Journal of Experimental Child Psychology 150 (2016) 285–300

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

# Do sex and age affect strategic behavior and inequity aversion in children?

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ARTICLE INFO

*Article history:*
Received 23 November 2015
Revised 21 May 2016

*Keywords:*
Ultimatum game
Fairness
Inequity aversion
Strategic behavior
Sex
Children

ABSTRACT

The ultimatum game is commonly used to explore fairness in adults in bargaining situations. Although the changes in responses that occur during development have been investigated in children, the results have been mixed. Whereas some studies show that proposers offer more when they grow older, others indicate the opposite. Moreover, these studies are outcome-based and leave intentions out of the scene, although intentions play a relevant role in daily life. The mini-ultimatum game offers the opportunity to test both outcomes and intentions, but one major obstacle for accurately pinpointing developmental transitions in strategic behavior and inequity aversion so far has been the multiple confounds that have plagued previous studies, including different methods, small sample sizes, and reduced age differences. We administered an anonymous direct-method one-shot mini-ultimatum game to 478 6- and 10-year-old children. Strategic behavior was present at 10 years of age; older participants matched more accurately what responders would accept than younger participants. However, this was true only for older girls. No sex differences were detected in younger children. No age group seemed to consider the proposer's intentions given that the rejections of the default option were not significant across conditions. Both disadvantageous and advantageous inequity aversions were present in 6-year-olds. However, older children exhibited significantly more disadvantageous inequity aversion than younger children. This contrast made the pattern of rejection

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http://dx.doi.org/10.1016/j.jecp.2016.05.011

of 6-year-olds look more similar to the pattern of rejection found in adults. No sex differences were found in responders' behavior.


## Introduction

Fairness is an important consideration when interacting with others, particularly when resource distribution or the provision of services is involved. When sharing resources, fairness can be construed from a purely selfish perspective (the largest share for me). However, when reaching an agreement between donor and recipient is necessary, fairness for the donors should include their partners' outcomes (equal/similar for both), whereas fairness for the recipients should consider outcomes with the interplay of the donors' intentions (the best option available, although unequal for both) (Blake, McAuliffe, & Warneken, 2014; Falk & Fischbacher, 2006). Recent years have seen great interest in tracing the development of fairness in children, particularly in relation to strategic behavior (donors) and inequity aversion (recipients) (e.g., Blake et al., 2015; Camerer, 2003; Sally & Hill, 2006; Shaw & Olson, 2012).

From a donor's perspective, strategic thinking (i.e., making different offers depending on a recipient's options and social influence) can be beneficial from material (rewards) and social (reputation) perspectives. However, strategic thinking does require certain perspective-taking abilities to consider another person's view (Harbaugh, Krause, & Liday, 2003; Takagishi, Kameshima, Schug, Koizumi, & Yamagishi, 2010) and even the ability to incur some costs to close a deal. This means that the underlying concept of fairness should deviate from a purely selfish perspective to include some consideration of the partner's outcomes. Even though already at 3 years of age children understand others' desires (Rakoczy, Warneken, & Tomasello, 2007) and from 4 years onward are capable of incurring a cost in sharing games (Moore, 2009), strategic thinking seems to appear later in development, between 6 and 13 years of age (Harbaugh et al., 2003; Leman, Keller, Takezawa, & Gummerum, 2009; Steinbeis, Bernhardt, & Singer, 2012) or even later when donors need to extract information from the recipient's earlier choices (Harbaugh, Krause, & Vesterlund, 2007).

From a recipient's perspective, acceptance of non-zero offers are beneficial whereas rejection of offers that are considered too low can reduce both the appearance of weakness (reputation) and the promotion of future cooperation (Fehr & Fischbacher, 2003; Fehr & Gächter, 2000). Disadvantageous inequity aversion is defined as the willingness to sacrifice material payoffs for the sake of greater equality when the partner is obtaining more than oneself (Fehr & Schmidt, 1999). Infants expect equal distributions (Schmidt & Sommerville, 2011; Sloane, Baillargeon, & Premack, 2012) and show negative emotions when peers obtain more than they do (LoBue, Nishida, Chiong, DeLoache, & Haidt, 2011). Indeed, recent studies have shown that children from 4 years of age onward are willing to pay a cost to prevent others from receiving more than they receive (Blake & McAuliffe, 2011; Sheskin, Bloom, & Wynn, 2014) and may even act spitefully (McAuliffe, Blake, & Warneken, 2014; Sheskin et al., 2014). These rejections in one-shot games have been explained by a strong bias to social comparison, so that children seek a relative advantage over their partners at least until preadolescence (Blake et al., 2014). Interestingly, rejections can also be motivated by advantageous inequity aversion, that is, rejecting a better offer than the partner. In this case, however, it seems that this type of inequity aversion appears later in development (around 8 years of age; Blake & McAuliffe, 2011; McAuliffe et al., 2014) compared with disadvantageous inequity aversion.

Most of the studies mentioned earlier were outcome-based, thereby leaving the players' intentions out of the picture. Typically, the experimenter presented an unfair distribution to the participants and measured their responses. Thus, the underlying concept of fairness for the recipients could be based only on the partner's outcomes. Intentions, however, can play an important role in the donor's offer and the recipient's decision to accept or reject an offer. For example, in front of two unequal offers, recipients might not reject if they know that donors chose the one that reduced the inequality

between them the most. In this case, to reach an agreement, the underlying concept of fairness should not be based just on the partner's outcomes but also on the interplay between outcomes and intentions. Economic games such as the ultimatum game (UG; Güth, Schmittberger, & Schwarze, 1982), in which both partners can play a decisive role in determining the final outcome, are one way of bringing together the donor's and recipient's perspectives, including the consideration of intentions to test which is the underlying concept of fairness (largest for me vs. equal for both vs. unequal for both but best option available). In this game, a proposer decides how to split rewards with a partner, who as a responder in turn decides whether to accept or reject the offer. In the case of acceptance each player receives his or her corresponding split, but in the case of rejection nobody receives anything. The mini-ultimatum game (MUG; Falk, Fehr, & Fischbacher, 2003) is a simplified version of the UG in which two splits are pre-assigned and the proposer needs to decide which one of the two he or she offers to the responder. One split (8/2) whose acceptance delivers 8 and 2 rewards to the proposer and recipient, respectively, is pitted against three other splits, thereby creating four different conditions varying in the level of unfairness: Fair (8/2 and 5/5), Hyperfair (8/2 and 2/8), No Choice (8/2 and 8/2), and Hyperunfair (8/2 and 10/0).

From the proposer's perspective, the rewards he or she is willing to lose to make an acceptable offer for the partner gives an idea of the proposer's capacity to foresee others' preferences and to incur costs to obtain gains (strategic behavior). For example, in the Hyperunfair condition, the proposer should choose 10 to obtain the largest payoff, but this option allocates 0 for the responder. If the proposer is able to foresee a rejection of this option, it would be more strategic to choose 8 instead because it allocates at least 2 rewards to the partner. From the responder's perspective, non-zero rejections give an idea of the subjective thresholds for what should be acceptable in social comparisons (inequity aversion). Any 8/2 offer can trigger disadvantageous inequity aversion because the proposer is getting more than the responder. In addition, the alternative option in the Hyperfair condition (2/8) allows for testing the existence of advantageous inequity aversion. Finally, because the proposer decides between only two options (with a common option across conditions), one can see whether the responder is sensitive to the proposer's intention independent of outcome-based considerations. For instance, although an 8/2 offer from the recipient's perspective can be considered unfair from an outcome-based interpretation, it might turn into a fair offer from an intention-based look when the other alternative is 10/0.

Compared with the large body of evidence available in adults (see Güth & Kocher, 2014, for an updated review), there are still few studies that have investigated in detail children's responses in the UG and MUG and how they change with age (e.g., Fehr, Bernhardt, & Rockenbach, 2008; Kail & Cavanaugh, 2004). Moreover, many of these studies have found contradictory results. For example, Harbaugh and colleagues (2003) found that proposers in the UG offered better outcomes as they grew older, whereas Murnighan and Saxon (1998) found the opposite. Similar mixed results on age and sex have been found in recent contributions in adults (e.g., Carpenter, Burks, & Verhoogen, 2005; Eckel & Grossman, 2008; García-Gallego, Georgantzís, & Jaramillo-Gutiérrez, 2012; Saad & Gill, 2001; Solnick, 2001). In children, sex differences have not been explored (e.g., Güroğlu, van den Bos, & Crone, 2009; Sutter, 2007; Wittig, Jensen, & Tomasello, 2013). However, it is conceivable that such differences may exist given that boys and girls differ in their attitudes toward game play (Vogelsang, Jensen, Kirschner, Tennie, & Tomasello, 2014). Boys are more task-oriented (prioritize rewards) and competitive than girls, who seem to focus more on interpersonal proximity (prioritize cooperation) (Maccoby, 2002), which could reflect sex differences in moral development, particularly in the way individuals determine what is fair or unfair. Jaffee and Hyde (2000) concluded that sex differences may be found in some age ranges only, specifically during adolescence, with girls showing slightly higher levels of prosocial reasoning than boys (Beutel & Johnson, 2004). Consequently, our understanding of how bargaining behavior varies across development remains unclear.

To our knowledge, only four MUG studies have been conducted with children and adolescents (Gummerum & Chu, 2014; Güroğlu et al., 2009; Sutter, 2007; Wittig et al., 2013). These studies do not offer a clear picture of the development of strategic behavior or inequity aversion. For example, children of similar ages in two studies (Güroğlu et al., 2009; Sutter, 2007) made vastly different offers (three times lower). It is conceivable that differences in the age distribution in the respective samples may have been responsible for this outcome (Güroğlu et al., 2009, included only 9-year-olds, whereas

Sutter, 2007, considered 7- to 10-year-olds). Moreover, the earliest record of disadvantageous inequity aversion is placed at 5 years of age (Wittig et al., 2013); Blake and colleagues (2015) placed it at 4 years of age, but their study was outcome-based, without the interplay of intentions. However, the rejections of the default option never happened in the Hyperunfair condition, different from the next reported age in MUG, at 9 years of age, where rejections of the default option happened in all conditions. Therefore, it remains unclear how proposers adapt their offers to the pattern of rejections as well as how inequity aversion varies across development.

A second source that may have substantially contributed to the mixed results available is the use of different methodologies (see House, Henrich, Brosnan, & Silk, 2012, for a comprehensive review). Two main methods have been used to test the MUG. In the strategy (or vector) method, participants answer questions about their hypothetical offers and acceptance thresholds. Because they do not interact with a real partner, this method is also called "cold play." Data are collected separately for proposers and responders and are used to find general tendencies within a population. Sometimes the proposers' choices are recycled (e.g., if they composed only 10% of the sample, as in Gummerum & Chu, 2014, or if there were no-shows, as in Sutter, 2007). In contrast, the direct-response method (or "hot play") confronts two participants (with or without anonymity) who play the complementary roles. Data are collected on each dyad, which allows a more refined and direct analysis of the individuals' choices.

All MUG studies with children to date have used the strategy method except one that used the direct method (Wittig et al., 2013) using an apparatus with two shelves displaying the different amounts of stickers and pulling/pushing alternatives to propose and respond, respectively. The strategy method may be preferred over the direct method for its simplicity, low cost, and reduced sample size requirements (i.e., recycle of responses). However, answering hypothetical questions about offers, acceptances, and rejections might not activate the same cognitive and emotional processes as playing with another individual (Güth & Kocher, 2014; Sally & Hill, 2006).

The difference between the rewards played in the game and the rewards earned is another aspect that may affect children's responses, especially those of younger participants. All available studies except Wittig and colleagues (2013) have used a conversion procedure to translate the number of rewards obtained in the game into actual "take-home" rewards (e.g., 10 points = 2 euros; Sutter, 2007). To complicate comparisons across studies even more, each study has used a different conversion rule. Another aspect that affects responses, at least in adults, is whether games are played as "one-shot" or as repeated interactions (Cooper & Dutcher, 2011; Lin & Sunder, 2001). Repeating the UG led adult participants to learn norms, deduce thresholds, and decline low offers, which does not happen when the game is played in a one-shot modality. Most studies with children have used repetitions of the game that, just as with adults, may have affected children's responses.

Anonymity is another important consideration. Personal features such as the name, social distance, and beauty of participants influence behavior in bargaining games (Charness & Gneezy, 2008; Marchetti, Castelli, Harlé, & Sanfey, 2011). Wittig and colleagues (2013) used a non-anonymous test to enhance the truthfulness of the scenario. Although the participants belonged to different classes of the same kindergarten, this could still have affected their performance because children care about their reputation in front of people they know and share more resources (Engelmann, Over, Herrmann, & Tomasello, 2013). Therefore, despite the direct method and direct access of rewards they used, we do not know whether children's responses were affected by the visual access to their partner.

Our study was aimed at resolving the existing discrepancies in the literature by targeting critical ages (6 and 10 years) and addressing the various methodological concerns to which we referred. We implemented the MUG using a direct-method one-shot direct-reward delivery that guaranteed anonymity (see Table 1) with 6- and 10-year-olds as a way to provide data about the development of strategic behavior and inequity aversion. Wittig and colleagues' (2013) study is not vulnerable to most of those shortcomings that we mentioned earlier, but it is limited to 5 years of age. We studied 6-year-olds because this is the age when children begin formal schooling and are confronted with resource sharing on a daily basis—an activity that might increase the likelihood of showing certain strategic behavior and inequity aversion. Furthermore, we studied 10-year-olds because this is the age when children consistently punish transgressors based on others' intentions (Helwig, Zelazo, & Wilson, 2001; Zelazo, Helwig, & Lau, 1996). Note that current studies have not directly compared these two ages that mark the beginning and end of primary education, respectively.

**Table 1**
Factors analyzed and methods used in the study.

| | Implementation |
|---|---|
| *Factors* | |
| Age | Early and late childhood |
| Sex | Girls and boys |
| *Methods* | |
| Direct method | Real scenario |
| Reward conversion | What you see is what you get |
| Anonymity | Occluder (same age group) |
| One-shot | Each condition is presented only once |

Our first hypothesis tested whether strategic behavior was present at 6 or 10 years of age. To that end, we analyzed how proposers of the two age groups distributed their offers across conditions. A preference for the option different from 8/2 when it benefited their partner (5/5 in Fair and 2/8 in Hyperfair) and avoidance when it did not (10/0 in Hyperunfair) would indicate the presence of strategic behavior. We also examined whether the offers matched the pattern of rejections, namely whether what was offered was usually accepted by responders, because this would mean that the proposers could anticipate the responders' expectations. We predicted that 6-year-olds would not show a homogeneous pattern of offers, whereas this will be likely to exist in 10-year-olds, who would also be more likely to match the pattern of offers with the pattern of rejections. Our second hypothesis tested whether there are sex differences in strategic behavior. Here we compared the offers of boys and girls. We predicted that girls would show more strategic behavior than boys because girls develop moral reasoning earlier than boys. Such a difference should be particularly marked in our older participants. Our third hypothesis tested the presence of both disadvantageous and advantageous inequity at both ages. For this analysis, we focused on the responders' rejections. The 8/2 rejections informed us about the presence of disadvantageous inequity aversion in case the participants rejected when no better option was available (Hyperunfair and No Choice). The rejections of the alternative options informed us about the presence of advantageous inequity aversion in case the participants rejected when they earned more than the proposer (Hyperfair). Finally, we explored whether responders rejected based on outcomes (comparison between rejections of both options in Fair) as well as on proposers' intentions (comparison between rejections of both options in Hyperunfair and between 8/2 option in Fair and No Choice). We expected to find advantageous inequity aversion at both ages because at 5 years it was already present somehow (Wittig et al., 2013), whereas we expected disadvantageous inequity aversion to increase with age due to the increase of social comparison. Finally, we expected both age groups to reject based on both outcomes and intentions.

## Method

### *Participants*

We tested 338 first-grade children (mean age = 6.56 years, *SD* = 0.36), paired in 169 interactions (175 girls: 88 proposers and 87 responders; 163 boys: 81 proposers and 82 responders) and 140 fifth-grade children (mean age = 10.49 years, *SD* = 0.32), paired in 70 interactions (77 girls: 39 proposers and 38 responders; 63 boys: 31 proposers and 32 responders). Fully 94% of the participants were Spanish; the rest were of several other nationalities (Russian, Moroccan, Pakistani, Chinese, and Latin American). We randomized the sample so that there were a similar number of boys and girls playing each role and the same number of pairs playing each condition (see the sample distribution in Table S1 of the online Supplementary material). The experimenter spoke either Spanish or Catalan during the experiment, depending on the child's preference. We recruited the participants from four public and two private elementary schools, and we obtained informed consent from the school authorities and parents. The University of Barcelona's committee of bioethics (IRB00003099) also approved the study.

*Materials*

We used a wooden structure composed of two vertical poles (66 cm) joined on the upper side by a horizontal metal bar (81 cm). An opaque curtain was hung from the metal bar to the surface of the table, covering all the space of the structure except for a 50 × 12.5-cm window on the lower side of the curtain, which could be used for transferring objects (i.e., trays with rewards) on the table from one side to the other (see Fig. 1). Depending on the height of the chairs, a black piece of fabric was sometimes added to the window to reduce the size of the transfer area so that players could not get visual clues about the identity of the partner (i.e., skin color, bracelets), but making sure that they still had full visual access to the whole set of options. The curtain helped us to keep the game anonymous. Moreover, each side had a different color to differentiate the role of each player—blue for proposer and white for responder.

We avoided using food or money as rewards in compliance with the schools' policies. The reluctance to use money with children in bargaining games is also common in other countries, as reported in previous studies (Gummerum & Chu, 2014; Güroğlu et al., 2009; Harbaugh et al., 2007; Murnighan & Saxon, 1998). Instead, we used round, yellow, smiley-face foam stickers (diameter = 4 cm). Stickers for 6- and 10-year-old children have also been used in previous studies (e.g., Benenson, Pascoe, & Radmore, 2007; Gummerum & Chu, 2014; Liu et al., 2016). Nevertheless, we made sure that the children liked the stickers during pilot testing, where we gave them the opportunity to choose among different types (which varied in color, size, and shape). All of the children consistently selected the smiley-face sticker and were excited when they obtained such stickers.

There were four conditions, each of which consisted of two trays displaying distributions of stickers. One tray displayed 8/2 and the other tray displayed the corresponding alternative condition, namely Fair (8/2 and 5/5), Hyperfair (8/2 and 2/8), No Choice (8/2 and 8/2), Hyperunfair (8/2, 10/0). Each distribution was shown on a different plastic tray (35 × 22 × 7.5 cm). The base of each plastic tray was painted in two colors: half blue and half white. The stickers for the proposer were laid out on the blue part, and the stickers for the responder were arranged on the white part. Both trays were placed on the table, under the transfer area of the curtain, so that the color on the tray matched the

**Fig. 1.** Experimental setup. A wooden structure separates the proposer (right) and the responder (left). A curtain and trays with different colors on each side help participants to identify their role (blue for proposer and white for responder). A black piece of material and long sticks prevent participants from guessing their partner's identity. The experimenter participates only to give instructions to participants.

side of the curtain with the same color. The use of different colors allowed the participants to easily identify their role and the quantities that they and their partner could earn in each distribution, as in similar experiments (Güroğlu et al., 2009). Instead of using their hands, every player had a 22-cm-long plastic stick to push the tray through the transfer area so that no visual clues were provided (e.g., skin color, scars).

*Procedure*

Typically, the experimenter visited the school, introduced herself to all of the students in the class, explained how the MUG worked, and answered any questions that arose until the game was fully understood (this usually took $\sim$ 15 min). To describe the game, she placed all of the material (apparatus, plastic trays, stickers, and two sticks) on a table, asked the children to surround it, explained the rules, chose some volunteers to demonstrate the game, and asked them the meaning and outcome of every possible action (offer, accept, and reject). This ensured that the children knew that they could decide to either accept or reject the offer. In addition, to prevent these examples from contaminating the children's choices, we used different stickers and quantities from those in the test, as in previous studies (Sutter, 2007).

Subsequently, the participants were told that the game was one-shot and that players were to be the same age but anonymous, meaning that no information related to their partner would be provided (e.g., name, ethnicity). Each pair of children played only one condition (Fair, Hyperfair, No choice, or Hyperunfair), and every participant played only one role (proposer or responder).

We tested the children outside of the classroom in a quiet room at their school. We had different strategies to ensure anonymity. Before the game, both participants were taken from different classes, so that one student from one class entered first and remained behind the curtain and then another student from a different class entered in silence. Moreover, during the game the participants did not speak, the apparatus had an opaque curtain to separate them, a stick was used to push the trays instead of using hands, and a piece of cardboard was attached under the table to avoid extracting information about the partner's clothes.

To ensure that the children fully understood the task after the explanation of the game in class, we did the following. First, before entering the experiment room, every participant was told his or her role (proposer or responder) and was also asked two control questions (the participant was shown a piece of cardboard with an example of the game and needed to answer how many stickers each participant would earn in the case of rejection or acceptance of the offer). None of the children made a mistake. Second, during the game, the experimenter informed the participants about the available options and gave instructions to follow in the case of acceptance or rejection.

The task took approximately 5 min per pair to complete. The game started when both participants were in the experimental room facing the apparatus. The experimenter "read" the options in a loud voice (e.g., "Here you have two trays. In this one, there are [X] stickers for you [pointing to the proposer] and [X] stickers for you [pointing to the responder]. In that one . . ."). The proposer had 5 s to push one of the trays forward with the stick. Then, the experimenter "read" the offer that was chosen and the actions that could be taken (e.g., "He is telling you: [X] stickers for you, [X] stickers for me. If you like the deal, take the stickers and push the tray back with your stick. If you do not like it, just push the tray back with your stick. Choose whatever you want.") without providing any clues about the partner's identity (the English translation uses "He" as the subject of the sentence, but the expression in Spanish and Catalan is ambiguous [male or female]). Then, 5 s was counted before the responder decided. To accept the offer, the responder took the stickers on his or her side out of the tray and pushed it back to the proposer so that the proposer would know that the deal had been made and, thus, was allowed to take his or her respective stickers too. To reject the offer, the responder simply pushed the tray back to the proposer, so that the proposer would know that no deal had been made as the stickers remained untouched and, thus, the game was finished with a zero outcome for both players. When the offer was 0 in the Hyperunfair condition (10/0), because rejection could not be guessed by the proposer, the responder was asked to nod or shake his or her head in silence, meaning yes or no, respectively. Then, the proposer was informed about this by the experimenter (i.e., yes: "Your partner has taken the stickers. There is a deal, so now you can take yours." no: "Your partner has not taken the

stickers. There is no deal."). Once the game had finished, the experimenter asked some of the participants (both proposers and responders) about their decisions to explore their comprehension of the MUG. The participants did not take their stickers with them after the game, but the quantity was written down and delivered later that week, when all of the participants had completed the game. We did not give the stickers right after the game to prevent learning or copying others' numbers of stickers by children who had not yet participated. All of the children who participated in a game where the deal was rejected, as well as students who did not have parental consent to participate, received two stickers (the minimum offer) in order to compensate for extreme outcome differences in class between classmates.

### *Scoring and data analysis*

Both the game and the behavioral responses were videotaped with a Sony HDR-CX210 video camera. Participants noticed its presence, but all appeared to be comfortable and it did not seem to influence their choices. A random sample of 25% of the videos was coded by a second observer who was blind to the experimental design and question. She coded the proposer's choice (which tray he or she pushed) and the responder's response (grabbing the stickers or pushing the tray back). Inter-observer reliability for both measures was perfect ($\kappa = 1$).

We divided the results into four types of analysis: offers (age and sex) and rejections (age and sex). To address the aims stated in the Introduction, we conducted two types of non-parametric statistical tests with effect size calculations. We carried out Pearson's chi-square tests or Fisher's exact test (whenever the assumptions for the former test were not met, i.e., when there were very low expected frequencies) to compare the offers and rejection rates across ages and sexes. Cramer's $V$ was computed to assess the effect size whenever necessary. Finally, when we analyzed the offers, we excluded the No Choice condition (8/2 and 8/2) from the analysis given that both offers were the same and no information regarding the proposer's preferences could be extracted.

## Results

### *Offers*

The frequencies of the 8/2 choices by condition and age are shown in Table S2 of the Supplementary material. The first analysis we did was to compare them across all conditions within each group of age. We did not find any significant results except for the older girls (see Table S3 and below).

#### *Age*

Fig. 2 presents the percentages of children who offered non-8/2 options as a function of age and condition. The 10-year-old children were more likely to offer fair offers in the Fair condition ($n = 62$, $\chi^2 = 5.33$, $p = .021$, $V = .26$) and Hyperunfair condition ($n = 58$, $\chi^2 = 7.11$, $p = .008$, $V = .31$) than the younger participants. In contrast, there were no differences between age groups in the Hyperfair condition; approximately 30% of both younger and older children offered the 2/8 option (see Fig. 2).

#### *Sex*

There were no sex differences in the younger children (Fair: $n = 43$, $\chi^2 = 0.01$, $p = .94$, $V = .06$; Hyperfair: $n = 43$, $\chi^2 = 1.71$, $p = .19$, $V = .25$; Hyperunfair: $n = 41$, $\chi^2 = 0.12$, $p = .72$, $V = .11$) (see Fig. 3A). Differences appeared with age. At 10 years, girls significantly increased more strategic behavior by doubling their 5/5 offers in the Fair condition ($n = 38$, $\chi^2 = 6.05$, $p = .014$, $V = .40$) and suppressing the 10/0 offer, although the latter change was not significant ($n = 27$, Fisher's $p = .057$, $V = .32$). In contrast, boys maintained their unstrategic behavior, without significant changes according to age. Therefore, in a comparison of both groups, girls behaved in a significantly more egalitarian and strategic way than boys at 10 years of age ($n = 19$, Fisher's $p = .04$, $V = .48$). Remarkably, 100% of the girls made 5/5 choices in the Fair condition, but only 50% of the boys selected this option (see Fig. 3B).

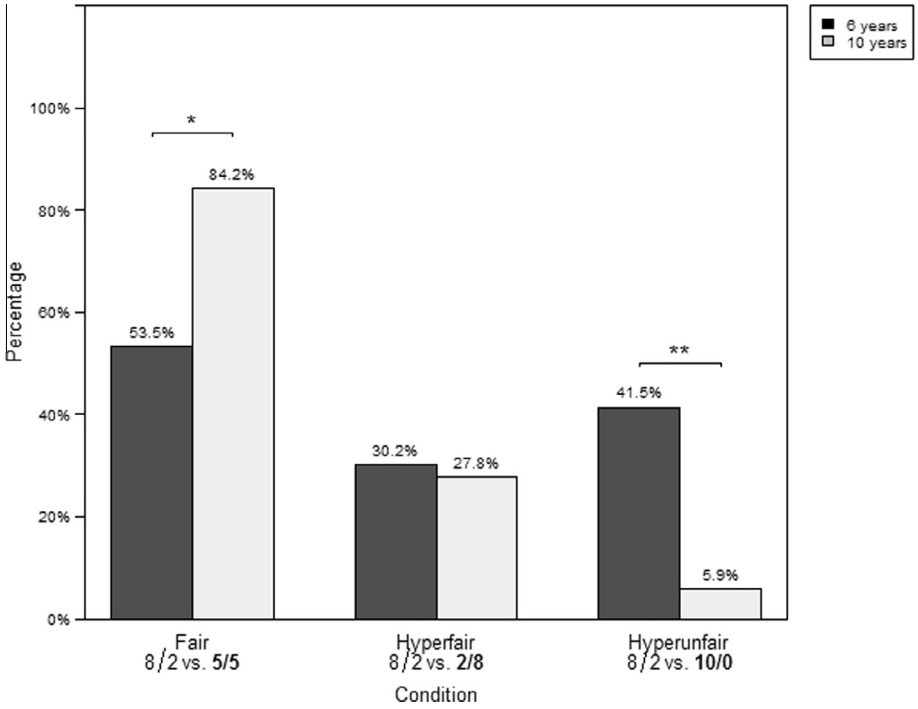


**Fig. 2.** Percentages of alternative offers (other than 8/2) as a function of condition and age. $^{*}p < .05$; $^{**}p < .01$.

Moreover, boys still showed selfish and less strategic behavior in the Hyperunfair condition (i.e., choosing 10/0 instead of 8/2), although the difference was not significant.

*Rejections*

The frequencies of the 8/2 rejections by condition and age are shown in Table S2 of the Supplementary material. The first analysis we did was to compare rejections of the default and alternative options across all conditions within each age group. We did not find any significant results except for the alternative option in the Hyperfair and Hyperunfair conditions in the younger children (see Table S4 and below).

*Age*

Regarding 8/2 rejections, overall both age groups had the same decreasing pattern across conditions. As can be seen in Fig. 4A, rejection of 8/2 was higher when a more advantageous option was available (Fair and Hyperfair), whereas rejection of 8/2 decreased, but still existed, when it was the best or the only option, but the proposer would still keep more rewards (Hyperunfair and No Choice). However, there were significant differences in the No Choice condition ($n = 58$, $\chi^2 = 4.55$, $p = .033$, $V = .28$), where older participants were more likely to reject the offer.

Regarding the rejection of alternative options, overall there was no difference between age groups. Only 3 of the 6-year-olds rejected 2/8. In general, both groups of children showed a similar pattern to adults; as can be seen in Fig. 4B, generous offers (Fair and Hyperfair) were rarely rejected, whereas 10/0 offers (Hyperunfair) accumulated the highest percentage of rejections.

We also wanted to get an idea about punishment and reinforcement of the proposer's intentions. To do this, we analyzed the difference between the percentages of rejection per condition. If responders punish unfair deals based on outcomes, they will reject the default option in the Fair

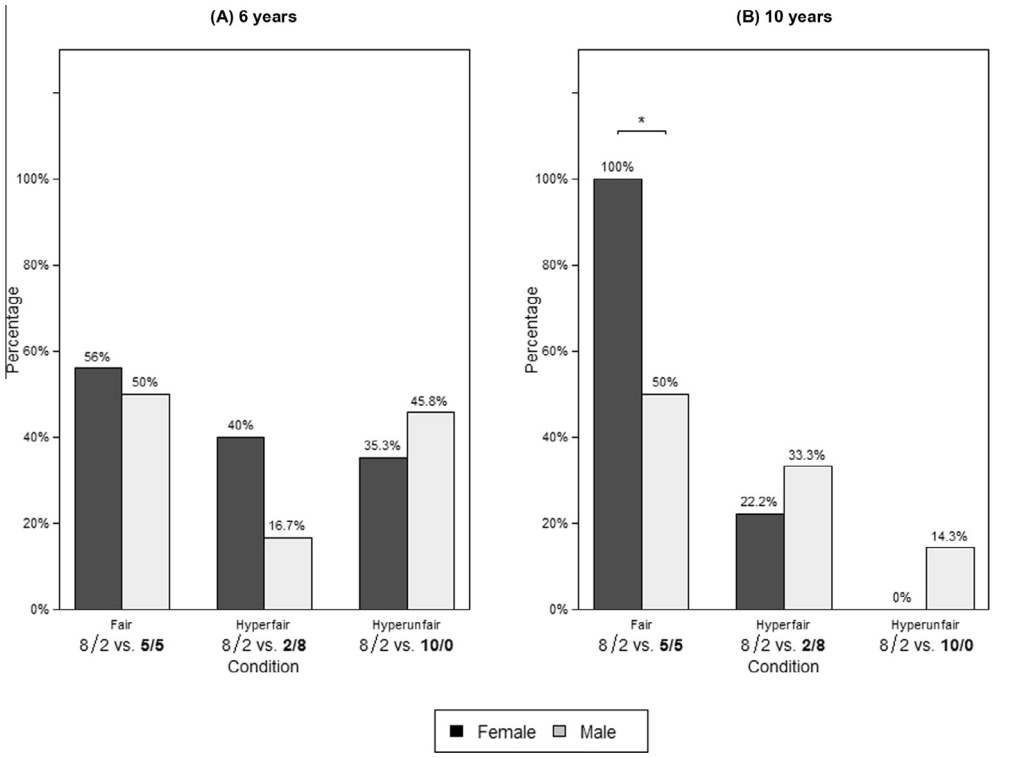


**Fig. 3.** Percentages of alternative offers (other than 8/2) as a function of condition and sex in 6-year-old (A) and 10-year-old (B) children. $^{*}p < .05$.

and Hyperfair conditions because there is a higher alternative option available or because the partner earns more than them. Statistically, the difference in rejection between options should be significant in both cases (default option mostly rejected and alternative option mostly accepted). Thus, we should find significantly more 8/2 rejections than 5/5 or 2/8 rejections. As expected, there were significant differences in rejection between the options in the Fair condition at both 6 years of age ($n = 43$, $\chi^2 = 0.20$, $p = .013$, $V = .38$) and 10 years of age ($n = 19$, Fisher's $p = .018$, $V = .56$). Both age groups significantly punished unstrategic proposers (those who offered 8/2 when they could have offered a better deal for the responders). The same should be found for the Hyperfair condition, but we decided to exclude it from the analysis because outcomes and intentions might be mixed.

On the other hand, if children acted under the consideration of intentions, we should find significant differences between the rejections of the default condition when the proposer had an equitable alternative available (Fair) and those when the proposer had no better option (No Choice). When we looked for them, there were no significant differences despite the absolute difference of approximately 30% between both conditions in both age groups (see Tables S2 and S4 in Supplementary material), possibly due to the smaller sample size in those particular subsamples. Another way to investigate whether children take the proposer's intentions into account would be to compare the rejections within the Hyperunfair condition. If responders reinforce intentions, they will accept an offer even though the proposer keeps more than them as long as the other option available was unfair (accepting 8/2 in Hyperunfair). Statistically, there should be significant differences in rejection between options (8/2 mostly accepted and 10/0 mostly rejected). This was the case at 6 years of age ($n = 41$, $\chi^2 = 20.057$, $p < .001$, $V = .70$) but not at 10 years of age ($n = 17$, Fisher's $p = .47$, $V \simeq 0$) because older participants rejected 8/2 meaningfully (43.8%). However, they showed a similar 8/2 rejection in the No Choice

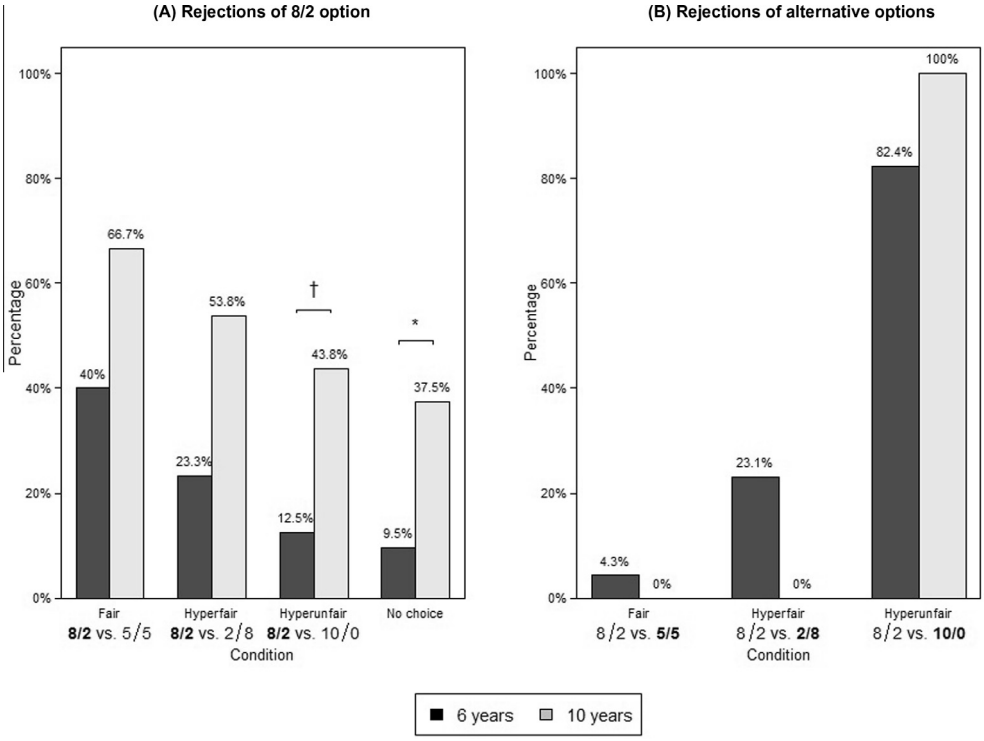


**Fig. 4.** Percentages of 8/2 (left) and alternative (right) rejections as a function of condition and age. $^{\dagger}p < .10$; $^{*}p < .05$. On the right, rejections of 5/5 and 2/8 offers at 6 years of age corresponded to 1 and 3 children, respectively.

condition (37.5%) when the proposer could not have any intention to offer unfairly. Therefore, it seems that 6-year-olds took the proposer's intentions into account, whereas inequity aversion might have masked this in older children (see Discussion for comparison between Fair and Hyperfair rejections).

*Sex*

No significant differences were found between boys and girls in rejections (Fair: $n = 23$, Fisher's $p = 1.00$, $V \simeq 0$; Hyperfair: $n = 13$, Fisher's $p = .56$, $V = .04$; Hyperunfair: $n = 17$, Fisher's $p = .58$, $V = .03$; No Choice: $n = 42$, $\chi^2 = 1.07$, $p = .74$, $V = .05$).

## Discussion

The goal of this study was to examine the developmental trajectory of strategic behavior in proposers and disadvantageous/advantageous inequity aversion in responders testing for sex and age differences. Our results show that only 10-year-olds matched their pattern of proposals with the pattern of rejections found in their peers, suggesting the existence of strategic behavior already at that age. However, this was true only for girls, thereby suggesting a significant difference between boys and girls in strategic reasoning by the end of primary education. With respect to responders, younger children seemed to take the proposer's intentions into account, whereas older children's pronounced aversion to inequity may have prevented us from detecting it. In fact, between groups, older participants rejected the default option significantly more than younger participants in conditions where there was no better option available (No Choice and Hyperunfair). Interestingly, this made the young children's pattern of rejections more similar to the pattern found in adults (Falk et al.,

2003), suggesting a concrete period of high disadvantageous inequity aversion and social comparison during late childhood.

The first hypothesis tested was whether proposers offered strategically. What makes participants succeed (i.e., reach an agreement) when playing the MUG is the ability to foresee the partner's preferences and adjust their responses accordingly. The 6-year-old children provided no strong evidence that they possessed strategic thinking yet because the pattern of proposals and rejections was inconsistent. Even though responders frequently punished partners who did not choose the equitable option, and most of them also rejected the 10/0 option, as proposers they did not consistently offer the fairest option available in these conditions considering their partner's outcomes. This is also what Harbaugh and his colleagues (2007) found in a learning UG experiment. In their study, children from 8 to 18 years of age played five rounds of UG. After each round, the experimenters showed the children the responder's behavior of every proposal (i.e., children could see which amounts had been rejected and which ones had been accepted). The authors found that proposers did not change their offers to match their partner's response; half of them chose 8/2 in the Fair condition, and nearly 42% offered a 10/0 option.

This is not to say, however, that 6-year-olds completely lack strategic behavior and their concept of fairness is essentially selfish given that half of them chose 5/5 and approximately 60% offered 8/2 in the Hyperunfair condition. Therefore, it is conceivable that these (selfish responses) do not necessarily imply that children do not *know* what is fair for others; rather, they do not *act* according to that knowledge (Damon, 1977). That was the case in a recent study (Smith, Blake, & Harris, 2013) where 3- to 8-year-old children were able to *state* that they and others should share equally but did not actually *carry out* that behavior until 7 or 8 years of age. The reason for this inconsistency, however, is still to be determined. One possibility might be that strategic behavior requires high cognitive demands. The lack of impulse control has proved to have an impact on prosocial behavior together with age (Steinbeis et al., 2012), and the executive control (i.e., overcoming immediate rewards, adjusting the behavior to the concern for others) is not fully developed at 6 years of age (Davidson, Amso, Anderson, & Diamond, 2006; Durston et al., 2006). However, recent data suggest that children still act in the same way when the problem of inhibition is removed (Smith et al., 2013). Another possibility is the requirement of a fully developed theory of mind (i.e., perspective taking), but recent evidence indicates that better scores in theory of mind are not necessarily associated with more prosocial behavior (Cowell, Samek, List, & Decety, 2015). Therefore, it might be that at this age the proposer's concept of fairness is predominantly selfish, trying (unstrategically) to keep the most for himself or herself, in line with previous studies of resource sharing (Overgaauw, Güroğlu, & Crone, 2012; Rochat et al., 2009), and only occasionally, but not consistently, taking the partner's outcome into account.

Unlike 6-year-olds, 10-year-olds displayed clear evidence of strategic behavior as indicated by a matching pattern of offers and rejections (i.e., in Hyperunfair, as responders, all participants in this age group rejected 10/0; then, as proposers, nearly all participants should—and did—offer 8/2). Thus, it seems that by the end of primary school children are able to understand that the outcome they would expect from others is the outcome that others expect from them; therefore, their concept of fairness becomes more centered in the partner. In other words, getting older increases the tendency to reduce inequality among participants overcoming the effect of outcome. This result advances the emergence of strategic behavior earlier in development, in contrast to Harbaugh and colleagues (2007) but in line with Güroğlu and colleagues (2009).

The second hypothesis we tested was the potential existence of sex differences in strategic behavior. Interestingly, as we had predicted, the developmental change between 6 and 10 years of age did not happen at the same time in girls and boys. Whereas girls increased their prosocial offers, and therefore reduced selfish behavior (older girls always offered 5/5 and never offered 10/0), boys made similar offers across the two age groups and showed a preference for keeping more items for themselves (half of them offered 5/5 and some still offered 10/0 when they were older). These sex differences are in line with previous findings (Murnighan & Saxon, 1998) and might indicate that, at least at 10 years of age, sex would be a discriminative factor in the development of fairness and prosocial considerations. Moreover, these sex differences might also be related to the playing method we used. Risk attitudes vary with age (e.g., Harbaugh, Krause, & Vesterlund, 2002), and they have been

argued to explain sex differences because different methods of playing UG yield different levels of risk for the participants. In the direct method, the respondent chooses after the proposer has made a choice; thus, the proposer, but not the respondent, faces some risk in his or her choice (Eckel and Grossman, 2008). As in our study, we used the direct method and found sex differences only in proposers; risk attitudes in conjunction with the direct method might have contributed to the sex differences we found between 10- and 6-year-olds.

Regarding the methodology used in the MUG, earlier we highlighted the opposite results that some studies have yielded and attributed them to different factors that we controlled in our study (selection of ages and type of scenario). If we compare our results with the evidence from children playing the MUG so far (see Table S5 and Graph S1 in Supplementary material), the emergence of strategic behavior (i.e., the progression toward prosocial offers over age) is not that clear. For example, it can be seen that children of similar ages made proposals three times lower in two different studies (see Graph S2; see also Güroğlu et al., 2009; Sutter, 2007). Hence, the oscillation of the graph across child development seems to indicate the existence of certain turning points. In contrast, if we take the results of every study separately and focus on the difference of proposals made in the Fair condition between the age groups it considered, this yields a different picture. In all of them, there is a remarkable tendency toward prosociality with age (see Graph S3). The relevance of this consideration lies in how developmental conclusions might vary according to the consistency of the methodology employed, so we encourage further research to carefully take into account the crucial factors for the MUG procedure we mentioned in order to make their data comparable to the already existing literature.

The third hypothesis we tested was whether rejections of the default option varied across conditions (disadvantageous inequity aversion) and whether 2/8 was rejected (advantageous inequity aversion). Our results follows the line of the robust body of evidence that shows a strong tendency to punish unequal offers when there is an equitable alternative available given that both age groups significantly punished proposers who did not offer the 5/5 option. Accordingly, it seems that in the presence of an equitable option, "fair" means "equal for both" in both age groups. In addition, as in previous studies (Güroğlu et al., 2009; Sutter, 2007), we did not find a significant difference between the rejection of the default option across conditions within each age group (see Table S6 and Graph S4 in Supplementary material). This could be interpreted as responders not consistently taking the proposer's intentions into account. However, we reported an absolute difference of approximately 30% between the 8/2 rejections in the Fair and No Choice conditions in every age group that might not have been significant due to small sample size after subsampling. In fact, if responders were mainly outcome based, the more they lose, the more they would reject. Consequently, the default option should yield more rejections in the Hyperfair condition than in the Fair condition provided that the alternative option in Hyperfair allocated more rewards to the responder. However, that is not the case in all of the studies conducted with young children so far (e.g., 55% vs. 50% in Gummerum and Chu, 2014; 68% vs. 72% in Güroğlu et al., 2009; 58% vs. 65% in Sutter, 2007; 15% vs. 33% in Wittig et al., 2013; 23% vs. 40% in our current study). Precisely because the differences among the percentages are not large, they contradict the prediction of higher expectation of rejections in the Hyperfair condition. Therefore, it is conceivable that young responders not only are considering outcomes but also might have some kind of consideration at least about the cost that the proposer would have incurred, and that is why they did not react more vigorously. In the case of older children, the general higher percentage of rejections (see below) might have hindered their considerations regarding the proposer's intentions.

We found significant differences in rejections of the default option between age groups. Both 6- and 10-year-olds rejected 8/2 in the No Choice and Hyperunfair conditions, but the older participants did it significantly more than the younger children. Accordingly, it seems that in the absence of a tie, despite both age groups possibly having taken the proposer's intentions into account somehow, they nevertheless both focused more on outcomes and shared the concept that "fair" is not only "the most advantageous option" but also "the partner having a similar number as me." This is a relevant finding because, to our knowledge, it is the first time that inequity aversion has been reported in 6-year-olds within the context of outcome/intentions (and not only outcomes as in Blake et al., 2015, and Sally and Hill, 2006). Whereas Wittig and colleagues (2013) showed that children by the age of 5 years never rejected the default option in the Hyperunfair condition, we showed that 12.5% of the 6-year-old responders did. It might be that during the preschool years children mainly address their look to

the outcomes they can get and conclude about fairness with respect to that comparison, and it is only in the absence of a better alternative (No Choice) when they turn their look to their partner's outcomes and reject driven by disadvantageous inequity aversion. In this sense, the beginning of school might introduce more peer activities and resource sharing situations, thereby promoting a stronger bias for social comparison. That would explain why just 1 year later, by 6 years of age, children extend the disadvantageous inequity aversion to contexts where the offered alternative is the best option available and persist in doing so across the primary grades (see Graph S5 in Supplementary material). In fact, the absolute percentages of 8/2 rejections reaches such a high rate in 10-year-olds that if we examine Falk and colleagues' (2003) data on adults, the 6-year-olds' pattern of rejection is much more similar to that of the 10-year-olds. This suggests a stronger bias for social comparison with age that vanishes later during adulthood.

This social comparison, however, is not necessarily linked to the responder's prejudice. The rejections of profitable options also deserve special attention because they might show advantageous inequity aversion. Previous work had delayed its appearance at approximately 8 years of age (Blake and McAuliffe, 2011; McAuliffe et al., 2014), potentially due to the late internalization of social norms. However, in line with the 8% of 5-year-olds who rejected a profitable 1/3 outcome in Wittig and colleagues' (2013) study, we showed that at least 3 of 13 6-year-olds (23%) also rejected the 2/8 offer. It might be argued that these few participants might not have understood the game, but control questions after the test showed that they had. In addition, it might be said that individual differences had an influence, but we looked for the potential existence of personality traits while bargaining and found negative results (unpublished). Taken together, this evidence may suggest that the emergence of advantageous inequity aversion arises earlier than reported in previous experiments. However, the few cases detected require further research with young children to confirm this finding.

## Conclusions

Our study tested the MUG using an anonymous, one-shot direct-response method that provided additional processing time for responses to test a large sample of children at two critical ages. Because different studies have yielded mixed responses when children bargain, future studies should consider methodology as one of the main sources of variation. With respect to proposers, we have shown that strategic behavior is present already at 10 years of age. However, this is true only in girls, presumably because of their differences in moral reasoning and risk attitudes. With respect to responders, at least 6-year-olds showed some evidence of taking proposers' intentions into account, whereas 10-year-olds might have also considered them, but this was difficult to determine due to their high aversion to inequity. We showed that 6-year-olds show both advantageous (at least 3 of 13) and disadvantageous inequity aversion, and their pattern of rejections is much more similar to that of adults (Falk et al., 2003) than that of 10-year-olds. This might be due to the absolute percentages of 8/2 rejections, which were higher in the older participants, potentially because social comparison is more relevant to them.

## Acknowledgments

This study was funded by a scholarship (FPU12/00409) from the Spanish Ministry of Education. The decisions regarding the design, analysis, and conclusions are attributable just to the authors. We thank all of the schools that participated and supported this research as well as their teachers, parents, and children—Arrels Blanquerna and Arrels Esperança (Badalona), Ramón Lull (Barcelona), 25 de Setembre and Torre de la Llebre (Rubí), and Institut Escola Lloret de Mar (Lloret de Mar)—and are grateful for the assistance of Santiago Bueno and Mercedes Guerra. We also appreciate the helpful comments of two anonymous reviewers.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jecp.2016.05.011.

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