Adolescent indirect reciprocity: Evidence from incentivized economic paradigms

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ABSTRACT

Introduction: Indirect reciprocity serves as a crucial component of how we interact with strangers. Two types of indirect reciprocity can be distinguished: pay-it-forward reciprocity and third party reciprocity. Pay-it-forward reciprocity refers to behaviors where people who have been treated well by others (either fairly or generously), extend that fairness or generosity to a stranger. Third-party reciprocity refers to behaviors where third-party bystanders altruistically punish those who transgress against others or kindly help the victims. The expansion of adolescents' social world increases opportunities to exercise indirect reciprocity yet very little research has focused on this topic in this age group. The current research addresses this lacuna and investigates how younger adolescents differ from older adolescents in pay-it-forward and third party reciprocity.
Methods: With incentivized economic paradigms, we investigated both types of indirect reciprocity in younger ($n = 50$) and older adolescents ($n = 46$).
Results: The pay-it-forward task revealed that receiving an equal (vs. unequal) distribution led both younger and older adolescents to become fairer to a third person. In the third-party task, older adolescents were more likely to devote their own resources to enforce fairness norms than younger adolescents.
Conclusion: Our results shed light on how adolescents perceive and act in complex social settings where direct reciprocity is unrealistic. Both younger and older adolescents are capable of engaging in both forms of indirect reciprocity with older adolescents being more discriminative in their norm-enforcing behaviors.

1. Introduction

Across adolescence, individuals gain autonomy to explore the social world extending adolescents' social experiences beyond the family context (Koepke & Denissen, 2012). While this expansion often involves spending more time with peers, adolescents also expand their social connection to a large-scale network that goes beyond peers to wider communities and the civic society (Smetana, Campione-Barr, & Metzger, 2006; Yates & Youniss, 1996). Moreover, the internet and social media platforms allow for a wide range of possibilities of interacting with both known and unknown others. In the context of these opportunities, it is important to

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investigate the development of behavior towards strangers. One crucial component of how we interact with strangers is indirect reciprocity. Despite its importance, indirect reciprocity is poorly studied in the field of adolescence research.

Indirect reciprocity is commonly observed in human beings and is regarded as a special type of altruism (Kurzban, Burton-Chellew, & West, 2015). Two types of indirect reciprocity can be distinguished: pay-it-forward reciprocity and third-party reciprocity (Fehr & Fischbacher, 2004a, 2004b; Nowak & Sigmund, 2005). Pay-it-forward reciprocity refers to behaviors where people who have been treated well by others (either fairly or generously), extend that fairness or generosity to a third person (Gray, Ward, & Norton, 2014). Although its evolutionary mechanism is unclear, pay-it-forward reciprocity may be explained by two potential mechanisms. The first explanation is rooted in the broaden-and-build theory of positive emotions (Fredrickson, 2004). This theory proposes that people being treated fairly may experience positive emotions such as gratitude, which could broaden the beneficiary's perspective towards others. This, in turn, encourages the person to pass on the fairness to someone else (Chang, Lin, & Chen, 2012; Nowak & Roch, 2007). The second mechanism draws from the theory of social learning (Bandura, 1969, 2014, pp. 69–128) and is simply these behaviors reflect mimicry of behaviors from moral exemplars. As an essential way to transmit fairness norms or kindness, pay-it-forward reciprocity is particularly important in modern societies characterized by great mobility and extensive transactions among strangers (Nowak & Sigmund, 2005).

Third-party reciprocity usually means that when witnessing an unfair distribution between two strangers, the anonymous un-affected third-party bystanders are willing to sacrifice their own resources to punish the unfair distributor (Fehr & Fischbacher, 2004b). In a broader sense, third-party reciprocity also includes the circumstance that bystanders restore the norm via helping (or compensating) the victim (Darley & Pittman, 2003; Leliveld, Dijk, & Beest, 2012; van Prooijen, 2010). Unlike pay-it-forward reciprocity, third-party reciprocity (especially punishment) is evolutionarily more meaningful such that it serves important social functions, such as maintaining fairness norms (Fehr & Fischbacher, 2004b), fostering cooperation via deterring norm violations (Nowak & Sigmund, 2005), and signaling trustworthiness (Jordan, Hoffman, Bloom, & Rand, 2016). This selfless norm-enforcing behavior might be driven by inequality aversion (Falk, Fehr & Fischbacher, 2003; Fehr & Fischbacher, 2004a; 2004b), which automatically arouses negative affective reactions and motivates norm-enforcing behaviors.

To the best of our knowledge, previous research on pay-it-forward reciprocity has predominantly focused on adults. Regarding third-party reciprocity, while the majority of previous studies focused on adults, recent studies have begun to investigate early indicators of third-party punishment among children. For instance, 6 and 8 years olds start to costly punish unequal distributors when they themselves are the victims while 8-year-olds are also willing to do so as unaffected bystanders (Jordan, McAuliffe, & Warneken, 2014a,b; for a review, see; McAuliffe, Blake, Steinbeis, & Warneken, 2017).

However, little is known regarding indirect reciprocity during the critical period of adolescence (but see Will, Crone, van den Bos, & Güroğlu, 2013). This is surprising given that adolescence is a crucial life period when individuals actively explore their identities, including moral identity (Erikson, 1994). Moral identity has been associated with a wide range of prosocial behaviors across the lifespan (Hardy & Carlo, 2011). Moreover, adolescents demonstrate not only continuity but also important uniqueness in psycho-social development. On the one hand, general cognitive functions (e.g., executive functions) as well as social-specific functions (e.g., perspective-taking skills) are necessary for indirect reciprocity. These abilities continue to develop rapidly throughout adolescence (Eisenberg, Morris, McDaniel, & Spinrad, 2004), suggesting developmental continuity from childhood to adulthood. On the other hand, literature from the field of personality psychology has repeatedly shown a disruption in personality maturation from late childhood to early adolescence. That is, early adolescence seems to show a lifetime dip of two personality traits that are closely related to prosocial behaviors – agreeableness and conscientiousness ("the disruptive hypothesis"; Luan, Hutteman, Denissen, Asendorpf, & van Aken, 2017; Soto, John, Gosling, & Potter, 2011; Soto & Tackett, 2016). Therefore, adolescence is a promising period for attitude and behavior changes (Mistry, Brown, Chow, & Collins, 2012). Studying age differences in adolescent indirect reciprocity could not only contribute to our understanding towards its underlying developmental mechanisms, but also inform educational policy-making and intervention programs directed at fostering responsible citizenship.

1.1. The present study

The present study investigated both forms of indirect reciprocity – pay-it-forward reciprocity (Gray et al., 2014) and third-party reciprocity (Fehr & Fischbacher, 2004b) in younger and older adolescents. We also explored the potential effects of meaningful demographic variables (i.e., gender and only-child status) on indirect reciprocity. Notably, both types of indirect reciprocity were measured by incentivized economic paradigms designed to capture behaviors with real monetary consequences (i.e., adolescents' decisions influenced their final payoffs). This method approximates the real world and shows higher external validity than tasks that assess hypothetical tendencies (Camerer & Mobbs, 2017).

Regarding pay-it-forward reciprocity, we expected that being fairly treated by a stranger (i.e., receiving an equal monetary distribution) would increase adolescents' subsequent distributive fairness towards an innocent new person. Regarding third-party reciprocity, we expected adolescents, as unaffected bystanders witnessing unfair situations, to devote personal resources in restoring fairness (either by helping victims or by punishing transgressors). Moreover, based on the disruption hypothesis of personality maturation (during late childhood to early adolescence) and increases in executive function during adolescence (Selman, 1980; Soto & Tackett, 2016), we expected that older adolescents would distribute more fairly to a third person than younger adolescents when being treated equally (vs. unequally). We also hypothesized that older adolescents would be more likely to engage in restoring fairness than younger adolescents when perceiving self-irrelevant inequality.

2. Method

2.1. Participants

Ninety-six adolescents from northwestern China (younger adolescents: n = 50, 24 boys, age = 14.18 ± 0.39; older adolescents: n = 46, 24 boys, age = 16.98 ± 0.65) participated in two indirect reciprocity tasks (within-subject design). The sample size was determined by a priori power analyses in G*Power (Faul, Erdfelder, Lang, & Buchner, 2007). Because there was no literature directly comparable to our design, expected effect size was based on the most relevant publication, namely Will et al. (2013; page 2240, interaction between recipient and age group, $F(8, 236)$ = 4.78, p < .001). The corresponding effect sizes were η^2 = 0.14, indicating a medium to large size. Based on this effect size, power analysis showed that reaching 80% statistical power (α = 0.05) required total N = 51. We followed this suggestion and decided to collect at least 90 participants and employ a within-subject design.

All participants were of Chinese nationality, with Chinese as their mother language. Only-children constituted 59.4% of the sample, with another 32.3% having one sibling, 7.3% two siblings, and 1% three siblings. With regards to the educational background of participants' parents, in total 45.9% of fathers and 32.3% of mothers had attended college, and 95.8% of fathers and 90.6% of mothers had at least a secondary school education. Household monthly income was below 3000 CNY for 6.3% of the sample (i.e., below 483 USD), 30.2% was within 3000–5000 CNY (i.e., 483–806 USD), 36.5% was within 5000–8000 CNY (i.e., 806–1290 USD), 20.8% was within 8000–12,000 CNY (i.e., 1290–1935 USD), and 6.3% was above 12,000 CNY (i.e., above 1935 USD), indicating a representative sampling. The current project, Socio-Economic Decision-Making during Adolescence, was approved by the University Committee on Human Research Protection (protocol number: HR2016/11048). Both participants and their parents signed consent forms, and participants were debriefed after the experiment.

2.2. Procedure

Experiments were conducted in classrooms, with the presence of trained experimenters explaining instructions and payoffs. Experimenters emphasized strict confidentiality, encouraged honest responses, and communication between participants was prohibited. To ensure that participants understood the instructions, they were only allowed to start the task once they had correctly answered a series of comprehension questions (10–15 questions per task). Each participant completed two target tasks (i.e., the pay-it-forward task and the third-party task) and another filler task.[2] Once completed, participants filled out a battery of questionnaires.[3] All tasks were presented in a pen-and-paper format. Monetary units (MU; 1 MU = 0.1 CNY ≈ 0.02 USD) were used in both tasks. Within two weeks after the experiment, participants received cash in sealed envelopes with the amount given based on their decisions in randomly chosen trials.

Pay-it-forward task. The pay-it-forward task (Gray et al., 2014) included two rounds, one in which an equal distribution of money was given (20/20 MU) and one in which an unequal distribution was given (35/5 MU), with each round consisting of two games (see Fig. 1a). In Game 1, participants received either an equal or unequal money distribution from Player X (i.e., 20/20 or 35/5 MU respectively) with the order of the two conditions (i.e., unequal and equal) counterbalanced across participants. In Game 2, participants were endowed with 40 MU and asked to indicate the amount of money they would like to allocate to a new player (Player Y; 0–40 MU). Lastly, participants rated the unfairness level of the split received from Player X on a 9-point Likert scale (0 = *extremely fair*, 4 = *unfair*, 8 = *extremely unfair*). Participants were told that Players X and Y were students from other schools who were not paired with any other participants. They were also told that Players X in the two rounds were different persons, and so were Players Y. There was no time limit for their responses.

Third-party task. We adopted a modified version of the third-party punishment game (Fehr & Fischbacher, 2004b) that has been employed in previous research (David, Hu, Krüger, & Weber, 2017; Hu et al., 2016; Hu, Strang, & Weber, 2015; Leliveld et al., 2012). The game included three roles (see Fig. 1b), namely the distributor (Player A), the recipient (Player B), and the bystander (participants), and consisted of two stages. Similar to the pay-it-forward task, participants were told that Player A and Player B were students from other schools (but different from those in the pay-it-forward task), who were not paired with any other participants.

The task procedure was as follows. In Stage 1, participants were told that a Player A had already split 40 MU with a Player B. But they were not informed of how much Player A allocated to Player B. Stage 2 included two rounds. In each round, first, participants received an endowment of 40 MU. Second, they were asked to respond given one of the two scenarios in Stage 1, namely Player A distributed money to a Player B either equally or unequally (i.e., 20/20 or 35/5 MU respectively; the "strategy method", see Brandts & Charness, 2011; Jordan, McAuliffe, & Warneken, 2014a,b). Third, participants chose one decision from three options: decrease A's

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[2] Besides the two target tasks of indirect reciprocity and demographic information reported in the present manuscript, we also performed a filler task which measured adolescents' altruism behaviors via the Dictator Game (Kahneman, Knetsch, & Thaler, 1986). In this task, participants were endowed with a certain amount of monetary units (MU), and were asked how many MU they would like to share with an anonymous in other schools. This task aims to hide the main goal of the whole study and helped participants to better understand the scenarios in the two target tasks. Participants received the filler task or the pay-it-forward task either first or second (in a counterbalanced order) and then they completed the third-party task. Due to its relatively complex scenario, the third-party task was always given last in order to ensure that the participant understood the task properly.

[3] In the post-task questionnaire, we additionally measured trait empathy via a modified Chinese version of Interpersonal Reactivity Index (Davis, 1983) by Zhan (1987). Because of the focus and scope of the manuscript (i.e., indirect reciprocity), we did not include these measures. However, additional information could be obtained from the first author upon request.
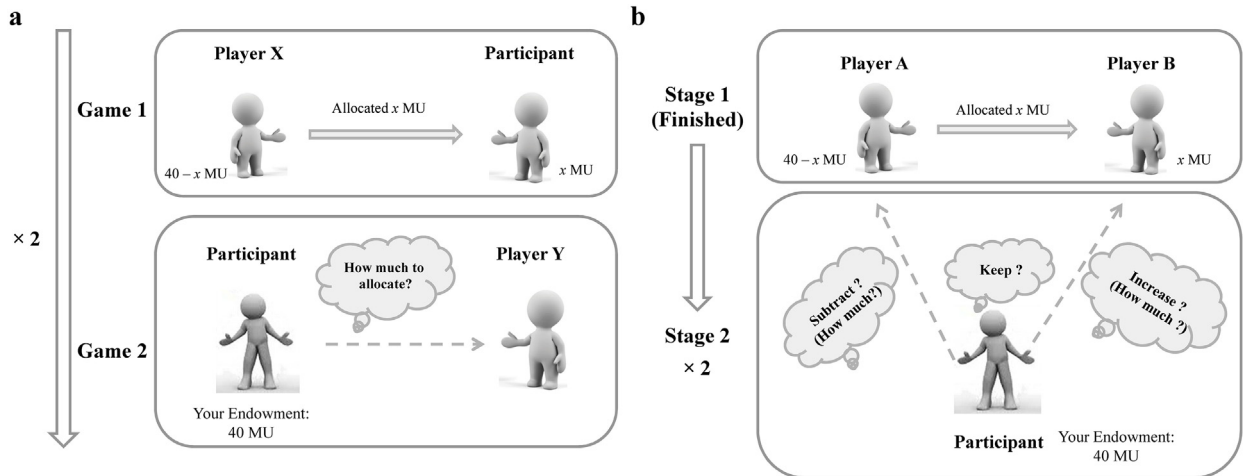
a

b

Fig. 1. (a) Procedure of the pay-it-forward task; (b) Procedure of the third-party task.

payoff (i.e., punish A) or increase B's payoff (i.e., help B) at a personal monetary cost, or keep their money and do nothing. If participants chose to engage (either by punishing A or by helping B), they were asked to further indicate the amount of the money they would spend on punishing/helping (i.e., ranging from 1 to 40 MU, with 1 MU as the changing unit). Consistent with previous research, for an investment of 1 MU, the offenders' payoffs would be reduced by 3 MU or the victims' payoffs would be increased by 3 MU (Fehr & Fischbacher, 2004b; Leliveld et al., 2012). The order of the distribution condition (i.e., unequal and equal) in Stage 2 was counterbalanced across participants. Lastly, participants rated the unfairness level of the money split made by Player A on a 9-point Likert scale (0 = *extremely fair*, 4 = *unfair*, 8 = *extremely unfair*). Again, there was no time limit for responses.

2.3. Analytic strategy

Data analyses were conducted in STATA 13.0 (Stata Corp., College Station, TX, US). All participants were included in analyses. There was only one missing observation in our sample (i.e., in the unfairness rating of the pay-it-forward task), and this case was excluded in relevant analyses. To ease interpretation, in both tasks the transferred percentage (i.e., the ratio between the transferred amount and the 40 MU endowment) rather than the absolute amount was used in all analyses.

Our general statistical approach was to adopt linear regressions with transferred percentage or unfairness rating as dependent variables. For choice data in the third-party task, logistic regression was performed. The categorical predictors of interest were coded as dummy variables, namely *split* (0 = equal, 1 = unequal in the third-party task; 0 = unequal, 1 = equal in the pay-it-forward task; in this way the control condition for each task was coded as 0) as well as *age group* (0 = younger adolescent, 1 = older adolescent). Our procedure was as follows: 1) we first created a model with *split* and *age group* as predictors to check the main effects of both predictors (i.e., the *main-effect-only* model); 2) To further examine the interaction effect, we then added the *split × age group* interaction term (i.e., the *full* model). For the robustness check, we ran the same regression analyses with gender (0 = boys, 1 = girls), and only-child status (0 = no, 1 = yes) as covariates. Due to the use of repeated measurements (i.e., a within-subject design), robust standard errors (SEs) were calculated to account for the violation of independence assumption (Hayes & Cai, 2007). Research data and code for data analyses are available upon request from the first author. All reported *p* values are two-tailed and *p* < 0.05 was considered statistically significant unless a special note. For summaries of descriptive statistics and correlations between all predictors in regression analyses for both tasks, see Tables S1 and S2 of the online supporting information.

3. Results

3.1. Pay-it-forward reciprocity

Manipulation check. As expected, the unequal split was rated as more unfair than the equal split (*b* = − 2.83, *p* < .001, β = − 0.56; see Table S3 for details).

Distribution to a new player. As shown in Fig. 2a, we only observed that after receiving an equal (vs. unequal) distribution from Player X, participants distributed significantly more to the next person (Play Y; *b* = 0.07, *p* < .001, β = 0.22; see Table S4 for details).

3.2. Third-party reciprocity

Manipulation check. As expected, participants rated the unequal split as more unfair than the equal split (*b* = 3.35, *p* < .001, β = 0.66; see Table S5 for details).
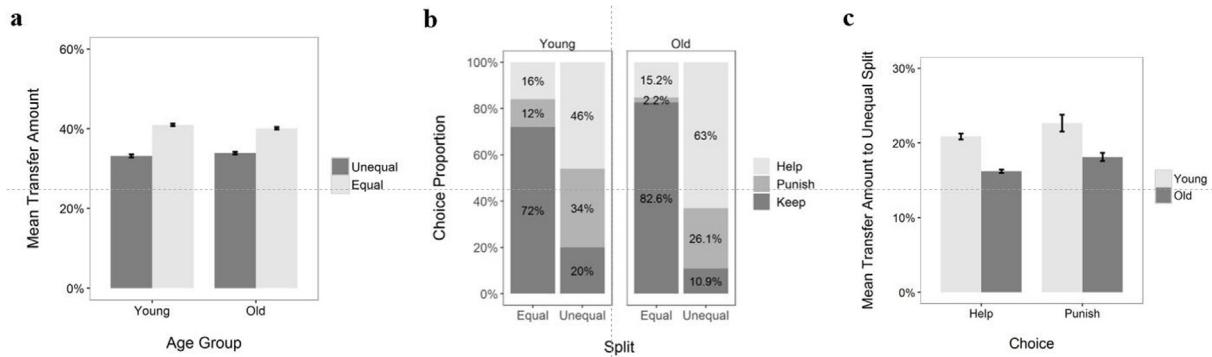
Fig. 2. (a) Mean transfer amount (%) in the pay-it-forward task ($n_{younger} = 50$, $n_{older} = 46$; Error bars indicate standard errors); (b) Choice proportion (%; $n_{younger} = 50$, $n_{older} = 46$) in the third-party task; (c) Mean transfer amount (%) to the unequal split condition (i.e., 35/5) in the third-party task (For analyses on help/punishment choice, $n_{younger} = 23/17$, $n_{older} = 29/12$; Error bars indicate standard errors).

Costly engagement vs. doing nothing. Participants in general are more likely to engage in the unequal split condition ($b = 2.33$, odds ratio = 18.17, $p < .001$). We also found a significant *split* × *age group* interaction effect ($b = 1.33$, odds ratio = 3.97, $p_{(one-tailed)} = .033$[4]), i.e., older adolescents significantly engaged more than younger adolescents in the unequal split condition (89.1% vs. 80.0%); whereas they engaged less than younger adolescents in the equal split condition (17.4% vs. 28.0%; see Fig. 2b). The robustness check further revealed that only-children were less likely to costly engage in restoring fairness than those with siblings ($b = -1.08$, odds ratio = 0.34, $p = .013$; see Table S6 for details).

Costly engagement: helping vs. punishing. By taking a close look at the costly engagements, we found a marginal significant main effect of *age group* ($b = 0.75$, odds ratio = 2.16, $p = .099$), such that compared to younger adolescents (helping vs. punishing: 57.4% vs. 42.6%), older adolescents showed a greater preference for helping victims over punishing distributors (73.5% vs. 26.5%). The robustness check surprisingly showed that boys (vs. girls) showed a greater preference for helping victims over punishing distributors ($b = -1.28$, odds ratio = 0.28, $p = .006$; see Table S7 for details).

Investment in punishing unfair distributors/helping victims.[5] As shown in Fig. 2c, we only found that younger adolescents invested significantly more money helping victims of unfair distributions than did older adolescents ($b = -0.05$, $p = .041$, $\beta = -0.29$; see Table S8 for details).

4. Discussion

The present study investigated two types of indirect reciprocity in adolescence using incentivized economic paradigms. As the first study on adolescents, we extended prior research predominantly based on adults by showing that adolescents also forwarded fairness and devoted their own resources in norm-enforcing behaviors, even when direct reciprocity was impossible and their reputation remained unknown. Moreover, the present study demonstrated important demographic factors that are meaningfully associated with indirect reciprocity.

4.1. Pay-it-forward reciprocity in adolescence

As expected, receiving a fair distribution from a stranger led both younger and older adolescents to subsequently make fairer distributions to another stranger. This effect was not subject to other demographic covariates. This result suggests that pay-it-forward reciprocity emerges by early adolescence. This form of indirect reciprocity is important for modern society characterized by high mobility and frequent transactions among strangers. Direct reciprocity is often not possible since recipients may not encounter their distributors again. However, distributors would be motivated to behave fairly in a single-shot transaction when they know that fair behaviors may transmit among people; that is, they too eventually might benefit from the kindness of strangers. Thus, paying-it-forward seems common among both younger and older adolescents.

The present findings provide the first empirical evidence of pay-it-forward reciprocity in an adolescent sample which could be explained by both the broaden-and-build theory of positive emotions (Fredrickson, 2004) and social learning theory (Bandura, 1969, 2014, pp. 69–128). Supporting the broaden-and-build theory, previous studies have revealed the emergence of gratitude in early adolescence (Froh, Yurkewicz, & Kashdan, 2009). In addition, there is rich evidence for social learning theory by demonstrating the importance of peers in the development of moral reasoning and prosocial behaviors in adolescence (Choukas-Bradley, Giletta, Cohen, & Prinstein, 2015; Eisenberg et al., 2004; van Hoorn, van Dijk, Meuwese, Rieffe, & Crone, 2016).

Thus, it may be beneficial for educational practitioners to pay more attention to the school environment and interpersonal

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[4] We used one-tailed significance test here as it was a hypothesis-driven test.

[5] For this specific analysis, we focused on the unequal split condition because few participants choose to either help ($n_{younger} = 8$, $n_{older} = 7$) or punish ($n_{younger} = 6$, $n_{older} = 1$) in the equal split condition.

experiences of adolescents, given that personal experience influences adolescents' own behaviors in important ways and may further spread across networks. Previous research has shown that interpersonal behavioral cascades could be as powerful as three degrees of separation (i.e., from A to B to C to D; Fowler & Christakis, 2010). Therefore, whenever necessary, interventions should be provided to stop the transmission of unfair behaviors among adolescent networks and boost fair behaviors.

4.2. Third-party reciprocity in adolescence

We found that more than 80% of the adolescents in our sample were willing to devote their own resources to enforce fairness norms when witnessing an unequal distribution between two strangers. This result is in line with previous findings in adults (Leliveld et al., 2012; Lotz, Okimoto, Schlösser, & Fetchenhauer, 2011). Such norm-enforcing behavior is unlikely to be motivated by direct reciprocity because adolescents knew that their interaction with the people involved was single shot and their reaction would only affect their own payoff and remain anonymous. Moreover, as predicted, costly engagements in norm-enforcing behaviors were more likely to appear among older adolescents than younger adolescents. This is consistent with the disruption hypothesis of personality maturation during early adolescence (Luan et al., 2017; Soto & Tackett, 2016). It also aligns with previous findings that indirect reciprocity-related executive functions (e.g., perspective-taking) increase during adolescence (Selman, 1980).

Taking a closer look at costly engagements, we found that older adolescents, compared to younger adolescents, showed a greater preference for engaging by *helping* the victim rather than *punishing* the distributor. This might be due to the socialization of culturally appropriate behaviors in resolving conflicts (for a review, see Chen & French, 2008). Chinese culture greatly values maintaining relationship harmony and avoiding overt conflicts. Therefore, helping the victim would represent a more socially appropriate solution than punishing the distributor, at least in Chinese culture. According to the contextual-developmental perspective (Chen & French, 2008), older adolescents might internalize Chinese cultural norms (e.g., avoid direct conflicts) more deeply than younger adolescents, and thus would show a greater preference for restoring fairness in a peaceful manner (i.e., helping the victim). However, this explanation awaits further investigation with a cross-cultural design.

Besides these age-related differences, adolescents with diverse demographic characteristics varied in their norm-enforcing behaviors. First, adolescents with siblings were more likely to costly engage in norm-enforcing behaviors than their counterparts who grew up as only-children. This result echoes previous findings on personality differences between only-children and children with siblings (Cameron, Erkal, Gangadharan, & Meng, 2013). Since our findings controlled for gender, these results strongly indicate the important role of siblings in the development of indirect reciprocity. From a practical point of view, our results also provide support for the "two-child policy" recently launched by the Chinese government. This policy might not only improve the balanced development of the population but also reduce the social problems brought up by the generation of only-children, such as less mutual trust with others which may lead to worse interpersonal relationship (Cameron et al., 2013).

Intriguingly, boys showed a stronger preference than girls for engaging in restoring fairness by helping the victim rather than punishing the distributor. Although in general adolescent girls are more likely to show prosocial behaviors than boys (Hastings, Utendale, & Sullivan, 2007), such a gender effect seems to depend on the context (Brittian & Humphries, 2015). For instance, adolescent boys report more helping behavior in public situations compared to girls (Carlo & Randall, 2002). More relevantly, a study on justice sensitivity in children and adolescents found girls to show higher justice sensitivity than boys, especially from an observer perspective (Bondü & Elsner, 2015). Such observer-perspective justice sensitivity has been shown to be positively associated with third-party punishment behaviors in adults (Lotz, Baumert, Schlösser, Gresser, & Fetchenhauer, 2011). Therefore, the gender difference in engagement preference (i.e., help or punish) we found in adolescents might be driven by gender differences in justice sensitivity. Future studies are needed to test this explanation.

4.3. Limitations and future directions

Despite the strengths of employing incentivized economic paradigms to test actual behaviors in an understudied age group, several caveats regarding the present investigation need consideration. First, our study is cross-sectional. Although age-related differences were found while accounting for several demographic factors, future longitudinal studies are needed to shed more light on the developmental trajectory of indirect reciprocity across the lifespan.

Moreover, our study sparks other interesting research questions for future studies (not limited to the adolescent sample), which cannot be addressed by the present design. For instance, future studies could include a direct measure of gratitude to examine the role of gratitude in driving adolescents' pay-it-forward reciprocity. Additionally, future studies could include a non-social control condition (e.g., receiving money from a computer rather than a person) to rule out the possibility that the positive affect is simply driven by receiving more money (rather than intention-based gratitude derived from receiving money from a stranger).

Another intriguing question deserving further investigation is the relationship between these two types of indirect reciprocity. One potential research avenue is to adopt a parametric design together with computational modelling. This approach has been recently introduced in developmental studies of decision making (Davidow, Insel, & Somerville, 2018; Hauser, Will, Dubois, & Dolan, 2019; Palminteri, Kilford, Coricelli, & Blakemore, 2016). More specifically, future studies could include multiple rounds that distinguish the inequality level in small steps, instead of polarizing two conditions as equal or unequal. Regarding the analysis, researchers might adopt economic utility functions (i.e., computational models), which include the unknown parameters describing the latent subcomponents (e.g., inequality aversion) of each type of indirect reciprocity (Hu et al., 2018; Zhong, Chark, Hsu, & Chew, 2016). By fitting the models to the real behaviors with various estimation approaches, researchers might obtain one parameter for each type of indirect reciprocity for each participant, and then build up the link between these parameters.

In addition, future studies could extend this research by considering the effects of other social and cultural characteristics. For instance, future studies could examine these behaviors in individuals varying by social status, such as popularity among peers and teachers, as it is crucial for society to ensure that those in powerful positions are dedicated to maintaining cooperative societies and reducing economic inequality. In addition, participants in the present study grew up in Chinese culture, where maintaining harmonious relationships and avoiding conflict is at the heart of cultural values. It would be interesting for future studies to examine cross-cultural similarities and differences in the development of indirect reciprocity. For example, future studies could test whether Chinese adolescents, as unaffected third parties in unfair situations, prefer costly compensation over punishment to a greater extent than their western counterparts.

5. Conclusion

The rapid expansion of the social world during adolescence requires the development of complex social skills including both pay it forward and third party (indirect) reciprocity. To our knowledge, our study was the first to investigate both types of indirect reciprocity during the critical period of adolescence using incentivized economic paradigms. By showing how age, gender and the lack of siblings is associated with differences in indirect reciprocity among adolescents, the present study sheds light on the proximal mechanisms underlying indirect reciprocity from a developmental perspective. Moreover, these results have practical implications for educational practitioners. Promoting indirect reciprocity in adolescents at school (e.g., by setting up opportunities that cultivate civil responsibility, such as having students participate as jury members in mock courts cases or setting up special pay-it-forward days) could be one way to facilitate adolescents' development regarding (fairness or justice) norms and kindness during this crucial developmental period.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.adolescence.2019.06.010.

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