Social preferences in childhood and adolescence. A large-scale experiment to estimate primary and secondary motivations☆

Matthias Sutter[a,*], Francesco Feri[b], Daniela Glätzle-Rützler[c], Martin G. Kocher[d], Peter Martinsson[e], Katarina Nordblom[e]

[a] *Max Planck Institute for Research on Collective Goods Bonn, University of Cologne, Germany, and University of Innsbruck, Austria*
[b] *Royal Holloway University of London, United Kingdom and University of Trieste, Italy*
[c] *University of Innsbruck, Austria*
[d] *Institute of Advanced Studies, Vienna, University of Vienna and University of Gothenburg, Austria*
[e] *University of Gothenburg, Sweden*

A B S T R A C T

We elicit social preferences of 883 children and teenagers, aged eight to 17 years, in an experiment. Using an econometric mixture model we estimate a subject's primary and secondary social preference motivations. The secondary motivation indicates the motivation that becomes relevant when the primary motivation implies indifference between various choices. For girls, particularly older ones, maximin-preferences are the most frequent primary motivation, while for boys efficiency concerns are most relevant. Examining secondary motivations reveals that girls are mostly social-welfare-oriented, with strong equity concerns. Boys are also oriented towards social welfare, but are more concerned with efficiency than with equity.

JEL classification:
C91
D63
D64

Keywords:
Social preferences
Children
Adolescents
Age
Gender
Experiment

1. Introduction

Social preferences, sometimes referred to as other-regarding preferences, are important in many areas of decision making. They matter in charitable giving (Eckel and Grossman, 1998; List, 2011), bilateral or small-group bargaining (Kugler et al., 2007), social choice (Engelmann and Strobel, 2004), the private provision of public goods (Fischbacher and Gächter, 2010), or in exchange situations without contractual enforcement (Fehr et al., 1993; Charness and Dufwenberg, 2006). As a consequence, they shape the design of behaviorally optimal institutions and contracts (Fehr et al., 2007). Numerous models have been developed in economics that all capture important forms of social preferences (e.g., Rabin, 1993; Levine, 1998; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Dufwenberg and Kirchsteiger, 2004; Falk and Fischbacher, 2006; Kerschbamer, 2015). Given the ubiquitous importance of social preferences, research in economics on the origins and the development of social preferences over the life-cycle has gained ground in recent years, as Section 2 will show.

In this paper, we present an experiment with 883 children and adolescents, aged eight to 17 years. Using eight simple, one-shot allocation tasks (taken from Engelmann and Strobel, 2004), we study the distribution of effective social preferences across age and gender. According to the choices made in the incentivized allocation decisions, we can classify our experimental subjects according to five different motivations in terms of social preferences that have captured large interest in the literature[1]: *selfishness*, *efficiency* (maximizing the sum of payoffs in a reference group), *maximin* (maximizing the minimum payoff in a reference group), and two forms of *inequality aversion* (minimizing the difference in payoffs in a reference group). The classification is done by conducting a maximum likelihood error-rate analysis of subjects' decisions (following, in general, the econometric model used in Costa-Gomes et al., 2001). The mixture model used here assumes that each subject's motivation is drawn from a common prior distribution over the five types of motivations and that a subject's primary motivation is the same for all eight decisions, but that decision makers are allowed to make errors. One innovation of the paper, compared to related papers, is our ability to estimate also the secondary motivation of a particular subject. This secondary motivation becomes crucial for decisions when the primary motivation implies indifference between various available choices. By estimating both a primary and a secondary motivation, we believe that we are able to address the interplay between different motivations in a more detailed way than has been done so far.

The results from our experiment show that the distribution of primary motivations is strongly influenced by age and gender. For older boys (aged ten to 17), efficiency concerns become significantly more relevant, while inequality aversion loses importance. In contrast, older girls care much more about the minimum payoff in their reference groups (maximin-motivation). Comparing boys and girls, we find that efficiency concerns are significantly more important for boys than for girls from the age of ten years onwards, while a significantly higher proportion of girls are maximin-motivated in all age groups considered in our experiment. Girls are also significantly more inequality averse than boys when they are twelve years or older. Of course, our estimations reveal considerable heterogeneity of motivations in all age groups. It is interesting to note that, on average, the results for our oldest group of participants match the data of Engelmann and Strobel (2004) for adults reasonably well.

Also examining secondary motivations enables us to get a broader picture of social preferences and gender differences. Most girls' primary motivation is maximin, but for those who hold another primary motivation, the modal secondary motivations are maximin choices. This finding confirms the importance of this social preference for girls. Moreover, many boys are primarily efficiency-motivated, and for those who had another primary motivation, efficiency is the most common secondary motivation, confirming that boys indeed care most for efficiency. In sum, our estimation of secondary motivations corroborates our finding that girls and boys differ strongly in their social preferences, including both primary and secondary motivations.

The rest of the paper is organized as follows. In Section 2 we refer to related literature and put our contribution into perspective. Section 3 discusses some theoretical background and explains our experimental design. In Section 4 we present the experimental results, first on an aggregate level and then on the basis of a mixture model that allows estimating the distribution of motivations with regard to social preferences across age groups and gender. Section 5 discusses our findings and concludes the paper.

2. Related literature and our contribution

The development of social preferences early on in life has captured growing interest in economics and other disciplines in recent years. Studying potential changes of social preferences when children and teenagers grow up is interesting from a developmental perspective as it reveals insights on whether humans go through different phases in the development of their social behavior or whether social preferences can be considered as rather stable from early on in life (see, e.g., Fehr et al., 2008; Gummerum et al., 2010). Moreover, studying the development and evolution of social preferences in children and teenagers may be helpful for ultimately identifying their sources such as social norms, family backgrounds, or cultural influences (Deckers et al., 2015).

[1] Note that we are focusing here on outcome-based social preferences. Hence, we will disregard other aspects, like reciprocity, guilt, or intentions.

Fehr et al. (2008) present a study with 229 children aged three to eight years, in which children have to allocate rewards between themselves and one other child. They show that egalitarianism, i.e., inequality aversion develops strongly in the period of life that they capture. Children at the age of three and four behave selfishly to a very large degree, whereas the majority of children aged seven or eight prefer egalitarian allocations that avoid both advantageous and disadvantageous inequality. More precisely, about 60% of seven- to eight-year old children can be classified as having egalitarian preferences, while the corresponding share for three- to four-year olds is only 20%. Fehr et al. (2013) extend the study of Fehr et al. (2008) by letting 717 nine- to 17-year old children and adolescents make two-person allocation choices. Their major findings are that spite and inequality aversion become less important with increasing age, while efficiency seeking becomes more prevalent with increasing age.

Gummerum et al. (2010) find in a dictator game with 77 children aged three to five years that older children share more than younger children, and they show that girls are more generous than boys. Benenson et al. (2007) use a dictator game with 360 children aged four to nine years and find that older children and those from families with a higher socio-economic status behave more altruistically, i.e., prefer more egalitarian choices over more selfish ones. They find no gender difference in altruistic behavior. Eckel et al. (2011) conduct a dictator game experiment with 490 high school students from ninth and eleventh grades (15–17 years old), and 91 university students. They find very high levels of giving for their high school students, but do not observe any differences between genders.

Harbaugh et al. (2003) report an experiment with 310 children and teenagers aged seven to 18 years, showing that young children offer considerably less to recipients in the dictator game and the ultimatum game than older children and adults. Hence, the degree of selfishness, on average, decreases with age. Harbaugh et al. (2003) also show that boys make smaller dictator offers than girls, meaning that boys are, on average, more selfish.

Almås et al. (2010) run experiments with 486 children from ten to 18 years. They let them play modified dictator games and find that children's fairness norms evolve from favoring equality to favoring equity when they grow older. They observe significantly stronger efficiency concerns in adolescents than in younger children and find that male adolescents are more strongly oriented towards efficiency than female adolescents.

Finally, Martinsson et al. (2011) use dictator games taken from Charness and Rabin (2002) and compare the behavior of 650 Austrian and Swedish children, aged ten to 15 years. They find a general trend towards an increasing importance of social-welfare preferences with age, with only small differences across countries.

In sum, the clear majority of the mentioned studies suggest that in the course of growing up children become less selfish and more pro-social in allocation choices. While this general pattern mirrors findings in related psychological studies (see Eisenberg and Mussen, 1989; Gummerum et al., 2010), social preferences have a richer domain than just being more or less selfish, respectively more or less generous, in two-person allocation tasks. For this reason, we estimate the distribution of five different (outcome-based) motivations in terms of social preferences (selfishness, efficiency, maximin, inequality aversion à la Fehr and Schmidt, and inequality aversion à la Bolton and Ockenfels) across different age groups as well as separately for boys and girls. A notable distinction from the previous literature is that we use allocation tasks that involve three, rather than two, persons. With two-person tasks, the allocator is either better or worse off than the other person (if the allocation is unequal). With three-person tasks, it becomes possible that the allocator is better off than one other person in the group, but worse off than another one. Such situations give rise to weighing advantageous and disadvantageous inequality, and they also allow for estimating the importance of maximin-preferences separately. The importance of the latter justifies our approach ex post. Moreover, similar to the route taken in Almås et al. (2010) our paper contributes to the literature on social preferences in childhood and adolescence by presenting an econometric mixture model that allows us to estimate the influence of age and gender on the likelihood of revealing a particular motivation. We think that this makes the analysis of social preference motivations more informative than a mere description of choice frequencies, and it avoids the – in our view, unrealistic – assumption that a particular person is of a particular type with certainty and under all circumstances. Most importantly, however, our paper differs from all previously discussed papers in that it estimates both primary and secondary social preferences, thereby giving a more complete picture of how social preferences may motivate behavior, in particular when the primary motivation implies indifference between different choices.

3. The experiment

3.1. Theoretical background

We define the five motives for decision making regarding social preferences as follows. Let y_i and $y_{j\neq i}$ be the material payoffs of a player i and a set of other players $j \neq i$ (where the set can be a singleton, but can also include more than one other player). A player i that maximizes y_i regardless of $y_{j\neq i}$ in an allocation decision is said to be selfish (and subsumed under the category *Selfishness* in the following).

Social welfare considerations can take on various forms with two "extreme" special cases: if a subject maximizes the sum of payoffs ($\sum_{k=1}^{n} y_k$) she is classified as an *Efficiency*-oriented decision maker (following Utilitarian preferences), and if she maximizes the minimum payoff in her group of subjects she is denoted *Maximin*-motivated (following Rawlsian preferences).

Both forms of social welfare considerations (*Efficiency* and *Maximin*) play an important role in the well-known behavioral model of Charness and Rabin (2002).

Inequality aversion may also have a bearing on social welfare in that it may be informative about the relative importance between the two extreme points mentioned above. It could also be related to selfish concerns where one evaluates one's own income in relation to others' income. This will become apparent as we discuss primary as well as secondary social preferences. Inequality aversion has been captured in two seminal models. While in Fehr and Schmidt (1999) inequality is measured as the difference of one's own payoff to each of the other players' individual payoffs, and subjects have a disutility both from advantageous and disadvantageous inequality, in the ERC-model of Bolton and Ockenfels (2000) inequality is measured with respect to a subject's share of the total payoff in her group.

More precisely, the utility function of player i in the model of Fehr and Schmidt (1999) is specified as

$$U_i(y) = y_i - \alpha_i \frac{1}{n-1} \sum\nolimits_{j \neq i} max\left\{y_j - y_i, 0\right\} - \beta_i \frac{1}{n-1} \sum\nolimits_{j \neq i} max\left\{y_i - y_j, 0\right\} \tag{1}$$

where n is the number of players, and it is assumed that the inequality sensitivity parameters satisfy two assumptions: (i) $\beta_i \leq \alpha_i$, and (ii) $0 \leq \beta_i < 1$. Preferences according to Eq. (1), given that $\beta_i, \alpha_i > 0$, will be called the *F&S* motivation in our data analysis.

In the model of Bolton and Ockenfels (2000) player i maximizes her motivation function, which is given by

$$v_i = v_i(y_i, \sigma_i), \tag{2}$$

where y_i denotes the player i's own payoff and σ_i her share of the total payoff in her group. For any given y_i the value of the motivation function is maximized if $\sigma_i = 1/n$. Acting according to (2) will be classified as *ERC* motivated in the following.

3.2. Experimental design

In their seminal paper, Engelmann and Strobel (2004) have designed simple distribution games to explicitly test and discriminate between the above-mentioned motivations of social preferences. We, therefore, rely on several aspects of their experimental design in our study.[2]

In our experiment, each subject had to choose one out of three allocations in eight different games[3] that were originally designed by Engelmann and Strobel (2004) with the aim to discriminate between the different social preference motivations of *Selfishness*, *Efficiency*, *Maximin*, and inequality aversion of the *F&S*- or *ERC*-variant. Each allocation assigns each of three persons (labeled persons 1–3) a specific amount of money (see Tables 1–3). Decisions were always made in the role of person 2 who had to choose an allocation that distributed money to persons 1, 2, and 3. Only at the end of the experiment the roles of persons 1, 2, and 3 as well as payoff-relevant decisions were finally determined for each participant. Subjects were randomly assigned to groups of three people and the distribution chosen by person 2 was implemented.[4] The eight games can be grouped into three different sets of games that are introduced in the following.

3.2.1. Taxation games

In this set of games, the income of the decision maker (person 2) is the same in all three allocations and person 2 is always the "middle income" earner, while person 1 (person 3) is always the "high income" ("low income") earner. The decision maker has to decide on a distribution between high and low income, which resembles a redistributive tax system. We selected two out of the four taxation games used in Engelmann and Strobel (2004). The payoffs of the two games are presented in Table 1 (games **Fx** and **Ex** in Engelmann and Strobel, 2004).[5]

Obviously, one cannot identify a selfish motivation with taxation games, since the payoff for person 2 is the same in all three allocations. In both games, *Maximin* and *F&S* predict the same choice, while *ERC* predicts a different allocation choice than *F&S*. The efficient allocation (*Efficiency*) coincides in game **Fx** with *F&S* and *Maximin* and in game **Ex** with *ERC*. As a consequence, it is possible to distinguish the importance of the two inequality aversion models, *ERC* and *F&S*, without any confounding effects arising from efficiency concerns.

---

[2] Note that Engelmann and Strobel's (2004) results have initiated a discussion on the influence of different subject pools (such as economics versus non-economics students, or subjects not pursuing a college/university education) on results regarding the distribution of social preference types. See the comments by Fehr et al. (2006) and Bolton and Ockenfels (2006) on Engelmann and Strobel (2004) and the reply by Engelmann and Strobel (2006) for details. No reference was made in this discussion to the development of social preferences of children and adolescents.

[3] Following the literature we call the experimental task of choosing one out of three allocations a "game", although there is no strategic interaction. Strictly speaking, the task is an individual decision making task on the allocation of monetary payoffs. We also follow the terminology of Engelmann and Strobel (2004) when presenting the three subsets of games in Subsections 3.2.1–3.2.3.

[4] Note that Engelmann and Strobel (2004) also used decisions under role uncertainty in their main experiment, but report that determining roles right from the beginning in a control experiment (meaning that only participants in the role of person 2 had to make decisions) does not yield different results regarding the distribution of social preferences.

[5] For explanations regarding the predictions summarized in Table 1, see Engelmann and Strobel (2004). We have included in Tables 1–3 already the relative frequencies of actually chosen distributions. We shall refer to these results in Section 4.

Table 1
Taxation Games (payoffs in euro).

	Game **FX**			Game **EX**		
	Left	Middle	Right	Left	Middle	Right
Person 1 payoff	6.8	7.2	7.6	8.4	6.8	5.2
Person 2 payoff	4.0	4.0	4.0	4.8	4.8	4.8
Person 3 payoff	3.6	2	0.4	1.2	1.6	2.0
Total payoff	*14.4*	*13.2*	*12.0*	*14.4*	*13.2*	*12.0*
Prediction						
Selfish	Left	Middle	Right	Left	Middle	Right
Efficiency	Left			Left		
Maximin	Left					Right
F&S	Left					Right
ERC			Right	Left		
Choices, percentages						
Total sample ($N = 883$)	65.8	19.9	14.3	34.2	10.8	55.0
Boys ($N = 269$)	58.4	20.8	20.8	46.7	11.2	42.1
Girls ($N = 514$)	71.2	19.3	9.6	25.2	10.6	64.2
8/9 years old ($N = 116$)	53.5	18.1	28.5	40.4	17.5	42.1
10/11 years old ($N = 239$)	54.8	25.5	19.7	35.4	10.1	54.4
12/13 years old ($N = 210$)	68.6	21.4	10.0	28.2	9.1	62.7
14/15 years old ($N = 169$)	69.8	19.5	10.7	38.7	7.7	53.6
16/17 years old ($N = 149$)	84.6	10.7	4.7	30.9	12.8	56.4
Engelmann and Strobel (2004)	86.7	6.7	6.7	40.0	16.7	43.3
Chi^2-tests for differences*						
Gender differences		<0.001			0.001	
Age differences		0.001			0.019	
Age differences for boys		0.001			0.096	
Age differences for girls		0.001			0.030	

* p-values.

3.2.2. *Envy games*

In the three envy games presented in Table 2 (games **N**, **Nx**, and **Ny** in Engelmann and Strobel, 2004), the decision maker (i.e., person 2) is again the "middle income" earner. These games aim at eliciting preferences concerning inequality. Envy could make person 2 reduce the income of the high-income individual, although it would also reduce it for the low-income person. In game **N** the payoff of person 2 is fixed, and the *F&S*-choice is Pareto-dominated by the *ERC*-compliant allocation, whereas the *ERC*-choice is also Pareto-dominated by the efficient/maximin choices. Games **Nx** and **Ny** are necessary to distinguish between selfishness and the non-selfish motives.

3.2.3. *Rich and poor games*

Table 3 presents the third set of games. While the decision maker's payoff is held constant in each game, the relation to the other two players' payoffs varies. In game **R** (**P**) the decision maker is the richest (poorest) group member in any allocation, while in game **Ey** the decision maker is the "middle income" earner. In the "Rich and Poor" games, *F&S* and *ERC* predict the same choice of allocation. Consequently, these games are used to distinguish between efficiency concerns, maximin preferences, and inequality concerns.

3.3. *Experimental procedure*

The experiment was run in three elementary schools and four high schools in the Federal State of Tyrol, Austria. It was part of a larger series of experiments in which we visited the involved schools repeatedly over a period of two years, asking children to make decisions in different experimental tasks (for example, to study their risk and time preferences; see Sutter et al., 2013). There is an overlap in the subject pools used in Martinsson et al. (2011) and Fehr et al. (2013) and our paper. Out of the 883 subjects participating in the experiment of this paper, 705 had participated in Fehr et al. (2013) and 482 in Martinsson et al. (2011). In Section 2 we have presented the main research questions and results of these papers, and how we differ from them.

The whole project was approved by the State Board of Education of Tyrol and the principals of the selected schools. All parents of involved children were sent a letter with general information on the project and its aim to study economic decision making (including the information that children could earn money in the experiments), without revealing any specific details or experimental tasks to be completed. Parents were of course free not to approve participation of their children, but only five out of almost 900 did so. All other parents gave their consent.

Children and teenagers were also instructed clearly that participation was voluntary (and that they could earn money), but no single child refused to participate in any of the experiments that we conducted. Since the experiment was run during regular school hours, and given that all students in the selected classes participated, there is practically no self-selection

Table 2
Envy games (payoffs in euro).

	Game **N**			Game **NX**			Game **NY**		
	Left	Middle	Right	Left	Middle	Right	Left	Middle	Right
Person 1 payoff	6.4	5.2	4.0	6.4	5.2	4.0	4.0	5.2	6.4
Person 2 payoff	3.2	3.2	3.2	3.6	3.2	2.8	3.6	3.2	2.8
Person 3 payoff	2.0	1.2	0.4	2.0	1.2	0.4	0.4	1.2	2.0
Total payoff	*11.6*	*9.6*	*7.6*	*12.0*	*9.6*	*7.2*	*8.0*	*9.6*	*11.2*
Prediction									
Selfish	Left	Middle	Right	Left			Left		
Efficiency	Left			Left					Right
Maximin	Left			Left					Right
F&S			Right	Left		Right	Left		
ERC		Middle		Left	Middle		Left	Middle	
Choices, percentage									
Total sample ($N=883$)	67.2	12.5	20.3	87.9	7.9	4.2	42.7	18.0	39.2
Boys ($N=269$)	69.4	11.7	19.0	88.1	7.6	4.3	43.8	14.3	41.9
Girls ($N=514$)	65.7	13.1	21.3	87.8	8.0	4.1	42.0	20.7	37.3
8/9 years old ($N=116$)	47.0	17.4	35.7	74.8	13.9	11.3	41.4	17.2	41.4
10/11 years old ($N=239$)	66.1	13.0	20.9	84.8	9.3	5.9	42.0	10.1	47.9
12/13 years old ($N=210$)	69.5	9.5	21.0	92.9	3.3	3.8	45.7	14.3	40.0
14/15 years old ($N=169$)	73.4	13.6	13.0	87.6	11.2	1.2	34.3	25.4	40.2
16/17 years old ($N=149$)	74.5	10.7	14.8	96.6	3.4	0.0	50.3	28.2	21.5
Engelmann and Strobel (2004)	70.0	26.7	3.3	83.3	13.3	3.3	10.0	13.3	76.7
Chi^2-tests for differences*									
Gender differences	0.516			0.960			0.046		
Age differences	<0.001			0.001			0.001		
Age differences for boys	0.001			0.039			0.015		
Age differences for girls	0.123			0.001			0.001		

* p-values.

Table 3
"Rich and Poor" games (payoffs in euro).

	Game **R**			Game **R**			Game **EY**		
	Left	Middle	Right	Left	Middle	Right	Left	Middle	Right
Person 1 payoff	2.0	3.2	4.4	3.2	4.4	5.6	5.2	6.8	8.4
Person 2 payoff	4.8	4.8	4.8	1.6	1.6	1.6	3.6	3.6	3.6
Person 3 payoff	1.6	1.2	0.8	2.8	2.4	2.0	2.0	1.6	1.2
Total payoff	*8.4*	*9.2*	*10.0*	*7.6*	*8.4*	*9.2*	*10.8*	*12.0*	*13.2*
Prediction									
Selfish	Left	Middle	Right	Left	Middle	Right	Left	Middle	Right
Efficiency			Right			Right			Right
Maximin	Left			Left	Middle	Right	Left		
F&S			Right	Left			Left		
ERC			Right	Left			Left		
Choices, percentage									
Total sample ($N=883$)	46.3	27.5	26.3	37.4	21.7	40.9	47.6	15.3	37.1
Boys ($N=269$)	38.5	28.7	32.8	31.4	20.8	47.8	40.4	11.7	48.0
Girls ($N=514$)	51.9	26.6	21.5	41.7	22.4	35.9	52.8	18.0	29.2
8/9 years old ($N=116$)	49.1	24.1	26.7	35.3	21.6	43.1	44.8	16.4	38.8
10/11 years old ($N=239$)	45.4	19.3	35.3	39.8	19.3	41.0	51.1	19.0	30.0
12/13 years old ($N=210$)	50.7	21.5	27.8	41.0	24.8	34.3	50.5	15.2	34.3
14/15 years old ($N=169$)	38.5	44.4	17.2	30.8	21.3	47.9	39.1	13.0	47.9
16/17 years old ($N=149$)	48.0	32.4	19.6	37.6	22.2	40.3	50.0	11.5	38.5
Engelmann and Strobel (2004)	53.3	20.0	26.7	33.3	6.7	60.0	36.7	23.3	40.0
Chi2-tests for differences*									
Gender differences	0.001			0.001			0.001		
Age differences	<0.001			0.324			0.027		
Age differences for boys	0.013			0.316			0.236		
Age differences for girls	0.001			0.333			0.055		

Table 4
Number of participants by age and gender.

	All subjects			Subjects with correct answers in control questions			
	Girls	Boys	Total	Girls	Boys	Total	% valid
8/9 years (3rd grade)	56	60	**116**	31	33	**64**	55.2%
10/11 years (5th grade)	144	95	**239**	101	65	**166**	69.5%
12/13 years (7th grade)	122	88	**210**	96	74	**170**	81.0%
14/15 years (9th grade)	105	64	**169**	91	55	**146**	86.4%
16/17 years (11th grade)	86	63	**149**	77	56	**133**	89.3%
Total	513	370	**883**	396	283	**679**	76.9%

into the experiment. The participants were between eight and 17 years old. They were attending third, fifth, seventh, ninth, or eleventh grade in school. Table 4 presents the number of participants, split up by age and gender.[6]

The experiment was conducted as a pen-and-paper experiment in all 38 classes in which we conducted the experiment. Each single session was run jointly by the first (male) and third (female) authors of this paper, thus keeping conditions identical across sessions. The following procedure was used in all sessions: first, the instructions were explained, following a fixed script which is included in Appendix A1 in the Online Supplement.[7] Already in the course of explaining the experiment, subjects were given plenty of opportunities to ask private questions. It is important to stress that our explanations were visually supported by drawing "decision trees" on the blackboard in order to illustrate the choices to be taken and how role selection (as persons 1, 2, or 3) would take place. Furthermore, we went through many examples.

After the general explanation of the experimental task we asked subjects to answer two control questions that concerned the indication of payoffs contingent on particular choices and role assignments.[8] The sheet with the control questions was collected before we explained once more in public the correct solutions. Collecting these sheets allows us to check whether those subjects who made mistakes in the control questions make different choices in the experiment than those answering correctly. Overall, we had 679 out of 883 subjects who answered both questions correctly (accounting for 77% of the sample). The right-hand side of Table 4 shows the number of subjects with correct answers in each age group, indicating that the relative frequency of correct answers is increasing sharply with age. Since we explained the correct solutions *after* collecting the control questions, but *before* the experiment, and also answered any remaining questions on the control questions in detail, we are confident that participants understood the experimental task very well. For the analysis, we therefore present in the main text the results based on all 883 participants. In Appendix A3 in the Online Supplement, we provide a sensitivity analysis of our main results that excludes all participants with at least one incorrect answer in the control questions; hence, the results of this analysis are based on the 679 subjects with correct answers only. As it turns out, there are only minor differences between the two pools. In particular, taking the restricted sample renders selfish behavior less important (and sometimes insignificant), while the significance of all other social preferences remains practically unchanged.[9]

After the control questions had been worked through and no more questions remained unanswered, students were given their decision sheets and asked to make their eight choices. They could go back and forth and change their answers if they wished.

Students were informed at the beginning of the experiment that they would never be matched with someone from their own class, but with someone from the same grade in any of the schools participating in the experiment. The matching was determined after the experiment by randomly grouping persons 1, 2, and 3 from the same grade together, excluding class mates as potential matches. At the end of the experiment, each student answered a short questionnaire on demographic background data and then drew a card that determined her role (as person 1, 2, or 3) and then rolled an eight-sided dice to determine which decision was payoff-relevant.[10] Monetary earnings were distributed in sealed envelopes marked with a student's ID within two weeks after the experiment.[11]

[6] Note that one of the high schools involved is attended by girls only. Therefore, we have more girls than boys in our sample. There is no indication, however, that girls in the single-sex school exhibit a different behavior in our experiment than those in schools with co-education.

[7] Note that the translation of the fixed script does not account for the fact that, contingent on private questions that were taken by the experimenters, some parts of the instructions were repeated if necessary.

[8] The control questions were open questions. Consequently, nine possible answers could be given per control question (i.e. the nine different payoffs). Thus, getting both control questions right per mere guessing was very unlikely.

[9] Also when looking at the ranks of the five different motives, we notice a strong coincidence of the results in Table 5 and those presented in Appendix A3. Out of the ten panels (with age x gender), five show the exact same ranking, and in the other five there are two (out of the five) motivations that swap ranks, meaning that in total of the 50 ranks in Table 5 (5 per panel), 40 ranks are identical in Appendix A3, and the ten others are mutual swaps.

[10] We prepared for each age group the number of cards needed for all subjects to have full triples of person 1, person 2 and person 3. Hence, in each age group we had at most one triple that was incomplete. In the latter case, we used another person's decision a second time to substitute for the missing person in the triple, but everybody was of course paid based on exactly one decision of a person 2. Since it was independently determined for each subject which game was payoff-relevant, it may have been the case that someone made a decision relevant for themselves, but not for anyone else in a particular game (or vice versa). However, this fact should not matter for the decisions, since the payoff was determined by the assigned person 2 in the particular game that was chosen by the die roll.

[11] Since we were running several experiments with the children over the course of two years, children were sure (and had experienced it before) that we would come back and pay them the correct earnings according to the rules in the experiment.

In order to provide roughly the same relative monetary incentives to all participants we varied the stake sizes with age. Hence, the real payoffs were smaller in our game than in Engelmann and Strobel (2004), where subjects were university students.[12] The amounts presented in Tables 1–3 are in euros and euro-cents, and they applied for students aged 14–17 (grades nine and eleven). For the younger age groups (grades three, five, and seven) these amounts were divided by two to account for their significantly lower pocket money and purchasing power.[13] It should be noted that the school curriculum for third-graders in Austria includes a detailed treatment of money and how euros and euro-cents relate to each other and how money-amounts can be added or subtracted from each other. The lessons including this information had been prior to our experiment in the third grade, meaning that third-graders (and certainly all students in higher grades) were familiar with how to read the payoffs on our decision sheets and understood the examples that we used.

Finally, we would like to mention that we presented the games in a way that is slightly different from Engelmann and Strobel (2004). They had shown for each possible allocation the average payoff per person and the total sum of payoffs. The concept of an average is unfamiliar to the youngest children in our sample, and hence we did not mention it. Furthermore, we did not indicate the total sum of payoffs because we were afraid that this could provide a too strong focal point for the students' choices. As a consequence, we could keep the decision sheet as simple as possible.

4. Results

4.1. Overview of choices

The bottom panels of Tables 1–3 present an overview of the relative choice frequencies in the three different sets of games. We show overall averages ("Total sample"), average results for girls and boys separately, and also average results for each age group. In order to facilitate comparison of our results to choices made by adults we also include the relative choice frequencies from Engelmann and Strobel (2004) in the last line of each table. It is immediately obvious that our oldest participants (16- to 17-year olds) make decisions that are in most games similar to those in Engelmann and Strobel (2004). One marked exception is the Game **NX** where we observe a much larger frequency of selfish/inequality-motivated choices and a lower frequency of efficiency/maximin-motivated choices than Engelmann and Strobel (2004).

The general pattern in our data is that we find significant differences between the choices of girls and boys in all games except "Game **N**" and "game **Nx**" of the "Envy games". We also observe significant age differences in the choice frequencies in all games (least pronounced in "Game **P**" of the "Rich and Poor games"). In order to examine the influence of age and gender in greater detail and in a more rigorous way, we proceed in the following with an econometric analysis of the data.

4.2. Econometric analysis of social preferences

We conduct a maximum likelihood error-rate analysis of subjects' decisions following the general lines of the econometric model used in Costa-Gomes et al. (2001). The econometric model is a mixture model in which each subject's primary motivation is drawn from a common prior distribution over the five types of motivations *Selfishness*, *Efficiency*, *Maximin*, *F&S*, and *ERC*. A subject's motivation is assumed to be the same in all eight games, but decision makers are allowed to make errors.

More formally, let $i \in \{1, \ldots, N\}$ index the subjects and let $k \in \{1, \ldots, 5\}$ denote the different motivations of social preferences a subject can exhibit. Define $c \in \{1, 2, 3\}$ as the number of choices that are compatible with a given motivation k in a given game.[14] We assume that a k-motivated subject normally makes a k-compatible decision, but in each game the subject makes an error with probability $\varepsilon_k \in [0, 1]$. If a subject makes an error, she chooses each of the three available actions with probability 1/3. For a given k-motivated subject, the probability of a k-compatible decision in a given game is then $\frac{1}{c} - \frac{3-c}{3c}\varepsilon_k$. Accordingly, the probability of any single non *k-compatible* decision is $\frac{\varepsilon_k}{3}$. We assume that the errors are i.i.d. across games and subjects.[15]

The likelihood function is constructed as follows: let $T_{k,c}$ denote the total number of games in which there are c k-compatible decisions. Furthermore, x_k^{ic} represents the number of subject i's decisions that are compatible with k's behavior in games in which she has c k-motivated decisions, with $x_k^i = \left(x_k^{i1}, x_k^{i2}, x_k^{i3}\right)$, $x^i = \left(x_1^i, \ldots, x_5^i\right)$, and $x = \left(x^1, \ldots, x^N\right)$. Let p_k

[12] Given that the experiments by Engelmann and Strobel (2004) were incentivized using D-Mark, it implies that we multiplied real payoffs by 0.4 (0.8) for our younger (older) participants.

[13] According to the survey that we conducted with the same set of children, the average pocket money for 5th-graders is around € 5 per week, while it is about € 14 for 9th-graders. Age groups were provided with age-specific decision sheets with their payoffs in € stated accordingly.

[14] Recall that in some games the prediction for a specific motivation allows for more than one choice option.

[15] Engelmann and Strobel (2004) use a logit model in their estimation while we use a uniform distribution of the error term. Note that in the design of Engelmann and Strobel (2004) each subject faces only one decision, for which reason they cannot take into account any individual differences but have to focus on the "average subject" with all heterogeneity incorporated in the error. In our design each subject faces eight decisions, allowing us to take into account individual differences and to estimate the distribution of types directly (while the approach of Engelmann and Strobel, 2004, yields harder-to-interpret odds ratios).

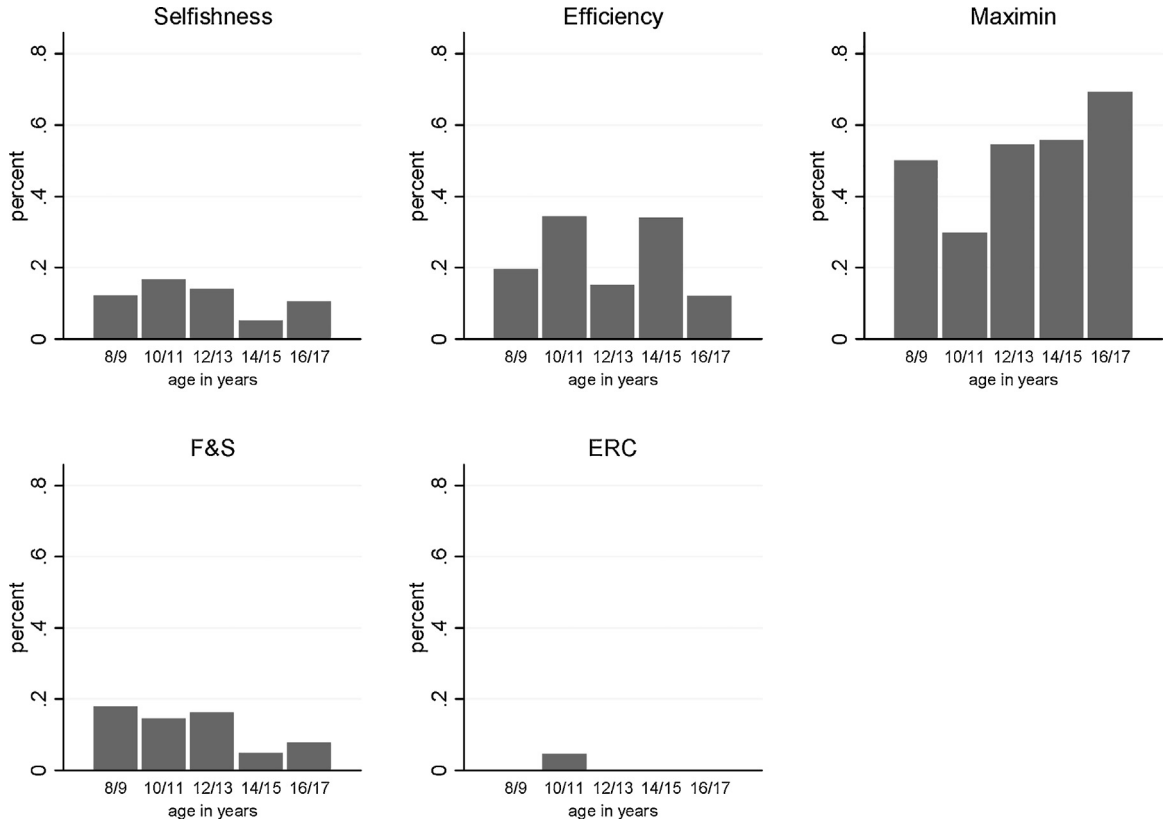

Fig. 1. Girls' estimated distribution of primary social preferences (based on Table 5).

denote a subject's common prior probability of being k-motivated, with $\sum_{k=1}^{5} p_k = 1$ and $p = (p_1, \ldots, p_5)$, while ε_k indicates the *error rate* of a k-motivated subject and $\varepsilon = (\varepsilon_1, \ldots, \varepsilon_5)$. The probability of observing a particular sample with x_k^i k compatible decisions when subject i is k-motivated can then be expressed as:

$$L_k^i\left(\varepsilon_k | x_k^i\right) = \prod\nolimits_{c=1,2,3} \left(\frac{1}{c} - \frac{3-c}{3c}\varepsilon_k\right)^{x_k^{ic}} \left(\frac{\varepsilon_k}{3}\right)^{T_{k,c} - x_k^{ic}}, \tag{3}$$

If one weighs the right-hand side by p_k, takes the sum over k, applies logarithms, and then sums over i, one gets the log-likelihood function for the entire sample:

$$\ln L(p, \varepsilon | x) = \sum_{i=5}^{N} \ln \sum_{k=1}^{5} p_k L_k^i\left(\varepsilon_k | x_k^i\right) \tag{4}$$

With five motivations the model has nine independent parameters: four independent motivation probabilities p_k, and five motivation error rates ε_k. We produce ten separate estimations for this set of parameters maximizing function (4), separately for each age group and gender.[16]

4.2.1. Primary social preference motivations

The estimated parameters $p = (p_1, \ldots, p_5)$ represent the distribution of social preference motivations and are given in Table 5 as well as presented graphically in Figs. 1 and 2.[17] A general pattern emerging from Table 5 is that *Efficiency* and *Maximin* explain the largest fraction of subjects' primary motivations indicating that social welfare as compared to selfish motives plays a major role. However, there are interesting effects of age and gender when considering single social

[16] We use an EM algorithm as proposed in the seminal paper of Dempster et al. (1977). Standard errors are estimated by bootstrapping.

[17] All the results presented here are robust to an alternative error structure reported in Appendix A4. In this alternative model, for a given motivation the non-compatible decisions have different probabilities to be chosen.

Table 5
Estimated distribution of primary social preferences by gender and age (full sample, standard errors in parenthesis).

		Girls		Boys	
	Motivation	Motivation probability p_k	Error rate ε_k	Motivation probability p_k	Error rate ε_k
Age group 8/9	Selfishness	0.122**	0.000***	0.321***	0.244***
		(0.061)	(0.125)	(0.116)	(0.169)
	Efficiency	0.197***	0.328***	0.303***	0.333***
		(0.067)	(0.087)	(0.073)	(0.070)
	Maximin	0.501***	0.630***	0.054	0.090***
		(0.104)	(0.076)	(0.046)	(0.253)
	F&S	0.180**	0.422***	0.163**	0.385**
		(0.077)	(0.100)	(0.077)	(0.263)
	ERC	0.000	1.000	0.159*	1.000
		(0.025)	(0.095)	(0.093)	(0.040)
	LogLikelihood	−434.99		−457.01	
Age group 10/11	Selfishness	0.166***	0.000***	0.128***	0.000***
		(0.046)	(0.076)	(0.049)	(0.113)
	Efficiency	0.345***	0.479***	0.362***	0.356***
		(0.050)	(0.037)	(0.060)	(0.054)
	Maximin	0.297***	0.227***	0.275***	0.365***
		(0.050)	(0.041)	(.065)	(0.079)
	F&S	0.146***	0.324***	0.150***	0.407***
		(0.039)	(0.042)	(0.052)	(0.079)
	ERC	0.046	1.000	0.086*	0.791
		(0.029)	(0.068)	(0.050)	(0.231)
	LogLikelihood	−1023.00		−690.06	
Age group 12/13	Selfishness	0.140***	0.203***	0.223***	0.000***
		(0.053)	(0.111)	(0.060)	(0.026)
	Efficiency	0.151***	0.394***	0.429***	0.414***
		(0.046)	(0.066)	(0.072)	(0.050)
	Maximin	0.546***	0.325***	0.292***	0.412***
		(0.060)	(0.031)	(0.079)	(0.061)
	F&S	0.163***	0.336***	0.055	0.213***
		(0.047)	(0.045)	(0.034)	(0.157)
	ERC	0.000	1.000	0.000	1.000
		(0.001)	(0.007)	(0.001)	(0.001)
	LogLikelihood	−830.69		−622.13	
Age group 14/15	Selfishness	0.052	0.000***	0.277***	0.456***
		(0.040)	(0.216)	(0.097)	(0.191)
	Efficiency	0.341***	0.491***	0.532***	0.388***
		(0.068)	(0.056)	(0.092)	(0.060)
	Maximin	0.558***	0.470***	0.192***	0.284***
		(0.079)	(0.043)	(0.074)	(0.106)
	F&S	0.048	0.343**	0.000	1.000
		(0.038)	(0.295)	(0.017)	(0.157)
	ERC	0.000	1.000	0.000	1.000
		(0.017)	(0.002)	(0.016)	(0.021)
	LogLikelihood	−777.06		−456.47	
Age group 16/17	Selfishness	0.106*	0.000***	0.215***	0.060***
		(0.059)	(0.084)	(0.078)	(0.076)
	Efficiency	0.121***	0.347***	0.507***	0.334***
		(0.043)	(0.065)	(0.078)	(0.030)
	Maximin	0.694***	0.437***	0.278***	0.301***
		(0.078)	(0.034)	(0.070)	(0.034)
	F&S	0.079	0.356***	0.000	0.276***
		(0.053)	(0.061)	(0.022)	(0.224)
	ERC	0.000	1.000	0.000	0.930*
		(0.001)	(0.012)	(0.001)	(0.040)
	LogLikelihood	−606.22		−411.00	
All age groups	Selfishness	0.126***	0.071***	0.226***	0.183***
		(0.026)	(0.078)	(0.039)	(0.081)
	Efficiency	0.249***	0.458***	0.433***	0.379***
		(0.027)	(0.03)	(0.033)	(0.025)
	Maximin	0.483***	0.387***	0.223***	0.341***
		(0.035)	(0.022)	(0.034)	(0.040)
	F&S	0.126***	0.348***	0.082***	0.355***
		(0.021)	(0.024)	(0.022)	(0.046)
	ERC	0.015	1.000	0.036	1.000
		(0.015)	(0.12)	(0.024)	(0.097)
	LogLikelihood	−3705.18		−2663.64	

Note: ***, **, * denote significance at the 1%, 5%, 10% level, for motivation probability the null hypothesis is $p_k = 0$, for error rate the null hypothesis is $\varepsilon_k = 1$ (i.e. random behavior).

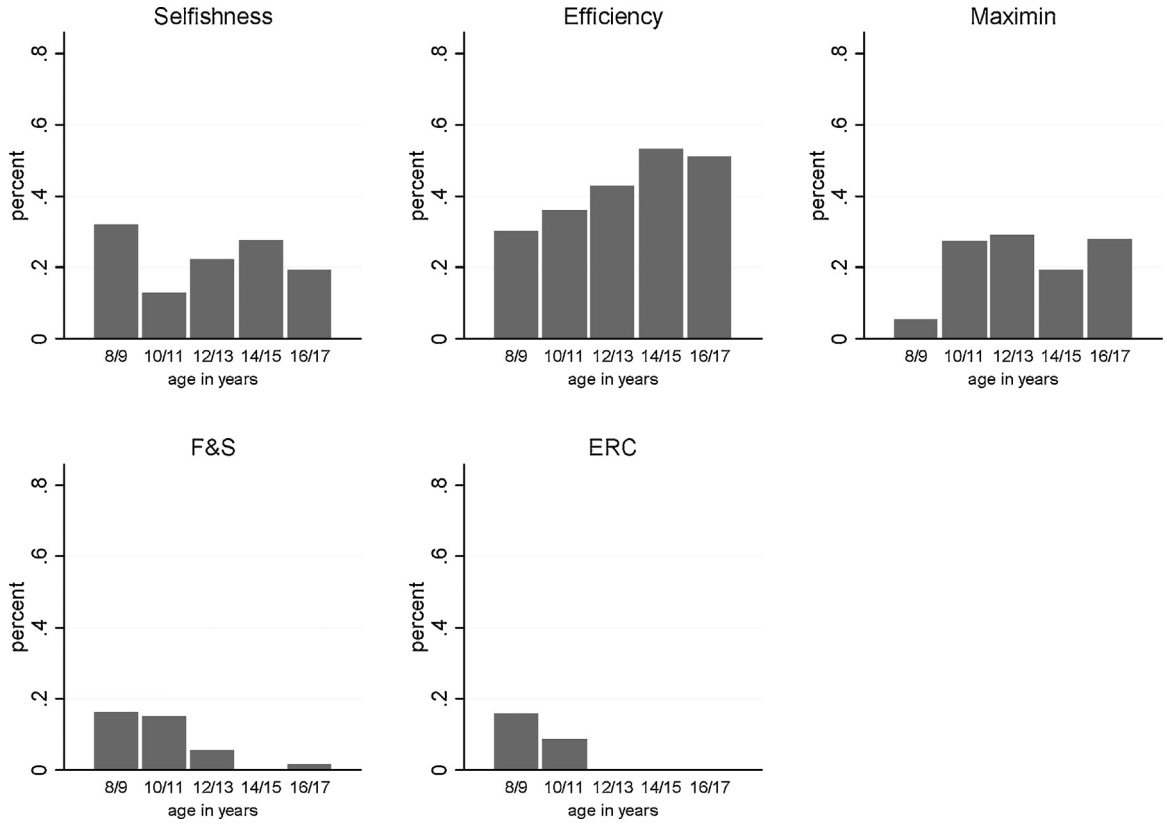

Fig. 2. Boys' estimated distribution of primary social preferences (based on Table 5).

preferences. From Fig. 1 as well as Table 5 it becomes obvious that girls are primarily *Maximin*-motivated and that this motivation increases with age. In total, roughly 50% of the girls have *Maximin* as their primary motivation. Among boys, Fig. 2 and Table 5 show that *Efficiency* is instead the most common social preference motive (in slightly more than 40% of boys, with an almost monotonic increase with age). *Efficiency* is also the second most common motivation among girls, but without the clear age profile as for boys. Among boys, more than 20% are primarily motivated by *Selfishness* and *Maximin*, respectively, while a much smaller share of girls display selfish preferences (12%). *F&S*-preferences are about as common among girls as *Selfishness*, and even less among boys. Moreover, these preferences become less prominent with age. More precisely, the estimated probability of *F&S*-preferences becomes even insignificant in the two oldest age groups (14/15 years and 16/17 years). *ERC*-preferences are not significant in any age group (borderline for boys of age eight to eleven), corroborating the conclusion of Engelmann and Strobel (2004) that *ERC* is not as suitable in explaining behavior as *F&S*.

To evaluate how well our model can explain the data, we counted how many observations correspond precisely to the behavior of the primary motivation subjects are assigned to. Using the estimated parameters, by Eq. (3) we calculated for each subject the probability to obtain the observed data, assuming that the individual has a given k-motivation, i.e. $p(x_i|k_i)$, where – with a slight abuse of notation – x_i denotes the choices and $k_i \in \{1, \ldots, 5\}$ denotes the primary motivation of individual i. Finally, using Bayes rule we can compute the probability that an individual i is k-motivated, given the observed choices, i.e., $p(k_i|x_i)$. For example, the probability that individual i is motivated by *Selfishness* ($k_i = 1$), given the observed choices x_i, is:

$$p(k_i = 1|x_i) = \frac{p(x_i|k_i = 1)\hat{p}_1}{p(x_i|k_i = 1)\hat{p}_1 + p(x_i|k_i = 2)\hat{p}_2 + p(x_i|k_i = 3)\hat{p}_3 + p(x_i|k_i = 4)\hat{p}_4 + p(x_i|k_i = 5)\hat{p}_5}.$$

Then we assign each individual to the primary motivation that gives us the highest posterior probability and use the assigned motivation for each individual to check if the observed behavior of the individual coincides with the predicted behavior. This way, we calculate the proportion of observations where subjects behave exactly in accordance with the primary motivation they were assigned to (Table 6). Across all age groups and both genders, this fraction ranges from 72.1% to 83.7%, thus indicating a large share of correctly predicted choices.[18]

[18] The predictions of the model are equally good for all groups, meaning that its fit does not depend on age and gender.

Table 6
Fraction of actual choices predicted correctly by the most likely primary motivation of each subject (in%).

	Girls	Boys
Age group 8/9	74.6	82.5
Age group 10/11	81.8	79.5
Age group 12/13	82.1	82.4
Age group 14/15	72.1	80.5
Age group 16/17	76.7	83.7

Table 7
Distribution of the second most likely motivation, conditional on the most likely primary motivation, by gender.

			Second most probable motivation				
			Selfishness	Efficiency	Maximin	F&S	ERC
Girls	Most probable motivation (primary motivation)	Selfishness	–	30.9	34.6	30.9	3.6
		Efficiency	11.5	–	67.7	0.0	20.8
		Maximin	21.8	43.2	–	34.7	0.4
		F&S	27.8	1.9	63.0	–	7.4
		ERC	0.0	33.3	33.3	33.3	–
Boys	Most probable motivation (primary motivation)	Selfishness	–	37.0	25.9	12.3	24.7
		Efficiency	49.7	–	37.9	1.3	11.1
		Maximin	41.7	38.5	–	13.5	6.3
		F&S	53.6	0.0	28.6	–	17.9
		ERC	16.7	50.0	16.7	16.7	–

4.2.2. Secondary social preference motivations

Our approach also allows checking the posterior distribution of a subject's most probable secondary motivation,[19] conditional on his or her primary motivation. This is important to look at because if a subject's primary motivation implies indifference between various choices (e.g., a selfish person is indifferent between choices in the taxation and rich-and-poor games), then the secondary motivation will become crucial for making the choice.

Table 7 presents the posterior distribution of the secondary motivations, conditional on primary motivations. In the rows we present, conditional on each of the primary motivations (whose posterior relative frequency is shown in Table A1 in the Online Supplement), the relative frequency with which any of the four remaining motivations is the most likely secondary motivation. We observe differences between girls and boys also here.

A majority of the girls have *Maximin* as their primary motivation, and among these, the secondary motivation is most likely *Efficiency*, followed by *F&S*. Among the 24% girls who are primarily *Efficiency*-motivated more than two thirds display *Maximin* as their secondary motivation, further corroborating that this motive plays a great role for girls' decision making.

Among the boys, the most common primary motivation is *Efficiency*, and the secondary motivations conditional on having *Efficiency* as the primary are about equally divided over *Selfishness* and *Maximin*. The boys whose primary motivation is instead *Selfishness* (*Maximin*) hold secondary motivations that are to the largest extent *Efficiency,* followed by *Maximin* (*Efficiency* and *Selfishness* are of roughly equal importance). Hence, Table 7 corroborates our finding that girls and boys differ clearly in their social preferences, also when taking secondary motivations into account.

4.2.3. Robustness check for primary social preference motivations

As a final robustness check of our results we assess the impact of age and gender on a subject's probability of having a specific primary motivation in another way: we assume that parameters p_k have the following multinomial logit specification:

$$p_k = \frac{e^{\alpha_{k,0}+\alpha_{k,1}\cdot gender+\alpha_{k,2}\cdot age+\alpha_{k,3}\cdot gen\_age}}{1+\sum_{h=1}^{4} e^{\alpha_{h,0}+\alpha_{h,1}\cdot gender+\alpha_{h,2}\cdot age+\alpha_{h,3}\cdot gen\_age}} \; for\, k \in \{1,2,3,4\} \tag{6}$$

$$p_5 = \frac{1}{1+\sum_{h=1}^{4} e^{\alpha_{h,0}+\alpha_{h,1}\cdot gender+\alpha_{h,2}\cdot age+\alpha_{h,3}\cdot gen\_age}} \tag{7}$$

where "gen_age" is the interaction variable between gender and age.[20] Specifications (6) and (7) are plugged into (4). Then we produce a one-step estimation, maximizing function (4), over the whole dataset.

By this specification the model has 21 parameters that we can use to estimate the marginal effect of age and gender on the prior probabilities of being *k*-motivated. Table 8 presents the results of this analysis.

[19] We assign each individual to the motivation that gives us the second highest posterior probability computed using the procedure described above.
[20] In this estimation, we use the exact age (in years and months) of the subjects at the time of the experimental sessions. This allows for a finer-grained estimation of the age affect.

Table 8
Marginal effect on the prior k-motivation probabilities.

Effect of/on		Selfishness	Efficiency	Maximin	F&S	ERC
Age	for Male	−0.010	0.026**	0.013	−0.022***	−0.007
		(0.014)	(0.013)	(0.011)	(0.006)	(0.007)
	for Female	−0.010	−0.014	0.043***	−0.014	−0.005
		(0.010)	(0.010)	(0.013)	(0.008)	(0.007)
Gender (female effect)	for age group 8/9	−0.019	−0.019	0.150**	−0.018	−0.093
		(0.072)	(0.068)	(0.066)	(0.071)	(0.109)
	for age group 10/11	−0.056	−0.143***	0.179***	0.030	−0.010
		(0.051)	(0.052)	(0.054)	(0.040)	(0.040)
	for age group 12/13	−0.062	−0.238***	0.235***	0.064**	0.002
		(0.041)	(0.041)	(0.044)	(0.032)	(0.016)
	for age group 14/15	−0.058	−0.309***	0.297***	0.069**	0.001
		(0.052)	(0.050)	(0.055)	(0.033)	(0.005)
	for age group 16/17	−0.052	−0.370***	0.362***	0.060*	0.000
		(0.067)	(0.070)	(0.078)	(0.033)	(0.001)

Notes: ***, **, * denote significance at the 1%, 5%, 10% level, standard errors in parentheses.
Marginal effects of age are computed evaluating the derivatives w.r.t age of equations (6) and (7), evaluated at the average age of male and female. Marginal effects of gender are computed taking the differences of equations (6) and (7) between female and male, evaluated at the average age of each age group.

Not many subjects hold *Selfishness* as their primary motivation. Although there are some differences (see Table A1) they are not statistically significant with respect to age and gender. The probability of holding *Efficiency* as the primary motivation is increasing with age for boys, but constant for girls. More precisely, the probability of having *Efficiency* as the primary motivation is the same for boys and girls in the youngest age group of eight- to nine-year olds, but it is significantly higher for boys in all other age groups. *Maximin*-preferences become more prominent with increasing age for girls, but their prominence remains constant across all age groups for boys, and it is significantly lower for boys than for girls in all age groups.

The likelihood of exhibiting *F&S*-preferences is decreasing with age for boys while it is constant for girls. There are no significant gender differences with respect to *F&S*-preferences in the two youngest age groups, up to the age of eleven years. In the three oldest age groups, girls exhibit significantly higher values, i.e., they care more about inequality than boys.

The overall picture emerging from Table 8 can be summarized as follows: efficiency-concerns become much more important, while inequality aversion becomes less important for boys as they grow older. The desire to maximize the payoff of the worst-off group member becomes more important when girls get older.

5. Discussion and conclusion

We have studied the influence of age and gender on the distribution of individual social preferences. In our experiment, subjects had to make eight different, fully incentivized allocation choices that were originally designed by Engelmann and Strobel (2004) to distinguish between five different social preference motivations: selfishness, efficiency concerns (by maximizing the sum of payoffs), maximin preferences (by maximizing the payoff of the worst off), and two forms of inequality aversion (based on the models by Fehr and Schmidt 1999, and Bolton and Ockenfels, 2000). We have run our experiments with almost 900 eight- to 17-year old children and adolescents. The experiments were conducted in school (from third to eleventh grade), with practically no drop-outs, thus avoiding potential problems that might arise from self-selection into experiments. A comparison of the behavior of our oldest subjects with the choices of the subjects in Engelmann and Strobel (2004) reveals that the decisions of both subject pools (i.e., our oldest high school students and the university students in Engelmann and Strobel, 2004) are largely in line with each other, except for one instance where their subjects lay an even stronger focus on efficiency/maximin-concerns.

Our experimental results show that inequality aversion turns out to be a significant motivation in our younger age groups of eight- to twelve-year olds. For the older age groups, however, we note that inequality aversion is no longer a significant motivation. Our findings on inequality aversion are in line with Fehr et al. (2013) and Martinsson et al. (2011), and they complement in an interesting way the results of Fehr et al. (2008). The latter have found that inequality aversion develops and becomes the most prominent motivation for allocation choices when children are seven to eight years old, compared to younger children of age three to six. Our findings show that inequality aversion as a motivating force may, indeed, reach a peak before the age of ten years and then decline in importance, especially for boys, making room for other concerns, especially efficiency-orientation. Note that a majority of children was found to be inequality averse in Fehr et al. (2008), while only about 20% of our youngest participants were classified as inequality averse. One potential source for this difference stems from the fact that Fehr et al. (2008) did not use money as a reward, while we did. Unpublished work by Fehr et al. (2017) suggests that using money – instead of goods such as fruits or stickers – in experiments with children reduces the fraction of inequality averse children.

We find that efficiency concerns are significantly increasing with age in our male sample (with the primary motivation ranging from about 30% at the age of eight to roughly 50% at the age of 17). For girls, the evidence is a bit more mixed, as the

estimated shares go up and down over the different age groups, but in almost all age groups (except the youngest ones) girls are significantly less efficiency-oriented than boys. The relative increase of efficiency concerns for boys is consistent with the findings reported in Almås et al. (2010), who have also found that boys care more about efficiency than girls. Moreover, a significant increase of efficiency concerns in the age group of nine- to 17-year olds and a stronger male focus on efficiency has also been documented in the paper by Fehr et al. (2013). In the study of Almås et al. (2010), girls also care relatively more about equality. Note that the two-person design of Almås et al. (2010) does not allow disentangling equality motives from maximin-preferences properly. Hence, their finding and ours, that girls are primarily maximin-motivated and thereby very equity concerned, could be fully consistent with each other, although we do not find very strong support for the two inequality measures when contrasted with the maximin motivation.

A novel feature of our experiment, compared to previous papers, was the estimation of both primary and secondary social preference motivations. As we have argued above, the most likely social preference motivation may imply indifference between various choices in some situations, which means that then the second most important motivation will become crucial for making the choice. Moreover, estimating both the primary and the secondary motivation gives a more nuanced picture of the complex interplay of social preferences.

Our main findings regarding secondary motivations are re-assuring for our results on primary motivations. Among the girls whose primary motivation is maximin, the secondary motivation is likely either efficiency or F&S. This indicates a strong preference for social welfare as compared to selfish motives, which scores low on both primary and secondary motivations among girls. The girls whose primary motivation is instead efficiency hold secondary motivations that are to more than two thirds maximin-motivated.

Among the boys whose primary motivation is efficiency, the secondary motivations are about equally divided between selfishness and maximin. The boys whose primary motivation is instead selfishness (maximin) hold secondary motivations that are to the largest extent efficiency-motivated followed by maximin (efficiency and selfishness are roughly equally important). Hence, although a non-negligible fraction of the boys displays maximin preferences as either primary or secondary motivation, the general picture is that girls are strongly equality-concerned, with maximin preferences as the strongest motive, while boys are more self- and efficiency-oriented and less concerned with equity.

Summing up, our experiment indicates that there are significant developments in revealed social preferences from eight-year old children to 17-year old adolescents and that there are also relevant gender differences.[21] The insights from our experiment can be considered of broader interest for several reasons: it seems plausible that social preferences shape many economically relevant decisions of teenagers, for instance in the domains of education, employment or charitable giving. Furthermore, economists might care about the development of social preferences in childhood and adolescence because the results of economic experiments might prove helpful in designing (economics and ethics) curricula in schools. For instance, experimental results could provide guidance on how to make children aware of different sharing norms and how to deal with conflicting norms. Future experiments could look at further motives or elaborate in even greater depth on the ones investigated here. It would also be interesting to see our results confirmed in an experiment that uses another set of decision tasks.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jebo.2017.12.007.

References

Almås, Ingvild, Cappelen, Alexander W., Ø. Sørensen, Erik, Tungodden, Bertil, 2010. Fairness and the development of inequality acceptance. Science 328 (May (28)), 1176–1178.

Benenson, Joyce F., Pascoe, Joanna, Radmore, Nicola, 2007. Children's altruistic behavior in the dictator game. Evol. Hum. Behav. 28 (3), 168–175.

Bolton, Gary E., Ockenfels, Axel, 2000. ERC: a theory of equity, reciprocity, and competition. Am. Econ. Rev. 90 (1), 166–193.

Bolton, Gary E., Ockenfels, Axel, 2006. Inequality aversion, efficiency, and maximin preferences in simple distribution experiments: comment. Am. Econ. Rev. 96 (5), 1906–1911.

Charness, Gary, Dufwenberg, Martin, 2006. Promises and partnership. Econometrica 74 (6), 1579–1601.

Charness, Gary, Rabin, Matthew, 2002. Understanding social preferences with simple tests. Q. J. Econ. 117 (3), 817–869.

Costa-Gomes, Miguel, Crawford, Vincent P., Broseta, Bruno, 2001. Cognition and behavior in normal-form games: an experimental study. Econometrica 69 (5), 1193–1235.

Croson, Rachel, Gneezy, Uri, 2009. Gender differences in preferences. J. Econ. Lit. 47 (2), 448–474.

Deckers, Torsten, Falk, Armin, Kosse, Fabian, Schildberg-Hörisch, Hannah, 2015. How Does Socio-Economic Status Shape a Child's Personality. University of Bonn (Working Paper).

Dempster, N.M., Laird, D.B., Rubin, 1977. Maximum likelihood from incomplete data via the EM algorithm. J. R. Stati. Soc. Ser. B (Methodological) 39 (1), 1–38.

Dufwenberg, Martin, Kirchsteiger, Georg, 2004. A theory of sequential reciprocity. Games Econ. Behav. 47 (2), 268–298.

Eckel, Catherine C., Grossman, Philip. J., 1998. Are women less selfish than men? Evidence from dictator experiments. Econ. J., 726–735.

Eckel, Catherine, Grossman, Philip J., Johnson, Cathleen A., de Oliveira, Angela C.M., Rojas, Christian, Wilson, Rick, 2011. Social norms of sharing in high school: teen giving in the dictator game. J. Econ. Behav. Organ. 80 (3), 603–612.

[21] For an excellent overview of gender differences in preferences of adults in a variety of games see Croson and Gneezy (2009).

Eisenberg, Nancy, Mussen, Paul H., 1989. The Roots of Prosocial Behavior in Children. Cambridge University Press, Cambridge.
Engelmann, Dirk, Strobel, Martin, 2004. Inequality aversion, efficiency, and maximin preferences in simple distribution experiments. Am. Econ. Rev. 94 (4), 857–869.
Engelmann, Dirk, Strobel, Martin, 2006. Inequality aversion, efficiency, and maximin preferences in simple distribution experiments: reply. Am. Econ. Rev. 96 (5), 1918–1923.
Falk, Armin, Fischbacher, Urs, 2006. A theory of reciprocity. Games Econ. Behav. 54 (2), 293–315.
Fehr, Ernst, Schmidt, Klaus M., 1999. A theory of fairness, competition, and cooperation. Q. J. Econ. 114 (3), 817–868.
Fehr, Ernst, Kirchsteiger, Georg, Riedl, Arno, 1993. Does fairness prevent market clearing? an experimental investigation. Q. J. Econ. 108 (2), 437–459.
Fehr, Ernst, Naef, Michael, Schmidt, Klaus M., 2006. Inequality aversion, efficiency, and maximin preferences in simple distribution experiments: comment. Am. Econ. Rev. 96 (5), 1912–1917.
Fehr, Ernst, Klein, Alexander, Schmidt, Klaus M., 2007. Fairness and contract design. Econometrica 75 (1), 121–154.
Fehr, Ernst, Bernhard, Helen, Rockenbach, Bettina, 2008. Egalitarianism in young children. Nature 454 (August (28)), 1079–1084.
Fehr, Ernst, Rützler, Daniela, Sutter, Matthias, 2013. The development of egalitarianism, altruism, spite and parochialism in childhood and adolescence. Euro. Econ. Rev. 64, 369–383.
Fehr, Ernst, Rützler, Daniela, Sutter, Matthias, 2017. The Antisocial Effects of Money on Children (Unpublished paper).
Fischbacher, Urs, Gächter, Simon, 2010. Social preferences, beliefs, and the dynamics of free riding in public goods experiments. Am. Econ. Rev. 100 (1), 541–556.
Gummerum, Michaela, Hanoch, Yaniv, Keller, Monika, Parsons, Katie, Hummel, Alegra, 2010. Preschoolers' allocations in the dictator game: the role of moral emotions. J. Econ. Psychol. 31 (1), 25–34.
Harbaugh, William T., Krause, Kate, Liday, Jr., Steven G., 2003. Bargaining by Children. University of Oregon (Working Paper).
Kerschbamer, Rudolf, 2015. The geometry of distributional preferences and a non-parametric identification approach: the equality equivalence test. Euro. Econ. Rev. 76, 85–103.
Kugler, Tamar, Bornstein, Gary, Kocher, Martin G., Sutter, Matthias, 2007. Trust between individuals and groups: groups are less trusting than individuals but just as trustworthy. J. Econ. Psychol. 28 (6), 646–657.
Levine, David K., 1998. Modeling altruism and spitefulness in experiments. Rev. Econ. Dynam. 1 (3), 593–622.
List, John A., 2011. The market for charitable giving. J. Econ. Perspect. 25 (2), 157–180.
Martinsson, Peter, Nordblom, Katarina, Rützler, Daniela, Sutter, Matthias, 2011. Social preferences during childhood and the role of gender and age –an experiment in Austria and Sweden. Econ. Lett. 110 (3), 248–251.
Rabin, Matthew., 1993. Incorporating fairness into game theory and economics. Am. Econ. Rev. 83 (5), 1281–1302.
Sutter, Matthias, Kocher, Martin G., Rützler, Daniela, Trautmann, Stefan T., 2013. Impatience and uncertainty: experimental decisions predict adolescents' field behavior. Am. Econ. Rev. 103 (1), 510–531.