Digit ratio (2D:4D) and prosocial behavior in economic games: No direct correlation with generosity, bargaining or trust-related behaviors

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Supplementary materials

Details on the protocol and analysis and Tables SM1-7

1) Details on the protocol and analysis

2D:4D measurement

At the end of each session, both the left and right hands of all the participants were scanned using a high-resolution scanner (Canon Slide 90). The lengths of the index and ring fingers were measured from the scanned images as the distance from the middle of the basal crease to the tip of the finger using Photoshop (see Neyse and Brañas-Garza, 2014). Computer-assisted measurements of 2D:4D from scanned pictures have been found to be more precise and reliable than measurements using other methods (Allaway et al., 2009; Kemper and Schwerdtfeger, 2009). The 2D:4D of each hand was measured twice at an interval of one month by the same experienced researcher (not involved in this paper). These measurements displayed a high repeatability (right hand: intraclass correlation coefficient (ICC) = 0.957, $p<0.001$, left hand: ICC = 0.944, $p<0.001$) and were averaged to obtain a single value of the 2D:4D ratio for each hand. As expected, the left-hand and right-hand 2D:4Ds were correlated within individuals (r = 0.67, $p<0.001$ for males; r =0.71, p < 0.001 for females; Pearson correlation) and males displayed lower 2D:4D than females (right-hand means [SD]: $2D:4D_M$ =0.960 [0.033], $2D:4D_F$ =0.972 [0.033], $p<0.001$; left-hand means: $2D:4D_M$ =0.965 [0.032], $2D:4D_F$ =0.976 [0.032], p<0.001; t-test).

Social behavior measurement - Economic games

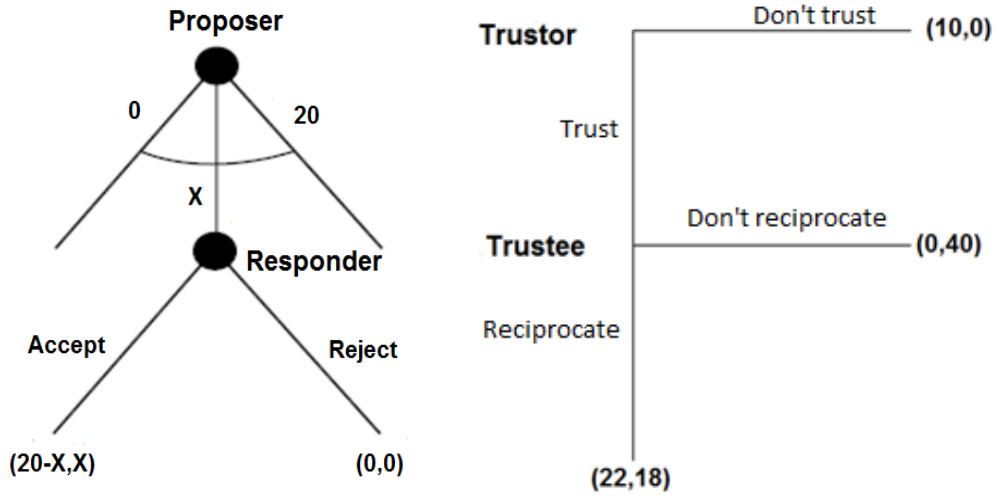
Our experiment consists of three canonical two-person games: the Dictator Game (hereafter 'DG'), the Ultimatum Game (UG), and the Trust Game (TG). The games were faced by each participant in random order and all participants played both roles in each game. For each decision, participants would be matched with a different anonymous individual selected at random among the other participants.

In the DG, one player, the Dictator, had to divide €20 between herself and another anonymous participant, the Receiver, who could not but accept the offer. In our experiment, subjects were only allowed to propose the split in €2 increments. We employ the amount of money donated to the other participant (*DG offer*) as a measure of generosity. Although the role of Receiver is passive in the DG, to make sure that Dictators' decisions affect others, the role of Receiver could have been selected for payment. That is, participants made five decisions but there existed six different roles for payment (and this was carefully explained to the participants).

In the UG (Güth et al., 1982; see Figure SM1), one player, the Proposer, had to propose a division of €20 between herself and another anonymous participant, the Responder, who—in contrast to the DG—could either accept or reject the proposal. If the latter accepted, the proposed division was implemented; in case of rejection, neither participant earned anything. Each subject participated in both roles. The *offer* made to the Responder will be our measure of Proposers' bargaining behavior. For the role of Responder, we used the strategy method: each subject had to state her willingness to accept or reject each of the possible proposals without knowing the offer of the Proposer. Below, we employ the minimum acceptable offer (hereafter '*mao'*)—the minimum amount of money that a subject would accept—as our measure of Responders' behavior. Such approach is common in the literature and the *mao* is typically interpreted as indicative for the Responder's willingness to punish the (unfair)

Proposer at a personal cost (e.g. Fehr and Fischbacher, 2003; Henrich et al., 2005; Brañas-Garza et al., 2006).

Figure SM1. Ultimatum (left) and Trust (right) Games in strategic form implemented in our study. The figure shows the payments (in €) associated to each of the possible outcomes for the Proposer (Trustor) and Responder (Trustee) in the Ultimatum (Trust) Game. The Dictator Game only differs from the Ultimatum Game in that the rejection option does not exist in the second stage and the payoffs consequently are (20-X,X).



As for the TG, we employ a binary version of the game (Ermisch et al., 2009; Figure SM1) and again resort to the strategy method. More precisely, one player, the Trustor, had to decide whether to pass €10 or €0 to the Trustee. If she passed €0, the Trustor earned €10 and the Trustee nothing; if she rather passed €10 (i.e., the Trustor trusted the Trustee), the latter would receive 4 × €10 = €40. In such a case, the Trustee had to decide whether to either send back €22 and keep €18 for herself (that is, being trustworthy) or keep all €40 without sending anything back, in which case the Trustor would not earn anything. The Trustor's decision thus measures trust, whereas the Trustee's decision measures positive reciprocity. Figure 1

displays the extensive form of the TG implemented. In the analysis below, *TG trust=1* if the participant chose to pass the money to the Trustee and 0 otherwise. Similarly, *TG reciprocity=1* if as a Trustee the participant chose to return the money to the Trustor and 0 otherwise.

Additional variables

As noted before, we administered all participants a survey eliciting a large amount of information (including *gender*, *age*, *household income, math skills,* and *social capital*). Besides we also include questions on life satisfaction, cognitive reflection and risk attitudes.

We measured participants' subjective well-being through the *life satisfaction* question (Zilioli et al., 2015; Espín et al., 2016b): "*In a scale from 1 to 7, where 1 means 'completely unsatisfied' and 7 means 'completely satisfied', in general, how satisfied are you with your life?*".

In addition, we also control for two measures of cognitive functioning. The first one is given by the number of correct responses in a simple *math* skills test (from 0 to 4). The second one measures the participants' tendency to *reflect* on their first intuition (i.e., their cognitive style, intuitive vs. reflective) and is given by the number of correct answers (from 0 to 3) in the Cognitive Reflection Test (Frederick, 2005). Cognitive skills and cognitive styles have been previously related to both social behaviors (Burks et al. 2009; Corgnet et al., 2015; Al-Ubaydli et al., 2016; Cabrales et al., 2017; Capraro et al., 2017) and 2D:4D (Brañas-Garza and Rustichini, 2011; Bosch-Domènech et al., 2014; Cueva et al., 2017) and thus represent potential confounding factors.

Social capital is measured using the so-called "trust question" from the General Social Survey and is included to control for the social environment where the participant typically interacts in daily life, i.e. whether people around can in general be trusted or not (binary

variable): "*Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?*"

Finally, our battery of controls includes three measures for participants' *risk attitudes* obtained from a series of binary decisions involving (hypothetical) monetary lotteries. Risk attitudes may correlate with both social behavior (Bohnet and Zeckhauser, 2004; Corgnet et al., 2016) and 2D:4D (e.g. Brañas-Garza and Rustichini, 2011; Brañas-Garza et al., 2018).

Econometric analysis

We first run a series of regression models. Our five social behavior measures (*DG offer*, *UG offer*, *UG mao*, *TG trust,* and *TG reciprocity*) are regressed on 2D:4D and 2D:4D-squared (*2D:4D-sq*; to test for non-linear relationships, e.g. Brañas-Garza et al., 2013). Additionally, since 2D:4D is sexually dimorphic, the relation between 2D:4D and behavioral traits is often gender-specific (e.g Brañas-Garza and Rustichini, 2011), the adherence to sharing rules may differ across men and women (Croson and Gneezy, 2009; Espinosa and Kovářík, 2015), and testosterone affects men and women asymmetrically (Zethraeus et al., 2009; Eisenegger et al., 2010), we use a dummy variable to control for gender and the interaction between gender and either 2D:4D or 2D:4D-squared. The regressions are conducted both with and without other control variables and for both the left- and right-hand 2D:4D. The control variables are *order effects*, *age*, *income*, *life satisfaction*, *social capital*, *math*, *reflection*, and *risk attitudes*. We use Ordinary Least Squares regressions for *DG offer*, *UG offer,* and *UG mao*, and logistic regressions for *TG trust* and *TG reciprocity*.

The analysis was performed using Stata/SE 15.1 (StataCorp).

2) Supplementary Tables

Table SM1. Descriptive statistics of 2D:4D, game outcomes and control variables

Variables	Mean or percentage	SD	Min	Max
Right 2D:4D	0.97	0.03	0.87	1.09
Left 2D:4D	0.97	0.03	0.88	1.07
Game outcomes				
DG offer	8.26	3.41	0	20
UG offer	9.56	1.67	0	20
UG mao	6.00	3.07	0	10
TG trust (%)	69.29		0	1
TG reciprocity (%)	79.11		0	1
Control variables				
Male (%)	41.07		0	1
Age	17.97	1.82	18	29
Household income	2.13	0.75	0	4
Life satisfaction	5.68	1.05	1	7
Social capital (%)	21.96		0	1
Math	2.46	0.81	0	4
Reflect (CRT)	0.72	0.95	0	3
Risk 1 (%)	9.82		0	1
Risk 2 (%)	33.04		0	1
Risk 3 (%)	11.96		0	1
Sample size	560			

Note: Percentages of cases '=1' are displayed for binary variables (0/1)

Table SM2. Bivariate relationships between all variables (Pearson, t-test and p-test)

	DG off	UG offer	UG MAO	TG trust	TG Rec	R 2D:4D	L 2D:4D
UG offer	0.28***						
UG mao	-0.03	0.09**					
TG trust	1.71*	-0.28	-1.79*				
TG reciprocity	5.39***	1.68*	-0.20	3.62***			
Right 2D:4D	0.06	-0.02	0.00	0.25	0.18		
Left 2D:4D	0.07	-0.02	0.01	-0.47	0.49	0.70***	
Male	-0.07	0.71	-0.89	1.42	0.87	-4.50***	-4.00***
Age	0.02	0.02	-0.03	1.18	0.08	0.06	0.05
Household income	-0.00	-0.01	-0.07	0.67	-0.35	0.00	-0.03
Life satisfaction	-0.01	-0.02	0.03	0.75	1.88*	-0.03	0.01
Social capital	1.37	1.32	-1.26	1.06	-0.83	0.97	1.74*
Math	-0.06	0.03	-0.06	0.15	2.35**	-0.02	0.01
Reflect (CRT)	-0.04	0.03	-0.06	0.30	1.29	-0.16	-0.13
Risk 1	1.65	-0.81	0.74	2.43**	0.87	1.31	1.43
Risk 2	-0.71	-1.70*	-0.76	0.74	-1.62	0.54	0.59
Risk 3	1.48	-1.15	-0.68	2.14**	-1.28	0.03	-0.32
	Male	Age	Household income	Social capital	Math	Life satisfaction	Reflect (CRT)
Age	3.18***						
Household income	1.19	-0.11***					
Social capital	3.42***	2.36**	-0.85				
Math	4.45***	0.03	0.00	1.39			
Life satisfaction	2.67***	-0.15***	0.11**	2.55**	0.09**		
Reflect (CRT)	4.61***	-0.01	-0.06	0.78	0.19***	0.02	
Risk 1	2.72***	-0.30	-0.38	1.00	1.04	1.32	1.10
Risk 2	2.19**	-2.51**	1.60	1.82*	2.09**	0.65	0.14
Risk 3	1.72*	-1.18	1.33	1.98**	0.24	2.39**	-0.05
	Risk 1	Risk 2					
Risk 2	4.78***						
Risk 3	1.93*	3.28***					

Note: Pearson correlation coefficients are displayed for the relationship between two continuous variables; for the relationship between a continuous and a binary variable, we report the t-statistic from t-tests (negative sign: 0>1, positive sign: 1>0; see Table SM1); for the relationship between two binary variables, we report the z-statistic from proportion tests (negative sign: negative relationship, positive sign: positive relationship). ***p<0.01, **p<0.05, *p<0.1

Table SM3. DG offer as a function of 2D:4D

RIGHT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	7.038*	5.717	-177.111	-121.709	3.197	1.927	-251.985	-216.667
	(0.056)	(0.120)	(0.208)	(0.387)	(0.462)	(0.664)	(0.143)	(0.202)
Male	0.070	0.005	0.058	-0.005	-9.046	-8.914	-37.451	-62.821
	(0.812)	(0.988)	(0.844)	(0.987)	(0.229)	(0.247)	(0.787)	(0.671)
$2D:4D^2$			94.754	65.543			130.738	111.933
			(0.189)	(0.364)			(0.138)	(0.199)
2D:4D *Male					9.449	9.248	65.609	118.630
					(0.220)	(0.240)	(0.818)	(0.697)
$2D:4D^2$*Male							-27.678	-55.411
							(0.850)	(0.723)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

LEFT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	7.504*	5.784	-97.719	-145.191	1.579	0.294	-125.801	-185.837
	(0.084)	(0.166)	(0.642)	(0.497)	(0.759)	(0.953)	(0.622)	(0.472)
Male	0.062	-0.002	0.061	-0.006	-14.252	-13.185	16.890	0.940
	(0.833)	(0.995)	(0.835)	(0.986)	(0.106)	(0.139)	(0.931)	(0.996)
$2D:4D^2$			54.083	77.589			65.308	95.412
			(0.616)	(0.479)			(0.619)	(0.473)
2D:4D *Male					14.769	13.606	-50.361	-16.761
					(0.101)	(0.134)	(0.900)	(0.969)
$2D:4D^2$*Male							34.008	16.272
							(0.868)	(0.941)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Note: Eight different models are estimated for the 2D:4D of each hand. Models labeled with even numbers include the following control variables: order effects, age, income, life satisfaction, social capital, math, reflection, and risk attitudes. Estimates of OLS regressions (p-values). *** p<0.01, ** p<0.05, * p<0.1

Table SM4. UG offer as a function of 2D:4D

RIGHT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-0.795	-0.754	119.560	99.483	-19.49	-1.417	66.154	48.608
	(0.685)	(0.706)	(0.103)	(0.1429	(0.448)	(0.577)	(0.521)	(0.619)
Male	0.095	0.111	0.103	0.118	-2.643	-1.464	-59.721	-61.474
	(0.529)	(0.531)	(0.496)	(0.503)	(0.494)	(0.701)	(0.420)	(0.397)
$2D:4D^2$			-61.929	-51.559			-34.891	-25.629
			(0.100)	(0.138)			(0.508)	(0.607)
2D:4D *Male					2.838	1.633	121.941	126.595
					(0.475)	(0.675)	(0.425)	(0.398)
$2D:4D^2$*Male							-62.049	-64.970
							(0.430)	(0.399)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

LEFT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-1.016	-0.903	40.589	31.333	-3.306	-3.009	-45.680	-62.339
	(0.655)	(0.703)	(0.652)	(0.742)	(0.205)	(0.244)	(0.569)	(0.492)
Male	0.094	0.110	0.094	0.111	-5.440	-4.965	-91.337	-99.727
	(0.531)	(0.535)	(0.529)	(0.533)	(0.251)	(0.297)	(0.357)	(0.375)
$2D:4D^2$			-21.384	-16.570			21.725	30.412
			(0.643)	(0.733)			(0.598)	(0.513)
2D:4D *Male					5.709	5.236	182.295	200.627
					(0.240)	(0.281)	(0.370)	(0.387)
$2D:4D^2$*Male							-91.274	-100.610
							(0.384)	(0.400)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Note: Eight different models are estimated for the 2D:4D of each hand. Models labeled with even numbers include the following control variables: order effects, age, income, life satisfaction, social capital, math, reflection, and risk attitudes. Estimates of OLS regressions (p-values). *** p<0.01, ** p<0.05, * p<0.1

Table SM5. UG MAO as a function of 2D:4D

RIGHT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-0.525	-1.804	-104.860	-37.509	-1.910	-3.282	-79.306	-44.706
	(0.890)	(0.621)	(0.477)	(0.792)	(0.673)	(0.455)	(0.609)	(0.775)
Male	-0.243	0.033	-0.250	0.030	-3.531	-3.480	54.744	11.729
	(0.367)	(0.908)	(0.352)	(0.916)	(0.647)	(0.636)	(0.730)	(0.949)
$2D:4D^2$			53.686	18.366			31.678	21.218
			(0.479)	(0.802)			(0.618)	(0.791)
2D:4D *Male					3.408	3.641	-118.279	-28.341
					(0.670)	(0.633)	(0.719)	(0.930)
$2D:4D^2$*Male							63.439	16.785
							(0.708)	(0.919)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

LEFT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	0.389	-1.110	-317.134*	-185.407	2.419	0.730	-282.032	-166.678
	(0.920)	(0.773)	(0.075)	(0.302)	(0.617)	(0.880)	(0.197)	(0.470)
Male	-0.231	0.043	-0.234	0.039	4.673	4.477	134.006	11.825
	(0.391)	(0.880)	(0.384)	(0.891)	(0.551)	(0.554)	(0.851)	(0.949)
$2D:4D^2$			163.201*	94.759			145.838	85.843
			(0.076)	(0.306)			(0.195)	(0.470)
2D:4D *Male					-5.060	-4.575	-67.432	-20.782
					(0.531)	(0.558)	(0.857)	(0.957)
$2D:4D^2$*Male							33.088	8.886
							(0.864)	(0.964)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Note: Eight different models are estimated for the 2D:4D of each hand. Models labeled with even numbers include the following control variables: order effects, age, income, life satisfaction, social capital, math, reflection, and risk attitudes. Estimates of OLS regressions (p-values). *** p<0.01, ** p<0.05, * p<0.1

Table SM6. TG trust as a function of 2D:4D

RIGHT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	1.463	0.878	-38.939	-31.118	1.961	1.489	-55.377	-50.114
	(0.594)	(0.760)	(0.733)	(0.782)	(0.573)	(0.679)	(0.692)	(0.721)
Male	0.287	0.124	0.284	0.122	1.544	1.662	-25.762	-32.615
	(0.136)	(0.559)	(0.140)	(0.566)	(0.777)	(0.774)	(0.827)	(0.780)
$2D:4D^2$			20.799	16.465			29.405	26.431
			(0.723)	(0.776)			(0.682)	(0.713)
2D:4D *Male					-1.304	-1.596	54.763	68.952
					(0.818)	(0.790)	(0.821)	(0.774)
$2D:4D^2$*Male							-28.748	-36.259
							(0.818)	(0.770)
Controls	no	yes	no	yes	no	yes	no	Yes
Observations	560	560	560	560	560	560	560	560

LEFT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-0.690	-0.627	172.769	182.877	0.879	-0.011	295.392*	292.150*
	(0.817)	(0.597)	(0.160)	(0.147)	(0.818)	(0.998)	(0.055)	(0.061)
Male	0.260	0.092	0.263	0.092	4.292	4.265	154.786	137.625
	(0.176)	(0.665)	(0.173)	(0.666)	(0.464)	(0.494)	(0.233)	(0.320)
$2D:4D^2$			-89.122	-94.812			-151.029*	-149.861*
			(0.158)	(0.143)			(0.055)	(0.061)
2D:4D *Male					-4.158	-4.307	-313.274	-278.120
					(0.491)	(0.502)	(0.241)	(0.328)
$2D:4D^2$*Male							158.553	140.384
							(0.248)	(0.336)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Note: Eight different models are estimated for the 2D:4D of each hand. Models labeled with even numbers include the following control variables: order effects, age, income, life satisfaction, social capital, math, reflection, and risk attitudes. Estimates of logistic regressions (p-values). *** p<0.01, ** p<0.05, * p<0.1

Table SM7. TG reciprocity as a function of 2D:4D

RIGHT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	1.093	1.696	-153.481	-178.953	-3.042	-2.541	-204.001	-253.795
	(0.707)	(0.588)	(0.220)	(0.149)	(0.416)	(0.529)	(0.218)	(0.153)
Male	0.197	0.052	0.187	0.035	-10.587*	-10.932*	48.031	59.753
	(0.355)	(0.828)	(0.378)	(0.884)	(0.070)	(0.072)	(0.705)	(0.663)
$2D:4D^2$			79.600	92.967			102.783	128.311
			(0.216)	(0.146)			(0.224)	(0.156)
2D:4D *Male					11.204*	11.417*	-114.918	-141.702
					(0.065)	(0.070)	(0.661)	(0.618)
$2D:4D^2$*Male							67.768	82.686
							(0.616)	(0.574)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

LEFT HAND

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	2.105	2.182	-126.253	-156.532	-0.573	-0.893	-292.803	-355.024
	(0.501)	(0.527)	(0.459)	(0.392)	(0.881)	(0.8349	(0.240)	(0.180)
Male	0.206	0.055	0.206	0.054	-6.833	-8.055	-163.398	-193.792
	(0.336)	(0.821)	(0.337)	(0.823)	(0.287)	(0.240)	(0.321)	(0.273)
$2D:4D^2$			66.049	81.692			141.745	181.472
			(0.452)	(0.386)			(0.243)	(0.183)
2D:4D *Male					7.279	8.392	328.816	389.684
					(0.273)	(0.237)	(0.332)	(0.285)
$2D:4D^2$*Male							-164.920	-195.486
							(0.344)	(0.298)
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Note: Eight different models are estimated for the 2D:4D of each hand. Models labeled with even numbers include the following control variables: order effects, age, income, life satisfaction, social capital, math, reflection, and risk attitudes. Estimates of logistic regressions (p-values). *** p<0.01, ** p<0.05, * p<0.1

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