decide how to divide the money between yourselves." Again, the entire decision tree was displayed such that participants could see the risk taken by player 1 by trusting them. Participants had to indicate whether they would choose to (1) divide the money equally (resulting in both player 1 and 2 receiving more money than in the no trust option), or (2) keep most of the money to themselves (resulting in player 1 receiving less and player 2 receiving more money than in the no trust option; see Figure 1). The first option can be labeled as a decision to reciprocate trust, whereas the second option can be labeled as a decision to exploit trust. Note, however, that such choice labels were not visible to participants during the game.

Risk manipulation. Risk for the trustor was manipulated in a way similar to van den Bos et al. (2010) and Malhotra (2004). Risk was manipulated by varying the potential coin loss for the trustor when trusting an exploiter compared to not trusting. There could either be no risk (i.e., no coins

could be lost by trusting an exploiter), a low risk (i.e., one coin could be lost), a medium risk (i.e., two coins could be lost), or a high risk (i.e., three coins could be lost). Of the eight trials as either the trustor or trustee, there were two trials per risk condition. The current manipulation diverges from the ones by van den Bos et al. (2010) and Malhotra (2004) by also including conditions for no risk and medium risk (instead of only low and large risks). Figure 1b displays trials with various levels of risk for the trustor.

Empathy. Empathy was measured with the Empathy Questionnaire for Children and Adolescents (EmQue-CA; Overgaauw et al., 2017). This questionnaire consists of 14 items, which were scored on a 3-point Likert scale (1 = *not true*, 2 = *somewhat true*, and 3 = *true*). The items measure three different forms of empathy toward various targets (friends, peers, family, and others in general): (1) affective empathy (six items, e.g., “When a friend is sad, I feel upset too”), (2) cognitive empathy (three items, e.g., “If a friend is sad, I mostly understand why”), and (3) intention to comfort (five items, e.g., “If a friend is sad, I want to do something to make it better”). For each of the three scales, mean scores were computed and used in analyses (minimum score = 1, maximum score = 3). See Appendix S2 in the online Supporting Information for the normality and reliability of each subscale of all individual difference measures.

Impulsivity. Impulsivity was measured using the Barratt Impulsiveness Scale (BIS-11; Patton, Stanford, & Barratt, 1995). This questionnaire consists of 30 items measured on a 4-point Likert scale (1 = *rarely/never*, 2 = *occasionally*, 3 = *often*, and 4 = *almost always/always*). An example item is “I do things without thinking.” Mean scores were computed using all 30 items and were used in analyses.

Machiavellianism. In this study, Machiavellianism was measured using the Dutch version of the Kiddie Mach (Peeters et al., 2010). This questionnaire consists of 20 items, which were measured on a 5-point Likert scale that ranged from -2 (*strongly disagree*) through 0 (*neutral*) to +2 (*strongly agree*). An example item is “Sometimes you have to hurt other people to get what you want”. Mean scores were computed using all 20 items.

Bullying. Bullying was measured using the KRVL (Klasgenoten Relatie Vragenlijst), the Dutch

version of the Olweus Bully/Victim Questionnaire (Olweus, 1989). The bullying subscale of the KRVL consists of six items, which were measured on a 5-point Likert scale ranging from (1) *never* to (5) *multiple times a week*. An example item is: “How often did you bully other children in the last 5 days?” A mean score for the subscale was computed with higher scores indicating higher levels of bullying others.

RESULTS

Please note that the present study includes multiple tests of significance. It is important to keep in mind that this could lead to Type I errors. As such, most confidence should be placed in the results reported with p -values < .001 (p -values below .001 were reported as $p < .001$), because p -values would survive Bonferroni correction below the value of $.05/196 = .00003$. Exact p -values are still reported in cases where $p > .001$, as they may be informative for future research.

Descriptive Statistics and Correlations

Descriptive statistics. Table 1 provides a detailed description of the frequency of trust and reciprocity choices (as well as a separate overview for males and females and for different levels of risk), as well as a description of scores on individual difference measures. In addition, Table 1 specifies whether gender differences were present. As expected, females reported higher levels of empathy than males, and males reported higher levels of bullying and Machiavellianism. No differences were found for impulsivity. See Appendix S3 in the online Supporting Information for correlations between age, gender, trust and reciprocity scores, and individual difference measures.

The Development of Trust in Adolescence in Males and Females

In order to examine the development of trust behavior in adolescent males and females in the four risk conditions, a repeated measures analysis of variance (ANOVA) was performed with percentage of trust decisions as dependent variable, level of risk (no risk, low risk, medium risk, high risk) as within-subject factor, and with age (12-year-olds, 13-year-olds, 14-year-olds, 15-year-olds, and 16–18-year-olds) and gender as between-subject factors. All assumptions of repeated measures ANOVA were met, except for the assumption of sphericity

TABLE 1
Descriptive Statistics of Trust Decisions, Reciprocity Decisions, and Social Behavior and Personality

Measure	No. of Items	Min. Score	Max. Score	Mean Score (SD) Males (N = 260)	Mean Score (SD) Females (N = 236)	Mean Score (SD) Total (N = 496)
Trust game						
% trust decisions	8	0	100	60.43 (28.98)	52.33 (25.94)	56.57 (27.84)**
No risk	2	0	100	70.77 (37.43)	62.29 (37.44)	66.73 (37.63)*
Low risk	2	0	100	60.38 (39.15)	51.06 (38.44)	55.95 (39.05)**
Medium risk	2	0	100	59.04 (40.33)	58.05 (39.12)	58.57 (39.72)
Large risk	2	0	100	51.54 (42.34)	37.92 (38.21)	45.06 (40.96)***
% reciprocity decisions	8	0	100	72.16 (30.89)	73.52 (29.59)	72.81 (30.25)
No risk	2	0	100	70.19 (38.38)	75.64 (36.17)	72.78 (37.40)
Low risk	2	0	100	73.65 (36.87)	71.82 (36.33)	72.78 (36.59)
Medium risk	2	0	100	70.19 (38.13)	69.92 (38.67)	70.06 (38.35)
Large risk	2	0	100	74.61 (35.83)	76.69 (36.43)	75.60 (36.09)
Affective empathy	7	1	3	1.73 (0.30)	2.19 (0.34)	1.95 (0.39)***
Cognitive empathy	5	1	3	2.23 (0.45)	2.41 (0.43)	2.32 (0.45)***
Intention to comfort	6	1	3	2.39 (0.40)	2.65 (0.30)	2.51 (0.38)***
Impulsivity	30	1.30	3.10	2.06 (0.29)	2.06 (0.27)	2.06 (0.30)
Machiavellianism	20	-24	32	-4.91 (7.59)	-9.04 (6.56)	-6.87 (7.41)***
Bullying	6	0.17	4	0.98 (0.58)	0.58 (0.35)	0.79 (0.53)***

Note. Asterisks denote significant gender differences.

* $p \leq .05$; ** $p < .01$; *** $p < .001$.

(as indicated by Mauchly's test, $W(5) = .95$, $p < .001$). Therefore, degrees of freedom were corrected using the Greenhouse-Geisser correction. The results of the Greenhouse-Geisser corrected repeated measures ANOVA (including all interactions) indicated that trust decisions did not differ between age groups, ANOVA $F(4, 468) = .74$, $p = .563$, $\eta^2_p = .01$ (see Figure 2). As expected, we observed a main effect of risk, $F(2.90, 1409.68) = 34.63$, $p < .001$, $\eta^2_p = .07$, which indicated that the percentage of trust decisions decreased when the associated risk increased. Tests of within-subjects contrasts revealed that the percentage of trust decisions was lower in the high-risk condition ($M = 45.06\%$) than in the medium-risk condition ($M = 58.57\%$) and low-risk condition ($M = 55.95\%$), $p < .001$. The percentage of trust decisions was lower in the medium- and low-risk decisions than in the no-risk condition ($M = 66.73\%$), $p < .001$. There was no significant difference between medium- and low-risk conditions.

As expected, a main effect of gender showed that trust decisions differed significantly between males and females, $F(1, 486) = 6.24$, $p = .013$, $\eta^2_p = .01$, with males ($M = 60.43\%$) trusting more often than females ($M = 52.33\%$). No interaction effects were present. Figures 3a,b display the main effects of risk and gender, respectively. Given that scores were averaged across two trials per condition, it may be argued that nonparametric analyses are better suited. As such, and for the sake of completeness, we performed a nonparametric analysis which resulted in highly similar results (see Appendix S4 in the online Supporting Information).

The Development of Reciprocity in Adolescence in Males and Females

To examine the development of reciprocity decisions in adolescent males and females in the four risk conditions, a repeated measures ANOVA was performed with percentage of reciprocity decisions as dependent variable, level of risk (no risk, low risk, medium risk, high risk) as within-subject factor, and with age (12-year-olds, 13-year-olds, 14-year-olds, 15-year-olds, and 16–18 year-olds) and gender as between-subject factors. Assumption checks showed that the distribution of reciprocity scores was somewhat skewed to the left. However, because ANOVAs are considered to be relatively robust to violations of normality (Schmider, Ziegler, Danay, Beyer, & Bühner, 2010), and analyses using transformed variables (log transformations and square root transformations) led to similar results, we decided to nevertheless report the results of the repeated measures ANOVA. No other violations of assumptions were observed. The results of the repeated measures ANOVA analysis showed a main effect of age, $F(1, 486) = 4.66$, $p = .001$, $\eta^2_p = .04$, indicating a decline in reciprocity scores across age groups (see Figure 2). To further explore the association between age and reciprocity, we performed a univariate ANOVA with general level of reciprocity as dependent variable and age (linear and quadratic) as predictor. Results revealed a significant linear trend, $F(1, 495) = 17.68$, $p < .001$, $\eta^2_p = .04$, $B = -5.81$, indicating a general decrease in reciprocity decisions with age, see Figure 2.

The ANOVA further resulted in a main effect of risk, $F(3, 1458) = 3.60$, $p = .013$, $\eta^2_p = .01$. As

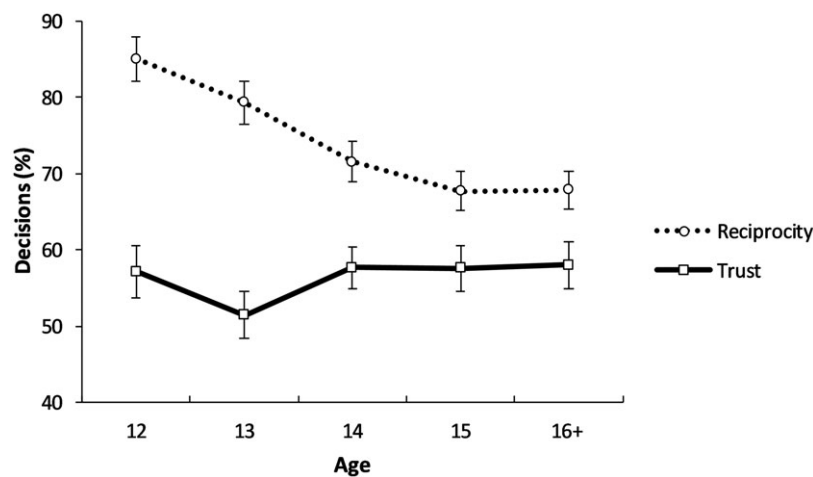


FIGURE 2 The mean percentages of trust and reciprocity over the four experimental conditions (level of risk) for each of the five age groups (error bars denote standard errors).

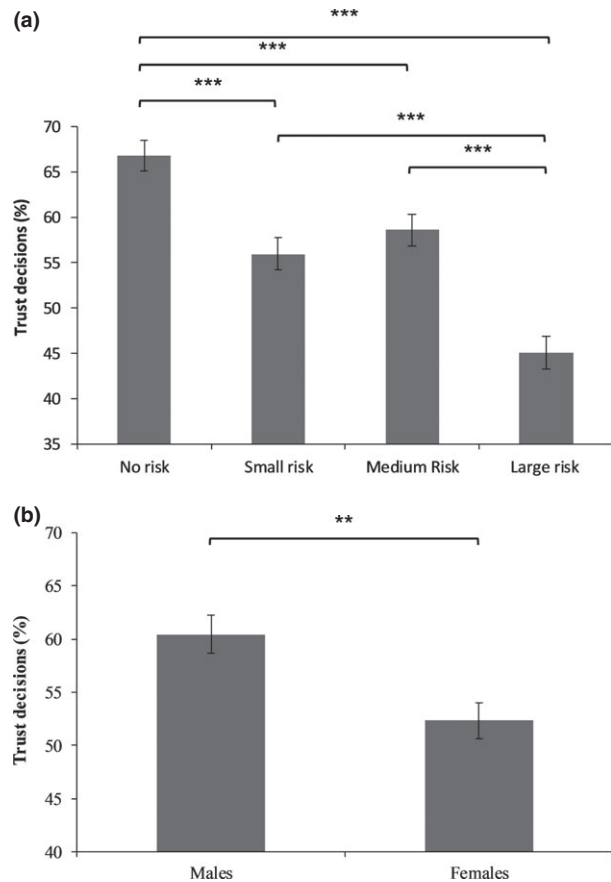


FIGURE 3 (a) Main effect of risk on trust decisions (error bars denote standard errors). (b) Main effect of gender on trust decisions (error bars denote standard errors). Asterisks indicate significant coefficients (** $p < .01$, *** $p < .001$).

expected, tests of within-subjects contrasts revealed that the percentage of reciprocity decisions was significantly higher in the high-risk condition ($M = 75.60\%$) than in the medium-risk condition ($M = 70.06\%$, $p < .001$) and the low-risk condition ($M = 72.78\%$, $p = .034$), but not the no-risk condition ($M = 72.78\%$, $p = .141$). There were no significant differences between the no-risk condition and the low-risk condition ($p = .661$), and between the low-risk condition and medium-risk condition ($p = .091$). In addition, the interaction effect between age and risk was marginally significant, $F(12, 1458) = 1.70$, $p = .062$, $\eta^2_p = .01$. Separate ANOVAs for each risk condition confirmed that the age-related decrease in reciprocity was observed in all conditions (all $ps < .02$). Comparisons between conditions showed that the age-related decrease was smaller for the high-risk condition and the no-risk condition than for the medium-risk condition (Age \times Condition interactions, $p < .05$). The low-risk condition did

not show significant differences from the other three conditions (Age \times Condition interactions n.s.). As can be seen in Figure 4, the marginally significant interaction suggests more differentiation in 15-year-olds, although this result should be interpreted with caution. Finally, as we expected, there was no gender difference in reciprocity scores, $F(1, 486) = .07$, $p = .798$, $\eta^2_p = .00$, and no additional interaction effects were observed. See Appendix S4 in the online Supporting Information for an alternative, nonparametric analysis.

Individual Differences in Trust and Reciprocity Development

To examine (1) whether individual differences in affective empathy, cognitive empathy, intention to comfort, impulsivity, and Machiavellianism, and bullying influenced trust and reciprocity behavior and its development; and (2) whether the individual difference measures mediated the relationship between age and trust, and age and reciprocity, we performed mediation analyses using SPSS Process 3.0 (Hayes, 2017). We controlled for gender in analyses because there were gender differences in several of the individual difference measures (see Table 1) and in trust behavior. To test whether indirect effects in the mediation analysis (i.e., the paths via the mediators) were significantly different from zero, we used a bootstrapping technique with 10,000 iterations, and computed 95% confidence intervals (CIs) for indirect effects (both the total indirect effects of all mediators combined and the specific indirect effect of each mediator). Using this technique, the mediation is considered significant if zero falls outside the confidence interval. Both analyses, controlled for gender, ($N = 493$) showed that intention to comfort, impulsivity, and Machiavellianism were significantly associated with age, thereby fulfilling the first requirement of mediation (intention to comfort: $t(490) = -2.96$, $p = .003$, $\beta = -.13$; impulsivity: $t(490) = 3.10$, $p = .002$, $\beta = .13$; bullying: $t(490) = 2.20$, $p = .028$, $\beta = .09$; Machiavellianism: $t(490) = 5.22$, $p < .001$, $\beta = .23$). Note that gender was also significantly associated with intention to comfort and Machiavellianism in the models that examined the association of age with these variables while controlling for gender. The analysis that examined trust development indicated no significant total effect of age on trust ($p > .05$), and no significant direct effect ($p > .05$) or indirect effect, $CBa\ CI [-.04, .02]$. This suggests that there was no association between

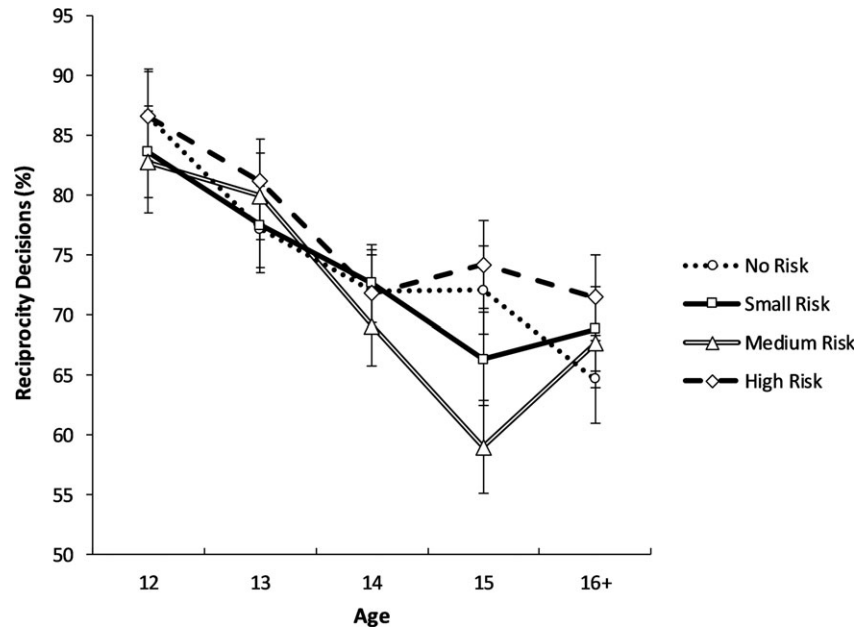


FIGURE 4 Percentages of reciprocity decisions in each condition across the five age groups. Error bars denote standard errors.

age and trust and that empathic abilities, impulsivity, and antisocial tendencies did not mediate this relation. This is in contrast with our hypothesis that trust and impulsivity would be associated. Within the total effects model, gender was the only variable associated with trust. The analysis that examined reciprocity development indicated a significant total effect of age on reciprocity, $t(490) = -3.62$, $p < .001$, $\beta = -.16$, which could be divided into an indirect effect, $\beta = -.04$, $CBa\ CI [-.07, -.01]$, and a direct effect, $\beta = -.13$, $p = .005$. This shows that the total indirect effect of age via affective empathy, cognitive empathy, intention to comfort, impulsivity, bullying, and Machiavellianism on reciprocity was significant, and that this combination of variables partially mediates the relation between age and reciprocity. To gain more understanding of the individual contribution of each mediator, we tested the specific indirect effects. These analyses revealed that only the indirect effect via intention to comfort was significant, $\beta = -.02$, $CBa\ CI [-.04, -.002]$, whereas the indirect effects via the other individual difference variables were not (i.e., for these variables zero fell within the $CBa\ CI$). In the total effects model, gender was not associated with reciprocity. Overall, the results of this mediation analysis suggest that the decrease in reciprocity with age is partly exerted through individual differences in intention to comfort (see

Figure 5). These results are in line with our expectation that intention to comfort is associated with reciprocity.

DISCUSSION

The present study aimed to provide an in-depth examination of the development of trust and reciprocity in a large sample of adolescents aged 12–18 years. For this purpose, we made use of a fixed-choice Trust Game. Consistent with prior research, higher risk for the first player (the trustor) resulted in fewer trust decisions by the first player and more reciprocity by the second player (the trustee), showing that adolescents take into account the perspective of the other player when making choices to trust and reciprocate (Malhotra, 2004; van den Bos et al., 2010). By including a large adolescent sample with a continuous age range, we demonstrated that (1) trust choices did not vary with age, but there was in general a higher level of trust for males than females. Reciprocity decreased with increasing age, although this was influenced by risk for the trustor. This age pattern was similar for males and females. We further showed that (2) individual differences in empathy, impulsivity, and antisocial behavior were unrelated to trust, but one form of empathy, namely, intention to comfort, mediated the relation between age and reciprocity. Here, patterns were again similar for males and

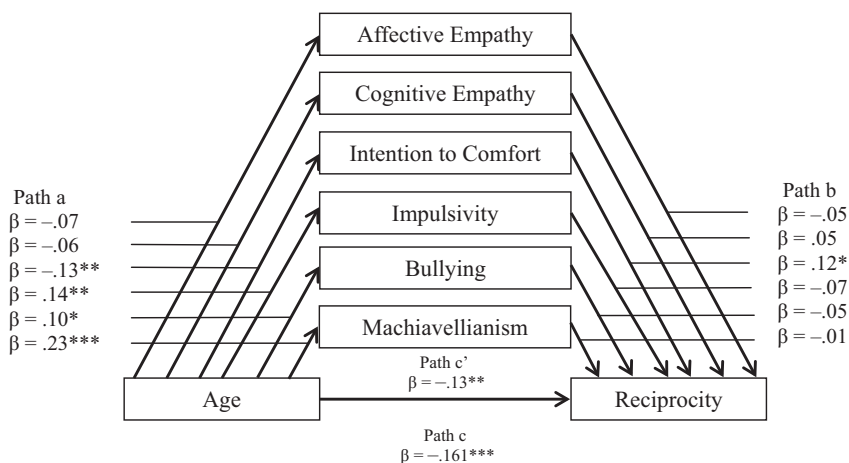


FIGURE 5 Mediation model for the effect of age on reciprocity via affective empathy, cognitive empathy, intention to comfort, impulsivity, bullying, and Machiavellianism, corrected for gender. Note: c = total effect, c' = direct effect. Values are standardized regression coefficients of direct effects, and asterisks indicate significant coefficients ($*p \leq .05$, $**p < .01$, $***p < .001$).

females. The discussion is organized along the lines of these findings.

Development of Trust and Reciprocity in Adolescence

In prior research, the development of trust and reciprocity in adolescence remained poorly understood (e.g., Eisenberg & Spinrad, 2014; Güroğlu et al., 2009). Studies using economic games, such as the Trust Game, in participants of varying age ranges were inconclusive about developmental changes in trust and reciprocity during adolescence (Derks et al., 2014; Fett et al., 2014; Güroğlu et al., 2014; Lemmers-Jansen et al., 2017; Sutter & Kocher, 2007; van den Bos et al., 2010). In this study, we observed that the average level of trust remained stable between ages 12 and 18 years, which is consistent with previous research demonstrating notable age-related increases in trust between childhood and adolescence (Sutter & Kocher, 2007; van den Bos et al., 2010), and less pronounced changes from adolescence into adulthood (Fett et al., 2014; Güroğlu et al., 2014). It should be noted that the inconsistency of results on trust and reciprocity development in prior research may be a consequence of the variety of Trust Game paradigms that have been used. For example, some studies have used one-shot Trust Games (e.g., in this study), but others used iterated multi-round Trust Games. Also, there have been differences between paradigms with regard to the number of rounds, the nature of interaction partners (computer versus real), having restriction of choice, and

whether participants received feedback or not. These differences may influence participants' decisions greatly. For example, decisions may be differently motivated or follow different norms when there are expected future interactions or when choices feel more real. The field would greatly benefit from a more expansive review of how these paradigm differences influence trust and reciprocity decisions.

Interestingly, we observed that males trusted more often than females. This is consistent with previous research by Derks et al. (2014) and Lemmers-Jansen et al. (2017), who also found that adolescent males are more likely to trust than females. Gender differences in trust may be explained by dissimilarities in how adolescent males and females evaluate the importance of equity and efficiency when making social decisions. A recent study with 8–18-year-old adolescents showed that males, compared to females, ascribe less importance to equity, but instead prefer efficient outcomes that maximize gains, which would in the current paradigm be reflected in trusting others (Meuwese et al., 2015). This is consistent with a sociocultural perspective on gender differences in trust decisions, in which male gender roles promote agentic (i.e., instrumental and efficient) behavior (Derks et al., 2014; Eagly, 2009; Lemmers-Jansen et al., 2017). Consistent with previous research, we observed no gender differences in general levels of reciprocity in adolescence (Fett et al., 2014; Sutter & Kocher, 2007; van den Bos et al., 2010). Regarding reciprocity development, we observed a general decrease in reciprocity between ages 12 and 18 years, which seems to

contradict previous findings showing increases in reciprocity in adolescence (Sutter & Kocher, 2007; van den Bos et al., 2010) or no age-related differences in reciprocity behavior (Fett et al., 2014). Our findings are, however, in line with a previous study that showed a negative relationship between age and reciprocity toward anonymous peers (Güroğlu et al., 2014). Consistent with previous research, reciprocity depended on the risk that the first player took to trust, and age-related changes in reciprocal behavior were context-dependent (see also van den Bos et al., 2010). That is to say, the percentage of reciprocity decisions was higher when the trustor took a high risk by trusting. Interestingly, this differentiation between risk conditions emerged over the course of adolescence, with largest differentiation in 15-year-olds, although this effect was not significant. This finding is in line with other studies that show increased sensitivity for social context in the Trust Game around the age of 15, which was also shown to be related to age-related changes in perspective taking (Güroğlu et al., 2014; van den Bos et al., 2011). Even though age-related decreases in reciprocity were observed across all risk levels, the decrease was smaller when there was either a high risk or no risk for the trustor, as compared to a medium risk. Surprisingly, the decrease in reciprocity decisions with reduced risk was not completely monotonic (i.e., consistently decreasing) across conditions. Together, these findings suggest that during adolescence there is a transition from general reciprocity to context-specific reciprocity. These findings fit well with prior research showing such a transition for social context, indicating that 9-year-old children do not yet differentiate between interaction partners when reciprocating trust, whereas older adolescents reciprocate more toward friends and less toward disliked others (Güroğlu et al., 2014). It should be noted that the current study was performed in a relatively homogeneous sample regarding the social background of participants; therefore, it will be important to extend these findings in future research to adolescents from more diverse backgrounds.

Malleability of Trust and Reciprocity in Adolescence

The next question we addressed was how individual differences in empathy, impulsivity, and antisocial behavior relate to trust and reciprocity during adolescence, while controlling for gender. First, we found no evidence that adolescents' trust decisions

were influenced by the aforementioned individual differences. This is somewhat surprising, given a previous study that showed that adolescents who score high on perspective taking demonstrate greater initial trust toward others (Fett et al., 2014), and a study that showed a positive association between impulsivity and trust in adolescence (Ibáñez et al., 2016). Perhaps these studies found different results because they used a different version of the Trust Game (Fett et al., 2014) or because they examined associations in a somewhat older sample (Ibáñez et al., 2016). Future research could aim to unravel these contradictory results. With regard to reciprocity, we examined whether individual differences mediated the age-related decrease in reciprocity. We found that intention to comfort was negatively associated with age, whereas impulsivity and Machiavellianism were positively associated with age. Inspection of separate correlations that were uncorrected for age suggested that individual differences in cognitive empathy, intention to comfort, impulsivity, bullying, and Machiavellianism were all associated with reciprocity. However, only intention to comfort was significantly associated with reciprocity when all individual differences were added to one comprehensive model—regardless of whether age was included in this model. In addition, only individual differences in intention to comfort mediated the age-related decrease in reciprocity. This suggests that the age-related decline in adolescents' reciprocity, which can be considered prosocial behavior, is associated with decreases in motivation to help and comfort others. It should be noted that, since this research is correlational, we cannot determine whether less prosocial behavior leads to less motivation or vice versa, or whether this relation is bidirectional. Interestingly, we found that the age-related decrease in reciprocity was mediated by intention to comfort, but not by affective and cognitive empathy. This finding aligns with previous research that has shown the importance of intentions or motivation for the actualization of prosocial behavior (Van Doesum, Van Lange, & Van Lange, 2013). Specifically, adolescents' motivations to comfort others may be crucial to their level of and development of prosocial behavior. An interesting question concerns whether these behaviors can be trained or fostered in adolescence (Crone & Dahl, 2012). Although not a main aim of this study, we also reported on the interrelatedness of risk levels and individual differences in empathy, impulsivity, and antisocial tendencies. Future research could further investigate these associations

and whether and how they interact in shaping adolescents' social decisions, such as decisions to trust and reciprocate.

Limitations and Future Directions

This study had several limitations. First, our study only examined adolescent development of trust and reciprocity toward anonymous peers and we did not examine inferences adolescents make about interaction partners based on their actions. Although it has been argued that the Trust Game with anonymous interaction partners is particularly suited to examine general levels of trust and reciprocity that underlie all forms of social interactions (van den Bos et al., 2010), recent studies have shown that it is important to take into account the influence of interaction partners, as the levels of trust and reciprocity differ depending on whom the participant is interacting with and the characteristics of the interaction partner (Güroğlu et al., 2014; Hillebrandt, Sebastian, & Blakemore, 2011; Lee, Jolles, & Krabbendam, 2016; van den Bos, van Dijk, & Crone, 2012). More generally, it has been shown that most adolescents' prosocial behavior toward family decreases or remains stable over time, whereas prosocial behavior toward friends increases from early to mid-adolescence (Güroğlu et al., 2014; Padilla-Walker et al., 2015).

An interesting venture for future research is thus to compare adolescent prosocial behavior toward various targets and to examine what characteristics of participants, their interaction partners, or the relationships between the two account for variations in prosocial behavior toward different targets. In addition, an interesting question for future research is to examine how trust and reciprocity change depending on the behavior of the other participant. In the current study, we eliminated learning effects by having participants make trust choices without receiving feedback, and as such these choices should be considered to be a decision-making process instead of a social learning process. However, other designs have tested these learning effects and suggest that adolescents adapt their behavior to the behavior of the other player (Fett et al., 2014; van den Bos et al., 2012).

Second, our study used a cross-sectional design to examine age differences in trust and reciprocity behavior. Although this approach is informative for understanding trust and reciprocity development, especially because it takes into account how context and individual differences shape development, longitudinal studies are needed to gain more

insight into how these behaviors change within individuals over time. It would be particularly important to study how various individual differences interact to shape prosocial motivations, and in what circumstances this will translate to actual trust and reciprocity behavior.

Relatedly, there are several ways to explore development, including using various levels of measurement for age, or examining puberty-instead of age-related development. This study aimed to map the developmental story of trust and reciprocity in adolescence by analyzing age using several measurement levels. It is possible that puberty or other operationalizations of development may shed additional light on trust and reciprocity development, and as such future research on this subject is warranted. Fourth, in the Trust Games where they played as trustees, participants were only presented with trusting others. This may have increased positive feelings toward the anonymous others' in those rounds, as compared to the rounds in which the participant played as trustor and where they received no information about the trustee's social decisions.

Finally, because economic games are relatively controlled laboratory paradigms, it is important that such measures are externally valid to ensure that they are informative to real-life prosocial development. Reassuringly, several studies demonstrated associations between economic games, including the Trust Game, and both actual and self-reported real-life prosocial behaviors (e.g. Franzen & Pointner, 2013; van den Bos, van Dijk, Westenberg, Rombouts, & Crone, 2009), pointing toward external validity of the Trust Game.

CONCLUSION

To conclude, the present study used a large sample with a wide age range to examine the development of trust and reciprocity in the relatively understudied period of adolescence. The results underscore the importance of context and individual differences in explaining apparently conflicting findings on the level and development of adolescents' social and prosocial behavior. Age-related differences and individual difference measures were mostly related to reciprocity, suggesting that this is the more malleable and sensitive social behavior in the Trust Game. Additionally, our findings suggest that adolescence is an important period for the transition from general reciprocity to more specific reciprocity, which is an important ability for adolescents to acquire as they are exposed (and even actively seek

out) more diverse social environments and relationships, which they, respectively, have to successfully navigate and maintain (Crone & Dahl, 2012; Padilla-Walker & Carlo, 2014). Whereas initial studies on prosocial behavior in adolescence (which mainly employed self-reports) merely provided descriptions of its developmental patterns, recent studies, such as the present one, using both self-reports and economic games, suggest that such descriptive studies are insufficient to understand the development of this complex behavior. A better conceptualization of how adolescents' sensitivities to varying contexts and individual differences influence their motivations to display prosocial behaviors, including trust and reciprocity, will be an important step toward understanding how to improve this behavior and its associated benefits in adolescents.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. Analysis examining the development of trust behavior not collapsed over ages 16–18.

Appendix S2. Normality and reliability for each subscale of the individual difference measures.

Appendix S3. Correlations between age, gender, trust and reciprocity scores, and individual difference measures.

Appendix S4. Non-parametric analyses regarding the percentage of trust and reciprocity scores, age, and gender.