Prenatal Stress and Cooperation: Evidence from a Public Goods Game in Post-Conflict Uganda

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Abstract

We study the impact of prenatal stress on later-life social preferences. We play a public goods game with Ugandan children born during a conflict characterized by high civilian victimization. To proxy for prenatal stress we use the 2D:4D digit ratio—a marker of fetal hormone exposure associated with maternal distress during early fetal development. We find that a rise in our proxy robustly reduces the probability of cooperation. Our findings extend the fetal origins literature to the domain of preferences. If severe prenatal stress affects next generation's taste for cooperation, violent conflict may have farther reaching consequences than previously thought.

1 Introduction

The nine months in utero may well be the most critical time in a person's life (Almond and Currie, 2011). Later-life characteristics are increasingly associated with "fetal origins", not only with respect to future abilities and health trajectories. In fact, suffering from severe trauma and stress during pregnancy alters the hormone exposure of the child, triggering epigenetic processes that may shape brain evolution and behavior (Dörner et al., 2001; Keverne and Curley, 2008). Different scientific disciplines have studied the correlation of prenatal hormone exposure with sexual identity, personality traits, and even financial trading ability (Csathó et al., 2003; Luxen and Buunk, 2005; Coates et al., 2009). In the lab, economists have investigated its relationship to altruism, cooperation in public goods games, and risk preferences (Garbarino et al., 2010; Buser, 2012; Brañas-Garza et al., 2013). To better understand the causality behind these relationships we bring these studies to the field, and look at the impact of prenatal stress on the preferences for cooperation of children born during an armed conflict that indiscriminately targeted unarmed civilians.

We play a dichotomous one-shot public goods game with 442 children born in Pader district in Northern Uganda during the 1998-2006 period of intense fighting between government forces and the Lord's Resistance Army (LRA). Simultaneously, we conduct an extensive socio-economic questionnaire including war exposure (victimization), post-traumatic stress disorder (PTSD) symptoms, and a closely related public goods game with their main caregiver. To proxy for prenatal stress we use the children's 2D:4D digit ratio—a marker of in utero hormone exposure (Manning et al., 2003; Lutchmaya et al., 2004; Zheng and Cohn, 2011). The 2D:4D digit ratio measures the relative length of the index finger with respect to the ring finger. It develops mostly during early gestational stages and remains relatively

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stable throughout life. It is established through an epigenetic process in which hormones released by the mother's body modify the gene expressions of the fetus—rather than altering the genetic code itself. As such, it represents an interaction of nature – the child's genetic code – and nurture—the mother's hormonal reaction to environmental stimuli. In particular, the 2D:4D digit ratio is negatively related to the fetal testosterone-to-estradiol (T:E2) ratio (Manning et al., 2003; Lutchmaya et al., 2004). Higher levels of maternal distress are associated with higher fetal testosterone levels (Ward and Weisz, 1980), higher fetal T:E2 ratios (Vom Saal et al., 1990), and lower offspring 2D:4D digit ratios (Lilley et al., 2010). Therefore, under the assumption that war exposure and traumatization where conditionally unconfounded in our context (Doom and Vlassenroot, 1999; Jackson, 2002; Blattman, 2009; Blattman and Annan, 2010), causal impacts of prenatal stress on public good contributions can be estimated using relative digit ratios as a proxy.

We find that prenatal stress does indeed affect later-life preferences for cooperation: a one standard deviation rise in our marker of prenatal stress reduces the child's probability of contribution to the public good by between 7 and 8 percentage points (or 17-20% of the mean prevalence). We control for alternative mechanisms such as early life deprivation, caregiver public good contributions (capturing environmental and genetic transmission), and war exposure after birth. We show that caregiver PTSD predicts lower digit ratios in children, but caregiver digit ratios do not predict caregiver traumatization—suggesting that in our setting self-selection into trauma is not the main driver of this relationship. Also, the children in our sample have significantly lower digit ratios than their biological mothers and siblings born before the war. We discuss the sensitivity to exogeneity assumptions, and the likelihood that our findings are driven by unobserved characteristics. We shed light on an alternative, epigenetic mechanism of preference transmission—beyond the standard nature-nurture debate. Preferences for cooperation may be endogenously determined right from the womb. If prenatal stress affects next generation's taste for cooperation, violent conflict may have farther reaching socio-economic consequences than previously thought. It may affect long-run development trajectories and post-conflict recovery across generations, even if the episodes of violence are limited in time.

The rest of the paper is organized as follows. Section 2 reviews the literature on the subject. Section 3 describes the context and background. Section 4 outlines the experimental design. Section 5 illustrates the empirical strategy and results, and Section 6 concludes.

2 Prenatal stress, preferences, and conflict

This paper explores the fetal origins of preferences for cooperation in a post-conflict setting. It builds upon three strands of literature—that on the consequences of trauma in utero, that on the relationship between prenatal hormone exposure and economic behavior, and that on the role of violent conflict in shaping preferences.

Several studies have investigated the physical and psychological consequences of stress and traumatic events in utero. Maternal prenatal anxiety may suppress the development of a functioning immune system, increasing the incidence of several health complications in infants (Stott, 1973). Moreover, exposure to violence during pregnancy has been found to deteriorate birth outcomes, typically in terms of birth weight, fetal growth, and preterm delivery (Mancuso et al., 2004; Lauderdale, 2006; Camacho, 2008; Foureaux Koppensteiner and Manacorda, 2013; Black et al., 2014; Quintana-Domeque and Rodenas, 2014).[1] Independent positive shocks, such as a rise in cocoa price at birth – expected to reduce financial distress in cocoa-producing areas of Ghana with respect to other regions – decrease the likelihood of

[1] While the mechanisms through which maternal stress influences birth outcomes are still subject to intensive investigation, the leading hypotheses identify three channels: neuroendocrine, inflammatory/immune, and behavioral. See Hobel et al. (2008) and Dunkel Schetter (2011) for an overview of the biopsychosocial processes.

mental distress during adulthood (Adhvaryu et al., 2015). Prenatal negative shocks, such as extreme weather or military invasions, are instead associated with higher prevalence of schizophrenia and autism van Os and Selten (1998); Walder et al. (2014).

In adults, the prolonged emotional disturbance and distress induced by conflict increases the likelihood of trauma, mental health problems, and PTSD (de Jong, 2002; Lopes Cardozo et al., 2004; Miller et al., 2008). The higher the post-traumatic hormonal release, the greater the chance that subjects develop PTSD (Delahanty et al., 2000). PTSD, in turn, increases the likelihood of persistent hormonal imbalance, particularly with respect to cortisol—the human stress hormone de Kloet et al. (2008); Song et al. (2008); Steudte et al. (2011). During pregnancy, maternal stress is transmitted to the fetus through hormonal releases (Mancuso et al., 2004; Weinstock, 2008). Due to obvious ethical considerations, experimental studies of this mechanism are generally limited to laboratory rodents. Prenatally stressed rodents exhibit higher concentrations of serum testosterone and higher testosterone to estradiol ratios (Ward and Weisz, 1980; Vom Saal et al., 1990). In turn, the fetal testosterone to estradiol ratio is negatively related to the 2D:4D digit ratio (Manning et al., 2003; Lutchmaya et al., 2004). Connecting the dots, Lilley et al. (2010) show that high levels of maternal corticosterone, the rodent equivalent to cortisol, are associated with lower offspring 2D:4D digit ratio. They suggest that the latter may be a useful phenotypic indicator of maternal distress during early fetal development.

The 2D:4D digit ratio measures the relative length of the index finger with respect to the ring finger. It is established through changes in gene expression which take place without a change in the DNA sequence – known as epigenetic modifications (Jirtle and Skinner, 2007) – and is widely accepted as a noninvasive marker and 'lifelong signature of prenatal hormonal exposure' (Zheng and Cohn, 2011). During early fetal development, increased androgen hormones (e.g. testosterone) or the inactivation of the estrogen receptor (ER-α) stimulate the ring finger growth, which leads to a lower 2D:4D ratio. On the other hand, the addition of estrogen (e.g. estradiol) or the inactivation of the androgen receptor (AR) decrease the ring finger growth, resulting in a higher 2D:4D ratio (Lutchmaya et al., 2004; Zheng and Cohn, 2011).

Because of its correlation to prenatal hormones, the digit ratio has been studied in relationship with a variety of later life behavioral traits. In the lab, Garbarino et al. (2010) show that a low 2D:4D is associated with greater risk-taking. This is confirmed by evidence that low digit ratio MBA students self-select more into risky finance careers (Sapienza et al., 2009), and that the financial ability among male high-frequency traders is negatively related to their 2D:4D ratio (Coates et al., 2009). Its relationship to social preferences is relatively less studied, especially on non-experimental populations. Among undergraduate students, Brañas-Garza et al. (2013) find a non-monotonic impact of the digit ratio on altruism. Also, self-assessed low digit ratios (2D$<$4D) predict lower giving in ultimatum, trust, and public good games (Buser, 2012). We combine the literature about the epigenetic effects of maternal distress with that on the correlation between the digit ratio and preferences, bringing them to a natural experimental setting characterized by indiscriminate violence against unarmed civilians and high prevalence of maternal traumatization. We use the 2D:4D digit ratio as a marker of maternal distress to explore how prenatal stress reflects on the preferences for cooperation of the next generation.

The relationship between violent conflict and the functioning of societies has been at the forefront of economic debate for years. War violence persistently impacts health, education, and poverty (Ghobarah et al., 2003; Chamarbagwala and Morán, 2011; Gates et al., 2012), but also affects individual preferences and behavior. It has been found to increase community participation and political engagement (Bellows and Miguel, 2009; Blattman, 2009), out-group aggressiveness and competitiveness (Miguel et al., 2011; Cecchi et al., 2015), as well as risk propensity, and discount rates (Voors et al., 2011; Callen et al., 2014). Individuals exposed to inter-community violence display more altruistic behavior, higher public good contributions, and trust within their networks (Voors et al., 2012; Gilligan et al., 2014). Intra-community

violence instead decreases social cohesion and trust, and increases sentiments of group identity (Cassar et al., 2013; Rohner et al., 2013). To the best of our knowledge, however, this is the first study attempting to gauge the effect conflict-related stress on the social preferences of individuals that had yet to be born at the time that it first affected them.

3 Context and background

In the last 25 years Uganda achieved high and steady GDP growth rates, averaging about 6.7% per year (World Bank, 2014). However, since independence in 1962, Uganda has witnessed many long periods of violence and constitutional suspension and only few short periods of peace and relative prosperity. In fact, even while the country's overall growth rate was faster than that of many of its neighbors by the end of the millennium, the North was enduring the last of a long series of conflicts: Joseph Kony's LRA insurgency (1987-2006).

Violence has been escalating recurrently in Uganda since 1971, when Idi Amin took power from the discredited President Milton Obote.[2] Amin ruled the country until the 1979 Uganda-Tanzania War led to his ousting. Obote's comeback instead triggered the Ugandan Bush War against the southern rebels of the National Resistance Army (NRA) headed by the current President of Uganda, Yoweri Museveni. Obote lost power for the second time in 1985, shortly before the NRA faction assaulted Kampala—gaining the power it still holds today (Finnström, 2008).

As the balance of power shifted southwards, rebel movements in the North gathered under the flag of the LRA (Doom and Vlassenroot, 1999). Limited in numbers and resources, the LRA resorted to pillaging villages and abducting local youth: an estimated 60,000 to 80,000 people were abducted across two decades (Annan et al., 2006; Pham et al., 2007). Throughout the years, weak government responses and the setup of an Acholi self-defense militia invigorated the LRA, which scaled up operations to discipline the local population (Finnström, 2008; Dolan, 2009).[3] The widespread killing and mutilation of Acholi civilians escalated dramatically after 1996, especially in the Acholi districts of Gulu, Kitgum, and Pader.[4] In these districts, more than a quarter of the males aged 10 to 25 at the end of the war had been abducted for at least two weeks, and only 80% of them returned from captivity (Blattman and Annan, 2010).

Pader district was particularly hit from 1998 onwards, when LRA operations gained momentum and moved southwards (Figure 1). Civilian fatalities peaked in 2002, after the start of "Operation Iron Fist" against rebel bases in South Sudan set off a bloody reaction by LRA forces. A truce between the LRA and the government was signed in 2006, and fighting in Uganda has been sporadic ever since.[5]

At its peak, LRA violence was largely indiscriminate and apparently random in nature. Small groups of roughly 15 fighters ventured into Uganda from their Sudanese bases for weeks at a time, ambushing government forces and raiding homesteads for supplies and recruits along the way. Homesteads, which tend to be relatively isolated in Norther Uganda, were targeted in an unplanned, arbitrary manner, regardless of their wealth or makeup (Doom and Vlassenroot, 1999; Jackson, 2002; Blattman, 2009). The randomness of the attacks was oftentimes deliberate, serving as a force multiplier to increase the perception of undiscerning threat in the civilian population (Vinci, 2005). Figures 2 and 3 show respectively the relative levels of war exposure and traumatization, corresponding with the diameters of the

[2] In 1966 Obote was implicated in a corruption scandal together with the then commander of armed forces, Idi Amin. He responded by suspending the constitution.

[3] Civilian victimization in these years was not only the result of LRA violence, and abuse from government troops was not uncommon.

[4] Between 1994 and 2002, in response to Uganda's support for the rebels in South Sudan, the Sudanese government provided the LRA with logistic support and military equipment.

[5] The LRA has not been disarmed nor demilitarized following the 2006 truce with the Ugandan government, and has been active in the Democratic Republic of the Congo, the Central African Republic and South Sudan.

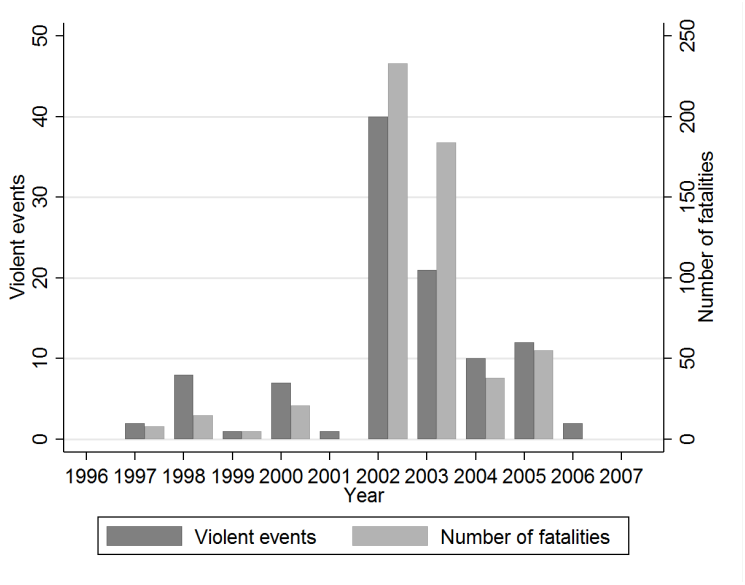

Figure 1: Civilian targeting in Pader district

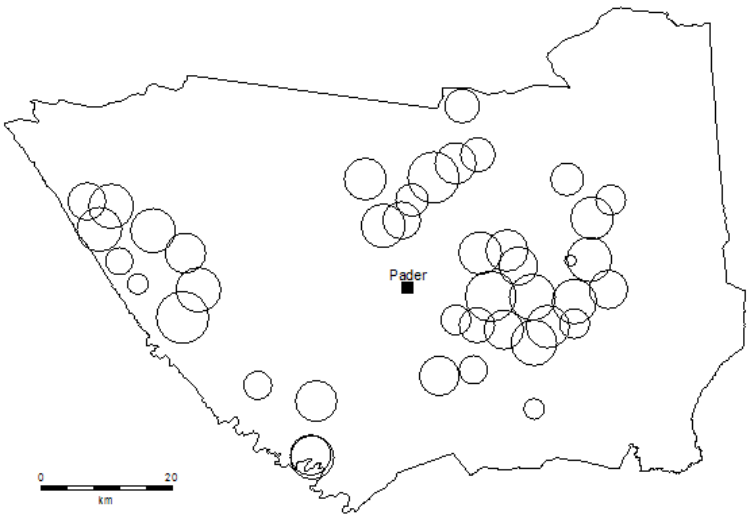

Figure 2: Average war exposure per school

circles representing each school in our sample. Coherent with literature, we find that both war exposure and traumatization show no detectable spatial autocorrelation on the school level (Moran's $I = -0.045$ and $I = -0.030$ respectively), nor are they correlated within schools (intra-class correlation coefficients are $\rho = 0.043$ and$\rho = 0.020$ respectively).[6] We come back to the plausibility of selection bias and the sensitivity of our results to the unconfoundedness assumption in Section 5.3.

4 Experimental design

Employing new data from behavioral games, biometric measurements and an extensive socioeconomic survey, we exploit the quasi-experimental variation in war exposure generated by rebel raids in Northern Uganda villages to gauge the impact of prenatal stress on later-life cooperation.

[6]See Tables A.1 and A.2 for full results of spatial autocorrelation and intra-class correlation analysis respectively.

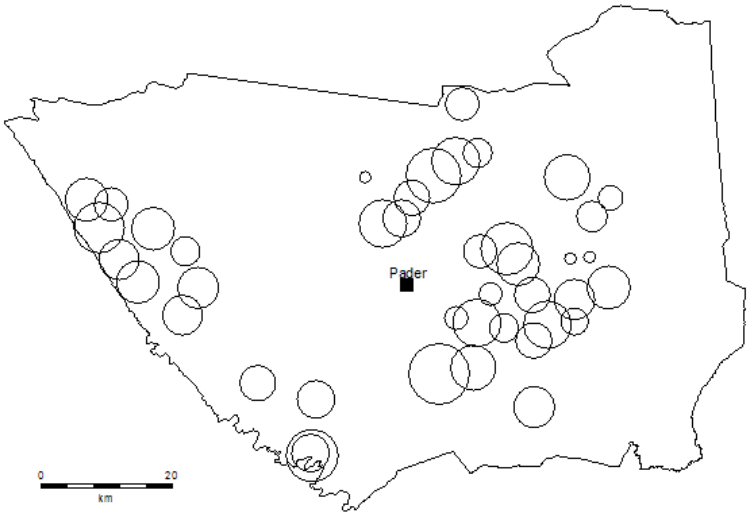

Figure 3: Average traumatization per school

Table 1: Descriptive statistics (children)

Variable	Observations	Mean	Std. Dev.	Min.	Max.
2D:4D	442	0.943	0.0425	0.733	1.111
Public good contribution	442	0.414	0.493	0	1
Age	442	11.05	2.160	6	14
Female	442	0.500	0.501	0	1
School grade	442	3.575	1.494	2	6
Height-for-age	441	-0.428	1.381	-4.820	5.800
BMI-for-age	440	-1.034	1.088	-5.980	2.010
IQ-for-age	442	95.59	15.00	79.92	162.7
Time preferences	442	0.253	0.435	0	1
Risk preferences	442	0.403	0.491	0	1
Postnatal war exposure	440	0.579	0.268	0	1

See Appendix C for variable definitions and Appendix D for survey and game instruments.

4.1 Sample and setting

Our sample includes 442 children and their caregivers from Pader district in Northern Uganda. In November 2012 we visited 42 primary schools in the district, and randomly selected 12 students from a list of pupils enlisted at the beginning of the year.[7] The descriptive statistics for the children are presented in Table 1. The average digit ratio – our marker of prenatal stress – is 0.94 in our sample, and 41% of the children chose to cooperate in the public goods game. Sections 4.2 and 4.3 below discuss the details of the digit ratio measurement and of the public goods game set-up respectively. On average the children are 11 years old, half of them are female, and their body mass and height are respectively 0.4 and 1 standard deviation below the mean for their age (de Onis et al., 2007).[8] To control for additional potential confounds, we also collect information about the children's cognitive ability (IQ) through standard Raven's progressive matrices (Kaplan and Saccuzzo, 2012), as well as their time and risk preferences (Voors et al., 2012). Child postnatal war exposure is a composite measure derived from the exposure of the caregiver and the child's year of birth (see Section 4.4).

[7] The randomization was stratified according to grade: 4 students were selected from grade 2, 4 from grade 4, and 4 from grade 6.Out of a total of 504, 62 students born prior to the intensification of violence in the area around 1998 were excluded from the analysis.

[8] Based on WHO recommendations for treating outliers (de Onis et al., 2007), we truncate the biometric data at 6 standard deviations from the mean. This results in 1 and 2 dropped observations for height-for-age and BMI-for-age respectively.

Table 2: Descriptive statistics (caregivers)

Variable	Observations	Mean	Std. Dev.	Min.	Max.
2D:4D	154	0.956	0.0377	0.844	1.066
Public good contribution	442	0.507	0.501	0	1
Age	440	42.03	11.89	19	92
Female	442	0.534	0.499	0	1
Education level	442	0.839	0.802	0	4
Risk preferences	442	0.312	0.464	0	1
War exposure	440	0.752	0.166	0.174	1
PTSD (dummy)	442	0.391	0.489	0	1
PTSD (factor)	442	0.000	1.000	-1.926	2.339
Christian	442	0.991	0.0948	0	1
Acholi	442	0.973	0.163	0	1
Household size	442	8.093	2.988	2	25
Assets index	442	0.000	1.000	-0.571	5.507

See Appendix C for variable definitions and Appendix E for survey and game instruments.

To account for environmental and genetic effects on preferences, we also interviewed each child's main caregiver—the adult household member with whom the child spends most time. The descriptive statistics for the caregivers are presented in Table 2. About half of the caregivers in our sample chose to cooperate in the public goods game (see Section 4.3 for details about the public goods game). Caregivers are on average 42 years of age,[9] 53% are female. Additionally, we collected information about their education level and risk preferences. All caregivers were exposed to at least some kind of conflict-related violence (thought the level of exposure varies greatly in our sample),[10] and 40% suffer from PTSD symptoms. The details of war exposure and trauma measurements are discussed in Section 4.4 below. Almost the entire sample is ethnically Acholi and Christian by religion. Households are typically composed of 8 people. We also collected information about their relative asset wealth (Sahn and Stifel, 2003).

In our setting, information about the current main caregivers can only serve as a proxy for environmental and genetic influences to which the children have been subjected throughout their lives. Of the 442 caregivers in our sample, only 190 are biological mothers. Another 163 are biological fathers, while the remaining 87 were grandparents, uncles/aunts, siblings or other relatives (in descending order of prevalence). 2 caregivers were not blood-related to the child at all. Nonetheless, the average caregiver in our sample had been taking care of the child for 93% of the child's life, making the information about the caregivers a strong proxy for the environment surrounding the children.

The traumatization of a child's caregiver does not necessarily have to correspond to that of the biological mother. We do expect, however, that even in cases where the caregiver is not the child's mother, the caregiver's war exposure and trauma are closely correlated with those of the mother and consequently with the child's prenatal stress. Indeed, we show below that caregiver trauma predicts children's digit ratio even when biological mothers are excluded. Similarly, given that a quarter of the caregivers in our sample are not their child's biological parents, the suitability of caregiver information to proxy for genetic effects on the children is not so evident. We show later that limiting our analysis only to child-caregiver pairs containing biological parents, or only their biological mothers, does not affect the results described below (we return to both these points in section 5.3).

[9] Two caregivers did not know their age, reducing the number of observations to 440.

[10] Two caregivers refused to complete the war exposure module of the survey, reducing the number of observations to 440. This reduction carries over the measure of child postnatal war exposure, which is derived from that of their caregiver.

4.2 The digit ratio

The index and ring finger lengths were measured on the ventral surface of the right hand from the midpoint of the basal crease to the tip of the digit. Given the contextual constraints and instruments available, measurement precision does not exceed 1 mm, resulting in an error of ±3.3% at the mean of our estimations.[11] While this is still far from the precision obtained in the lab (see Voracek et al., 2007), independent raters measured the digit lengths unaware of their scientific significance; errors should therefore result in unbiased random noise.[12]

4.3 Public goods game

We measure children's and caregivers' willingness to cooperate by involving them in a one-shot dichotomous public goods game similar to Cárdenas et al. (2009) and Barr et al. (2014). In each school, children played in randomly assigned groups of 6, and anonymously decided whether to select a "private card" or a "group card".[13] Children could in no way infer which other 5 participants belonged to their group (out of the 11 other children selected in that school). The private card allotted 3 candies to themselves and none to other unknown group members. The group card gave instead 1 candy to each group member including themselves (a graphical representation of the two cards can be found in Figure A.1). The joint surplus is therefore maximized when all participants choose the group card, such that each group member receives 6 candies. Nevertheless, free riders selecting the private card may obtain up to 8 candies. The Nash equilibrium is reached if everyone selects the private card, receiving 3 candies only. Caregivers played a very similar game, but played in groups of 12 instead of 6. The game was played in an isolated environment – typically their home – and caregivers where unaware of the identity of other participants. The private card was worth 4000 UGX, equivalent to approximately 1.5 USD; the group card was instead worth 500 UGX. The non-cooperative equilibrium thus yielded 4000 UGX each, joint maximization returned 6000 UGX each, and free riders could earn as much as 9500 UGX.[14] On average, 41% of the children and 51% of the caregivers opted for the cooperative option offered by the group card.

4.4 War exposure and trauma

Given their young age at the time of the conflict, we do not ask children war-related questions. Instead, we use information on the individual war exposure of their caregivers, and weigh it against the war violence that happened after the year of birth of the child. We use an adapted version of the War Trauma Questionnaire (WTQ), excluding the questions about shelling and bombardment which are not relevant to our setting (Macksoud, 1992; Papageorgiou et al., 2000). This questionnaire provides information on 23 war related traumatic events that a person may have witnessed, rated through 'yes' or 'no' statements. We create a war exposure (victimization) index using the average of positive responses to these violence related questions (Bellows and Miguel, 2009). On average, caregivers responded positively to 75% of the questions, with a minimum observed exposure of 17%. To proxy the child's postnatal war exposure we

[11] In a pilot, 30 raters separately measured 35 right hands, revealing comparable margins.

[12] Approximately two years after the main data collection we re-measured the digit lengths for a non-random sub-sample of 258 respondents. While the absolute length of the fingers had undoubtedly changed in the meanwhile, their ratio should remain relatively stable throughout lifetime. In line with expectations, the average error was ±3.7%. Results are not driven by systematic measurement error, and excluding measures with potentially greater error does not significantly alter the results (see Table A.3).

[13] Contrarily to many public goods games in which participants can choose their preferred contribution level, we opted for a dichotomous choice: respondents could either cooperate or not. While this reduced our ability to pick up the nuances present in the experimental sample, we believe that it facilitated the decision making process, especially for the youngest.

[14] The variation in pay-outs between the child and caregiver versions of the game was determined during a pilot. We adjusted the relative values of the "private" and "group" cards to maximize the variance of the responses in both samples and thus facilitate parametric analysis. Specifically, the number of candies assigned by the "private" card in the child version was dropped from 4 to 3 to increase the likelihood that children would select the "group" card.

weight the caregiver's war exposure index by the portion of violence potentially witnessed by the child after birth. To this end, we take the fraction of total civilian fatalities that occurred in Pader district following the child's birth (see Figure 1).[15]

We measure caregiver PTSD symptoms using the civilian version of the PCL self-report checklist (Weathers et al., 1993).[16] We convert individual scores into a PTSD dummy, following the recommendations of the US Department of Veteran Affairs, and the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM4).[17] As an additional robustness check, we perform factor analysis to extrapolate a factor for trauma.

5 Analysis and results

5.1 Main result

We hypothesize that maternal distress during pregnancy may reflect on the cooperation preferences of the offspring. The 2D:4D digit ratio is an indicator of maternal distress during early fetal development, negatively correlated to fetal testosterone to estradiol ratios.

We use the negative standardized digit ratio as our (relative) measure of prenatal stress:

$$DigitRatio_{is} = -\frac{2D:4D_{is} - \overline{2D:4D}}{\sigma} \tag{1}$$

where $2D:4D_{is}$ is the digit ratio of individual i; $\overline{2D:4D}$ is the mean digit ratio in the sample; σ is the standard error; and the negative sign produces a positive relationship between our proxy and actual prenatal stress—for ease of interpretation.

We first analyze the relationship between the digit ratio and cooperation in a public goods game graphically. From Buser (2012) we expect it to be negative. Indeed, Figure 4 illustrates that the prevalence of public good contributions decreases among children with lower digit ratio—as prenatal stress increases.

Parametrically, we show this relationship by estimating a specification with only the prenatal stress proxy as a regressor:

$$Cooperation_{is} = \alpha + \beta DigitRatio_{is} + \varepsilon_{is} \tag{2}$$

where $Cooperation_i$ is a dummy taking value of 1 if individual i played the group card in the public goods game; $DigitRatio_{is}$ is our measure of prenatal stress. Standard errors are clustered for 42 schools.

We find that our marker of prenatal distress is negatively correlated with the child's probability of contribution to the public good. Parametrically, one standard deviation drop in the digit ratio reduces the child's probability of contribution by about 8 percentage points (see Table 3, column 1). At the mean prevalence (41%), this results approximately in a 20% lower likelihood of cooperation.

[15] Source: ACLED Version 5, 1997-2013

[16] The civilian version of the PCL self-report checklist – a 17-item questionnaire – has been found to have strong psychometric properties, high internal consistency, and high test-retest reliability (Blanchard et al., 1996; Ruggiero et al., 2006; Conybeare et al., 2012). Moreover, it is strongly correlated with alternative measures of PTSD such as the Mississippi, MMPI-2 Keane, IES, and CAPS scales (Weathers et al., 1993; Dobie et al., 2002; Freedy et al., 2010).

[17] In our setting, we expect high rates of PTSD (Roberts et al., 2008; Pfeiffer and Elbert, 2011). We therefore take a conservatively high threshold for PTSD, at >66% of the maximum item score, to minimize the likelihood of false positives (Keen et al., 2008). We therefore find a lower PTSD prevalence (40%) than previous studies in the region that do not apply this correction. The DSM4 cut-off point requires at least 1 moderately positive answer in questions 1-5, 3 in 6-12, and 2 in 13-17. At the selected threshold, only 4 out of 442 caregivers do not meet this requirement. Our analysis is robust to their inclusion or exclusion from the PTSD count.

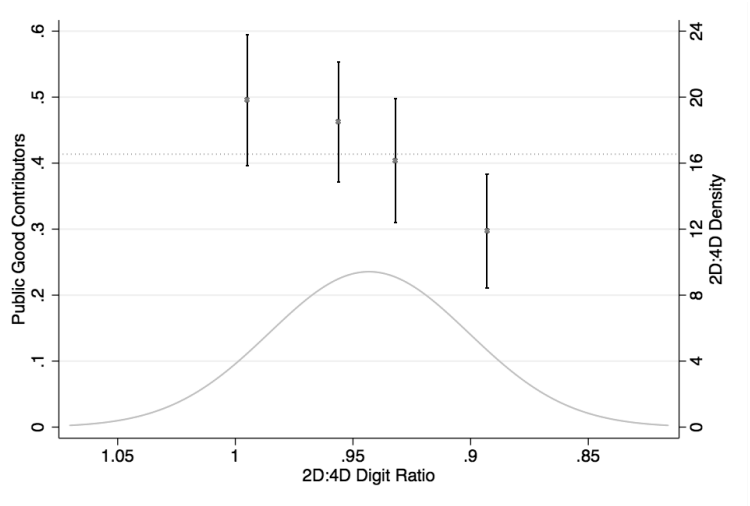

Figure 4: Digit ratio quartiles and prevalence of public good contributions

Result 1: Prenatal stress reduces the taste for cooperation. One standard deviation drop in the digit ratio decreases the child's probability of contribution to the public good by 20%

This relationship could potentially be driven by other child characteristics. Prosocial preferences develop throughout childhood and adolescence, and become increasingly gender-dependent with approaching adulthood (Eisenberg et al., 2006). Controlling for age, gender, their interaction, for school grade and for tribe does not, however, alter the result (see Table 3, column 2).

The probability of contributing to the public good may also be influenced by the social environment in which a child is growing up. Both family and peer demographics have been linked to children's prosocial behavior, though the evidence is often inconclusive Eisenberg et al. (2006). To account for possible environmental influences, we control for caregiver characteristics including the level of education, gender, age, and the interaction of the latter two.

We also control for the proportion of children who participated in the public goods game, but were excluded from the analysis due to their age.[18] The inclusion of these additional covariates does not affect the main result (see Table 3, column 3), nor does the inclusion of spatial fixed effects (see Table 3, column 4). We also control for family size and wealth, both of which have been associated with children's prosocial preferences (Zaff et al., 2003), as well as for the child's risk and time preferences, to reach the following fully specified linear probability model:[19]

$$Cooperation_{is} = \alpha + \beta DigitRatio_{is} + \gamma X'_{is} + \delta_s + \zeta_s + \eta Z'_{is} + \varepsilon_{is} \tag{3}$$

where $Cooperation_i$ is a dummy taking value of 1 if individual i played the group card in the public

[18] We initially sampled 4 second-graders, 4 fourth-graders and 4 sixth-graders from each of the 42 schools, resulting in a total sample of 504 children. All 12 children from each school would participate in the public goods game, but only those born after the reescalation of violence in Pader district in 1998 were included in our analysis, resulting in a removal of between 0 and 5 children per school. Since prosocial preferences increase with age, younger children playing the game in a group with a high share of older children may be more likely to contribute to the public good due to both peer effects and rational expectations about the behavior of the older children.

[19] Literature highlights several trade-offs between linear probability (LPM) and probit models. First, compared to a probit, the LPM does not estimate the structural parameters, but this paper is mostly concerned with marginal effects (intuitively interpretable with LPM). Second, LPM error terms are heteroskedastic by construct; we thus use cluster robust standard errors, which are heteroskedasticity-consistent. Finally, Horrace and Oaxaca (2006) show that the potential bias of LPM increases with the fraction of predicted probabilities that lie outside the (unconstrained) unit interval. In our main specification, the predicted probabilities lie between 0.003 and 0.815; we thus expect our estimations to be largely unbiased and consistent. In fact, marginal effects calculated through a probit very closely resemble those of our selected LPM (see Table A.4, column 1).

Table 3: Prenatal stress reduces cooperation

	Public Good Contribution				
	(1)	(2)	(3)	(4)	(5)
Standardized digit ratio (-)	-0.078***	-0.075***	-0.076***	-0.076***	-0.078***
	(0.024)	(0.024)	(0.025)	(0.025)	(0.024)
Child controls	N	Y	Y	Y	Y
Caregiver and peer controls	N	N	Y	Y	Y
Sub-county fixed effects	N	N	N	Y	Y
Child risk and time preferences	N	N	N	N	Y
Household size and assets index	N	N	N	N	Y
Observations	442	442	440	440	440
R^2	0.025	0.030	0.054	0.057	0.059

Standard errors corrected for school level clustering (42) are in parentheses.

Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.

Child controls: Age, Female, Age × Female; Caregiver controls: Age, Female, Age × Female, Acholi, Education; Peer controls: Proportion of excluded peers, Class dummies. See Table A.5 for the full list of coefficients.

goods game; $DigitRatio_{is}$ is our measure of prenatal stress; X'_{is} is a vector of child characteristics including age, gender, age × gender, education, ethnicity, and caregiver characteristics including age, gender, age × gender and education; δ_s represents the fraction of children in a school excluded from our analysis; ζ_s the spatial fixed effects at the sub-county level; and Z'_{is} a vector of covariates including household size, assets, time preferences and risk preferences of child i. Standard errors are still clustered for 42 schools.

The additional covariates included in vector Z'_{is} are potentially endogenous to our model. Since, they do not alter the main result (see Table 3, column 5), nor is their correlation with the probability to contribute to the public good statistically significant (see Table A.5), we exclude them from any further analysis.

Throughout several specifications – controlling for an increasingly extensive set of covariates – the main result remains stable: One standard deviation drop in the digit ratio decreases the child's probability of contribution to the public good by between 17% and 20%.

5.2 Alternative mechanisms

Next, we investigate potential alternative mechanisms. First, the literature discussed in Section 2 predicts that prenatal stress may capture the effect of early life deprivation. Height, for instance, is an anthropometric indicator of early-life experiences comparable to longitudinal measures such as height and weight at birth (Currie and Vogl, 2013). Similarly, low birth weight is associated with later-life low BMI (Walker et al., 2002), and severe deprivation at an early stage has persistent effects on cognitive ability (Beckett et al., 2006; Figlio et al., 2014). We control for these covariates in the following fully specified linear probability model:

$$Cooperation_{is} = \alpha + \beta DigitRatio_{is} + \gamma X'_{is} + \delta_s + \zeta_s + \theta H_{is} + \iota BMI_{is} + \kappa IQ_{is} + \varepsilon_{is} \quad (4)$$

where H_{is} is the height-for-age of child i, BMI_{is} is the body-mass-index-for-age of child i, and IQ_{is} is an age-standardized measure of cognitive ability, and all other notation has the same meaning as in (3).

We find that height-for-age is positively associated with cooperation: one standard deviation increase in the height-for-age increases the likelihood of contribution to the public good by between 3 and 6 percentage points in the simple and fully specified models respectively. BMI-for-age and IQ-for-age do not enter significantly (Table 4, columns 1-2). Nonetheless, prenatal stress remains significant: its

Table 4: Alternative mechanism 1: early life deprivation

	Public Good Contribution			
	(1)	(2)	(3)	(4)
Standardized digit ratio (-)			-0.077***	-0.073***
			(0.025)	(0.026)
Height-for-age	0.026*	0.061***	0.025*	0.058***
	(0.015)	(0.020)	(0.015)	(0.020)
BMI-for-age	-0.021	-0.023	-0.015	-0.017
	(0.024)	(0.023)	(0.025)	(0.024)
IQ-for-age	-0.011	-0.008	-0.012	-0.010
	(0.022)	(0.024)	(0.021)	(0.024)
Child controls	N	Y	N	Y
Caregiver and peer controls	N	Y	N	Y
Sub-county fixed effects	N	Y	N	Y
Observations	440	438	440	438
R^2	0.006	0.052	0.030	0.073

Standard errors corrected for school level clustering (42) are in parentheses.
Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.
Child controls: Age, Female, Age × Female;
Caregiver controls: Age, Female, Age × Female, Acholi, Education;
Peer controls: Proportion of excluded peers, Class dummies.

coefficient is stable and robust to controlling for markers of early life deprivation (Table 4, columns 3-4).

Second, the preferences of children may be driven by those of their caregivers through environmental as well as genetic mechanisms (Dohmen et al., 2012). We control for caregiver preferences in the following fully specified linear probability model:

$$Cooperation_{is} = \alpha + \beta DigitRatio_{is} + \gamma X_{is}^{'} + \delta_s + \zeta_s + \lambda CaregiverCoop_{is} + \mu CaregiverRisk_{is} + \varepsilon_{is} \quad (5)$$

where $CaregiverCoop_{is}$ is a dummy taking value of 1 if the caregiver of child i played the group card in the public goods game, $CaregiverRisk_{is}$ is a measure of the caregiver's risk propensity and all other notation has the same meaning as in above.

We find a strong relationship between the social preferences of the caregiver and the child, but not between the risk preferences of the caregiver and the social preferences of the child. Children are about 15 percentage points more likely to contribute if their main caregiver contributes to the public good in a separate game (Table 5, columns 1-2). The effect of prenatal stress is however not affected by these controls (Table 5, columns 3-4).[20]

Third, Section 2 highlights the role of postnatal war exposure in shaping individual preferences. The children in our sample were at most 8 years of age at the end of hostilities, but postnatal witnessing of conflict-related violence may still have affected their taste for cooperation (Bauer et al., 2014). We control for direct war exposure through the following fully specified linear probability model:

$$Cooperation_{is} = \alpha + \beta DigitRatio_{is} + \gamma X_{is}^{'} + \delta_s + \zeta_s + \nu PostWar_{is} + \varepsilon_{is} \quad (6)$$

where $PostWar_{is}$ is the measure of child postnatal war exposure[21] discussed in section 4 and all other notation is the same as above.

[20] For a sub-sample of 154 parents, we verify that the parents' digit ratio is not driving our result—i.e. the genetic component does not foreshadow the epigenetic effect. We find no effect of parental digit ratios on the cooperation of children (see Table A.6).

[21] Here we use the fraction of civilian fatalities after birth to weight the caregiver's war exposure. Using the fraction of LRA-related violent events does not change the results.

Table 5: Alternative mechanism 2: caregiver preferences

	Public Good Contribution			
	(1)	(2)	(3)	(4)
Standardized digit ratio (-)			-0.072***	-0.070***
			(0.025)	(0.025)
Caregiver cooperation	0.156***	0.158***	0.144***	0.145***
	(0.040)	(0.045)	(0.041)	(0.047)
Caregiver risk preferences	-0.003	0.007	0.001	0.014
	(0.054)	(0.055)	(0.054)	(0.055)
Child controls	N	Y	N	Y
Caregiver and peer controls	N	Y	N	Y
Sub-county fixed effects	N	Y	N	Y
Observations	442	440	442	440
R^2	0.025	0.053	0.046	0.078

Standard errors corrected for school level clustering (42) are in parentheses.
Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.
Child controls: Age, Female, Age × Female;
Caregiver controls: Age, Female, Age × Female, Acholi, Education;
Peer controls: Proportion of excluded peers, Class dummies.

Table 6: Alternative mechanism 3: postnatal war exposure

	Public Good Contribution			
	(1)	(2)	(3)	(4)
Standardized digit ratio (-)			-0.077***	-0.077***
			(0.024)	(0.025)
Postnatal war exposure	0.035*	0.015	0.035*	0.024
	(0.019)	(0.030)	(0.020)	(0.030)
Child controls	N	Y	N	Y
Caregiver and peer controls	N	Y	N	Y
Sub-county fixed effects	N	Y	N	Y
Observations	440	438	440	438
R^2	0.005	0.035	0.029	0.058

Standard errors corrected for school level clustering (42) are in parentheses.
Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.
Child controls: Age, Female, Age × Female;
Caregiver controls: Age, Female, Age × Female, Acholi, Education;
Peer controls: Proportion of excluded peers, Class dummies.

We find that in our sample postnatal war exposure does not significantly affect cooperation when controlling for child, caregiver and peer characteristics (Table 6, columns 1-2), and does not wash out the effect of prenatal stress (Table 6, columns 3-4).

Result 2: The relationship between prenatal stress and cooperation is stable and robust to controlling for early life deprivation markers, caregiver preferences and postnatal war exposure.

Controlling for the early life deprivation, caregiver preferences and postnatal war exposure at the same time – by combining models (4), (5) and (6) into one comprehensive fully specified model – does not alter result (see Table A.7). Likewise, the main result holds when estimated using a probit model, when including school and enumerator fixed effects, and when clustering standard errors on both school and year-of-birth levels (see Table A.4).

Table 7: Caregiver trauma predicts lower digit ratio in children

	Public Good Contribution			
	(1)	(2)	(3)	(4)
PTSD	-0.296**	-0.289**		
	(0.111)	(0.123)		
Trauma factor			-0.116**	-0.109*
			(0.051)	(0.058)
Child controls	N	Y	N	Y
Caregiver controls	N	Y	N	Y
Sub-county fixed effects	N	Y	N	Y
Observations	442	440	442	440
R^2	0.021	0.043	0.013	0.035

Standard errors corrected for school level clustering (42) are in parentheses.
Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.
Child controls: Age, Female, Age × Female;
Caregiver controls: Age, Female, Age × Female, Acholi, Education;

5.3 Causality and unobserved selection

We use the 2D:4D digit ratio as an indicator of maternal distress during early fetal development (Ward and Weisz, 1980; Vom Saal et al., 1990; Lilley et al., 2010). If prenatal stress results in smaller digit ratios, we should observe this pattern in our data. First, we test this using the following model:

$$2D:4D_{is} = \alpha + \beta CaregiverPTSD_{is} + \gamma X_i's + \delta_s + \zeta_s + \varepsilon_{is} \tag{7}$$

where $CaregiverPTSD_{is}$ is a measure of the PTSD symptoms of the caregiver; and all other notation has the same meaning as in (3).

We find that stronger symptoms of PTSD in caregivers are associated with lower child 2D:4D digit ratios (see Table 7).[22]

One of the advantages of using digit ratios as a proxy for prenatal stress is that we do not need to know the timing and extent of maternal traumatization for it to be measurable on the child's hand. As a matter of fact, out of 442 caregivers our sample comprises only 190 biological mothers. Table A.8 shows that our main result holds regardless of the relationship to the caregiver. On the other hand, one of the limitations of this analysis is that we are unable to verify whether traumatization took place before or after the birth of the child. As an alternative approach to verifying the relationship between digit ratio and prenatal stress, we use the peak of violence occurring after 2001 in Pader district as a natural experiment. The likelihood that traumatization had occurred after the gestational period in which the digit ratio develops is lower for children conceived in the later years of the conflict. In fact, conditional on traumatization, we find significantly lower digit ratios for children born in the period 2002-2006 than in the period 1998-2001 (see Figure 5). This is indicative that our analysis likely underestimates the true effect of traumatization on the digit ratio of the offspring.

While this is reassuring, it is by no means conclusive evidence. We measure traumatization symptoms 6 years after the end of the war, and an average of 11 years after the birth of the child. While literature shows that war related PTSD symptoms in Northern Uganda have in fact persisted for such a long period of time (Roberts et al., 2008; Pfeiffer and Elbert, 2011), it is plausible that post bellum events may have caused the observed PTSD. We thus complement this evidence with a mother fixed effects analysis, which involved a separate step of data collection.[23]

[22] The effect is quantitatively stable and robust to excluding caregiving mothers (see Table A.9). This is indicative of a close correlation between the caregivers traumatization and the likelihood of prenatal stress even in cases where the caregiver is not the child's mother.

[23] In 2014, we traced back as many mothers and older siblings of the sampled children as possible given the time gap,

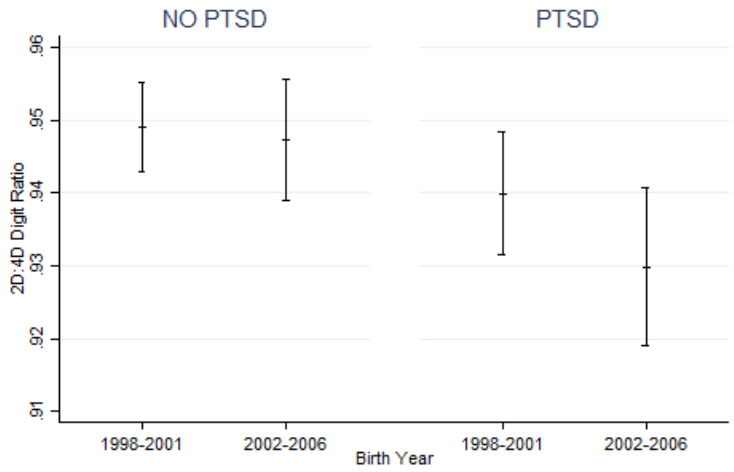

Figure 5: Conditional on PTSD, children born at the peak of violence exhibit lower digit ratios

Table 8: Children born during the conflict exhibit lower digit ratios than their relatives

	Observations		2D:4D			
	Child	Control	Child	Cont.	Diff.	Std. Err.
Biological mothers	84	84	0.942	0.956	-0.013***	0.005
Biological mothers (female child)	43	43	0.940	0.953	-0.013**	0.006
Same-mother sibling	43	43	0.936	0.948	-0.013*	0.008
Same-mother sibling (same sex)	26	26	0.941	0.950	-0.009	0.008

Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.

Through a series of paired t-tests, we compare the digit ratio of (84) biological mothers to that of their offspring (Table 8, row 1), and of their female offspring only (43) (Table 8, row 2). Moreover, we identify same-mother siblings born between 1990 and 1996, a relatively non-violent period in Pader district. We test the hypothesis that (43) siblings born prior to the intensification of war violence have a significantly different digit ratio (Table 8, row 3), and verify its robustness by looking at (26) same-sex siblings (Table 8, row 4). Children born during the conflict have significantly smaller digit ratios than their relatives born before the conflict.

Result 3: Caregiver trauma predicts lower digit ratios in children. Also, children that are born during the conflict exhibit significantly lower digit ratios than their biological mothers and same-mother siblings.

Finally, our results may be biased by unobserved selection. Table 9 presents the same caregiver descriptives as in Table 2, split at the median of children's digit ratio. This way we can compare the caregivers of the most prenatally stressed children with those of the least prenatally stressed ones. As expected, high prenatal stress is associated with higher levels of caregiver traumatization, and with lower caregiver taste for cooperation. All other covariates (with the exception of caregiver gender) are balanced across the two groups. On the one hand, lower taste for cooperation among traumatized caregivers is coherent with within-group conflict effects on preferences (Cassar et al., 2013), as well as the findings of Rohner et al. (2013) on the very LRA insurgency. On the other, we cannot rule out the possibility that less cooperative caregiver types may have self-selected into conflict traumatization. If so, we would be violating the initial assumption of unconfoundedness.

If a certain types of caregivers – with a certain preference for cooperation or risk before the war –

and measured their digit ratios.

Table 9: Split-sample balance (caregivers)

	High child 2D:4D (Low prenatal stress)		Low child 2D:4D (High prenatal stress)			
Variable	Obs.	Mean	Obs.	Mean	Diff.	Std. err.
2D:4D	76	0.957	78	0.956	-0.001	0.006
Public good contribution	221	0.561	221	0.452	-0.109**	0.047
Age	220	42.3	220	41.8	-0.5	1.1
Female	221	0.489	221	0.579	0.090*	0.047
Education level	221	0.864	221	0.814	-0.050	0.076
Risk preferences	221	0.299	221	0.326	0.027	0.044
War exposure	220	0.746	220	0.758	0.012	0.016
PTSD (dummy)	221	0.317	221	0.466	0.149***	0.046
PTSD (factor)	221	-0.142	221	0.142	0.284***	0.094
Christian	221	0.977	221	0.968	-0.009	0.015
Acholi	221	0.995	221	0.986	-0.009	0.009
Household size	221	7.92	221	8.26	0.34	0.28
Assets index	221	-0.028	221	0.028	0.056	0.095

Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.

Table 10: Conflict exposure predicts caregiver trauma, caregiver digit ratio does not

	PTSD			Trauma factor		
	(1)	(2)	(3)	(4)	(5)	(6)
War exposure	0.0815***	0.102***	0.138***	0.182***	0.230***	0.271***
	(0.0221)	(0.0225)	(0.0454)	(0.0527)	(0.0492)	(0.0960)
Female		0.284***	0.332***		0.563***	0.769***
		(0.0509)	(0.0859)		(0.106)	(0.156)
Caregiver digit ratio			-0.0855			0.906
			(1.184)			(2.220)
Caregiver controls	N	Y	Y	N	Y	Y
Sub-county fixed effects	N	Y	Y	N	Y	Y
Observations	440	438	154	440	438	154
R^2	0.028	0.105	0.157	0.033	0.129	0.229

Standard errors corrected for school level clustering (42) are in parentheses.

Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.

Caregiver controls: Age, Female, Age × Female, Acholi, Education.

self-selected into or out of traumatic events, they may have passed their preferences on to the children through genetic and environmental channels. Even though we control for the preferences of caregivers, this may not suffice to net out the selection bias. One way to test whether the patterns found in Table 9 are explained mostly by endogenous preference formation or by selection bias is to look at the relationship between the caregiver's digit ratio and their traumatization. Table 10 shows that, while caregiver war exposure is a strong predictor of their traumatization,[24] caregiver digit ratios are not. In other words, while Table 6 shows that caregiver traumatization is negatively correlated with child digit ratios, caregiver digit ratios are uncorrelated to their likelihood of being traumatized.

Again, this does not allow us to exclude all forms of self-selection. We are unable to conclusively verify the randomness of the behavior of armed groups, or the influence of other pre-war characteristics. Our causal interpretation of the results may thus suffer from potential bias due to the omission of such unobservables. Following Blattman and Annan (2010), we provide a graphical benchmark of the sensibility of our results to exogeneity assumptions (Imbens, 2003; Harada, 2012). The curve in Figure 6 represents

[24] We find a robustly positive and significant relationship between war exposure and trauma among caregivers, with a higher prevalence of PTSD among women. A one standard deviation increase in our war exposure index increases the likelihood of PTSD by almost 10%, and scores on the trauma factor by 20% of a standard deviation.

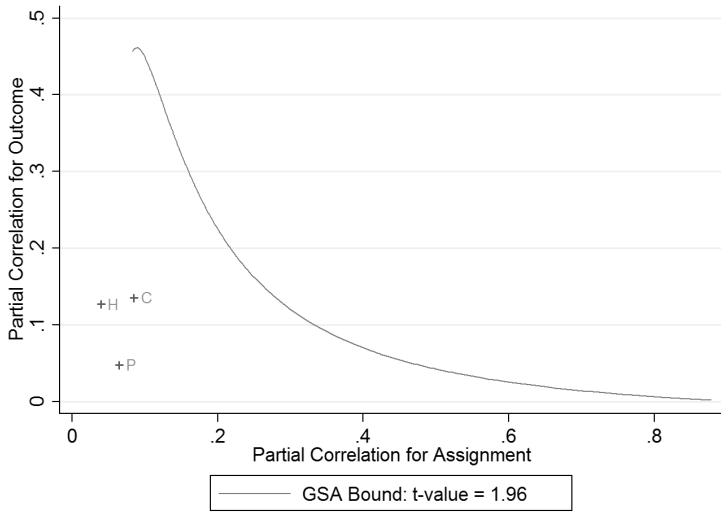

Figure 6: Sensitivity to the unconfoundedness assumption

the locus of partial correlation points of a hypothetical pseudo-unobservable with our assignment and outcome variables, that would reduce estimated effect below significance at the five percent level.[25] The selective contour is conservative, as it only reduces the coefficient size by about one quarter.[26] Yet, the alternative mechanisms we identify and discuss in above lie far below the selected threshold. To rule out the effect of prenatal stress, any unobserved covariate not considered in our analysis would require a partial correlation with both the treatment and the assignment well above the curve of Figure 6.

6 Conclusions

'The womb may be more important than the home', wrote the late David J. Barker (1990) in his seminal work on the fetal origins of adult disease. Barker's hypothesis has spawned a large volume of literature exploring its economic implications. This study builds upon the fetal origins literature, and tests the hypothesis that prenatal events may not only alter later-life individual abilities and health trajectories (Almond and Currie, 2011), but also social preferences. In particular, we look at the impact of prenatal stress on the preferences for cooperation among children born during an armed conflict. We play a dichotomous one-shot public goods game in Pader, a district in Northern Uganda, with children born during the 1998-2006 period of intense fighting between government forces and the Lord's Resistance Army (LRA). Our identification strategy exploits variations in the 2D:4D digit ratio—a marker of in utero hormone exposure negatively associated with high maternal distress during early fetal development. It also exploits the assumtion that that war exposure and traumatization where conditionally unconfounded in our context (Doom and Vlassenroot, 1999; Jackson, 2002; Blattman, 2009; Blattman and Annan, 2010). We find that a rise in our marker of prenatal distress robustly reduces the child's probability of contribution to the public good. The estimated effect is quantitatively large, stable, and robust to controlling for alternative mechanisms such as early life deprivation, caregiver public good contribution preferences, and war exposure after birth. We also show that it is robust to relaxing the assumtion of unconfoundedness and self-selection. In other words, we show that preferences are endogenously determined right from the womb.

[25] H: Height-for-age; C: Caregiver cooperation; P: Postnatal war exposure

[26] Blattman and Annan (2010), for instance, plot a contour that decreases the effect of the assignment by one half. This would be equivalent to shifting the contour in Figure 6 outwards.

Our results thus support three separate findings from previous studies. Firstly – and perhaps obviously – violent conflict exposure is traumatizing. Secondly, a mother's traumatization during pregnancy affects the hormonal balance of the fetus as observable through its 2D:4D digit ratio. Thirdly – and most importantly – in utero hormonal balance affects later-life social preferences. By analyzing these three relationships concurrently in a post-conflict context – where violence has differentially impacted large portions of the population – we find evidence supporting the entire causal chain: from conflict in one generation to economic behavior in the next one. Prenatal stress triggers adaptive mechanisms that go far beyond the well-established relationship between postnatal war exposure and preferences. The socio-economic consequences of conflict may thus be reaching much further than previously thought, and the womb may well be far more crucial than Barker ever imagined.

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Appendices

A Tables

Table A.1: Spatial autocorrelation of war exposure and trauma

	War exposure	PTSD
	(1)	(2)
Moran's I	-0.045	-0.030
$E(I)$	-0.024	-0.024
$sd(I)$	0.056	0.055
z	-0.364	-0.099
p-value	0.358	0.461
Observations	42a	42

p-values are based on a 1-tail test

Table A.2: Intraclass correlation of war exposure and trauma

	War exposure	PTSD
	(1)	(2)
ρ	0.043	0.020
Observations	440	442
Groups	42	42

ρ is the fraction of variance due to school-level random effects from a GLS regression.

Table A.3: Sensitivity of results to the exclusion of potentially biased measures

	Public Good Contribution			
	All	$\Delta < 5\%$	$\Delta < 3\%$	$\Delta < 1\%$
	(1)	(2)	(3)	(4)
Standardized digit ratio (-)	-0.078***	-0.108***	-0.100**	0.099
	(0.025)	(0.037)	(0.044)	(0.280)
Child controls	Y	Y	Y	Y
Caregiver and peer controls	Y	Y	Y	Y
Sub-county fixed effects	Y	Y	Y	Y
Observations	440	189	131	39
R^2	0.046	0.082	0.115	0.409

Δ is the two-year inter-observer measurement difference.

Standard errors corrected for school level clustering are in parentheses.

Confidence: *** $\leftrightarrow$ 99%, ** $\leftrightarrow$ 95%, * $\leftrightarrow$ 90%.

Child controls: Age, Female, Age $\times$ Female;

Caregiver controls: Age, Female, Age $\times$ Female, Acholi, Education;

Peer controls: Proportion of excluded peers, Class dummies.

Table A.4: Robustness of the main result to alternative specifications

	Public Good Contribution			
	Probit model	School f.e.	Enumerator f.e.	Two-way clustering
	(1)	(2)	(3)	(4)
Standardized digit ratio (-)	-0.083***	-0.065***	-0.052**	-0.076***
	(0.028)	(0.023)	(0.023)	(0.025)
Child controls	Y	Y	Y	Y
Caregiver and peer controls	Y	Y	Y	Y
Sub-county fixed effects	Y	N	Y	Y
School level clustered s.e.	42	N	42	42
Year of birth clustered s.e.	N	N	N	9
Observations	440	440	440	440
R^2	0.043	0.137	0.172	0.057

Confidence: *** $\leftrightarrow$ 99%, ** $\leftrightarrow$ 95%, * $\leftrightarrow$ 90%.

Child controls: Age, Female, Age $\times$ Female;

Caregiver controls: Age, Female, Age $\times$ Female, Acholi, Education;

Peer controls: Proportion of excluded peers, Class dummies.

Table A.5: Prenatal stress reduces cooperation (all coefficients)

	Public Good Contribution				
	(1)	(2)	(3)	(4)	(5)
Standardized digit ratio (-)	-0.078***	-0.075***	-0.076***	-0.076***	-0.078***
	(0.024)	(0.024)	(0.025)	(0.025)	(0.024)
Child age		0.006	0.023	0.021	0.021
		(0.015)	(0.020)	(0.020)	(0.020)
Child female		-0.161	-0.165	-0.176	-0.188
		(0.254)	(0.260)	(0.271)	(0.271)
Child age × female		0.015	0.015	0.016	0.017
		(0.022)	(0.023)	(0.024)	(0.024)
Caregiver age			-0.004	-0.004	-0.004
			(0.003)	(0.003)	(0.003)
Caregiver female			-0.302*	-0.296	-0.304*
			(0.176)	(0.176)	(0.178)
Caregiver age × female			0.008**	0.008**	0.008**
			(0.004)	(0.004)	(0.004)
Caregiver Acholi			0.037	0.016	0.019
			(0.101)	(0.117)	(0.124)
Caregiver education			0.019	0.020	0.018
			(0.035)	(0.036)	(0.037)
Proportion of excluded peers			-0.499*	-0.549	-0.562
			(0.288)	(0.346)	(0.355)
P2			0.111	0.108	0.109
			(0.077)	(0.078)	(0.078)
P6			0.007	0.010	0.008
			(0.061)	(0.062)	(0.064)
Lira Palwo sub-county				-0.047	-0.058
				(0.077)	(0.079)
Lukole sub-county				-0.051	-0.056
				(0.077)	(0.079)
Parabongo sub-county				-0.035	-0.043
				(0.085)	(0.087)
Patongo sub-county				-0.068	-0.071
				(0.134)	(0.133)
Awere sub-county				-0.097	-0.099
				(0.076)	(0.082)
Pajule sub-county				0.005	-0.004
				(0.098)	(0.100)
Puranga sub-county				-0.049	-0.050
				(0.085)	(0.089)
Child risk-preferences					0.012
					(0.047)
Child time-preferences					-0.014
					(0.057)
Household size					0.007
					(0.009)
Assets index					0.005
					(0.019)
Observations	442	442	440	440	440
R^2	0.025	0.030	0.054	0.057	0.059

Standard errors corrected for school level clustering (42) are in parentheses.

Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.

Atanga sub-county is taken as reference category, and therefore omitted.

Table A.6: Robustness of the main result to controlling for parental digit ratios

	Public Good Contribution			
	(1)	(2)	(3)	(4)
Standardized digit ratio (-)			-0.139***	-0.125***
			(0.036)	(0.040)
Caregiver digit ratio	-0.048	-0.077*	-0.060	-0.079*
(biological parents only)	(0.041)	(0.041)	(0.037)	(0.040)
Child controls	N	Y	N	Y
Caregiver and peer controls	N	Y	N	Y
Sub-county fixed effects	N	Y	N	Y
Observations	154	154	154	154
R^2	0.010	0.123	0.065	0.162

Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.

Child controls: Age, Female, Age × Female;

Caregiver controls: Age, Female, Age × Female, Acholi, Education;

Peer controls: Proportion of excluded peers, Class dummies.

Table A.7: Alternative mechanisms

	Public Good Contribution			
	(1)	(2)	(3)	(4)
Standardized digit ratio (-)			-0.070***	-0.068**
			(0.025)	(0.026)
Height-for-age	0.032**	0.058***	0.032**	0.055***
	(0.015)	(0.019)	(0.015)	(0.019)
BMI-for-age	-0.023	-0.022	-0.018	-0.017
	(0.023)	(0.022)	(0.024)	(0.023)
IQ-for-age	-0.008	-0.001	-0.009	-0.003
	(0.023)	(0.025)	(0.023)	(0.025)
Caregiver cooperation	0.144***	0.144***	0.133***	0.132***
	(0.038)	(0.042)	(0.039)	(0.044)
Caregiver risk preferences	0.002	0.020	0.006	0.026
	(0.053)	(0.054)	(0.054)	(0.054)
Postnatal war exposure	0.043**	0.028	0.043**	0.035
	(0.021)	(0.031)	(0.021)	(0.031)
Child controls	N	Y	N	Y
Caregiver and peer controls	N	Y	N	Y
Sub-county fixed effects	N	Y	N	Y
Observations	438	436	438	436
R^2	0.036	0.076	0.056	0.094

Standard errors corrected for school level clustering (42) are in parentheses.

Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.

Child controls: Age, Female, Age × Female;

Caregiver controls: Age, Female, Age × Female, Acholi, Education;

Peer controls: Proportion of excluded peers, Class dummies.

Table A.8: Sensitivity of results to caregiver relationship to the child

	Public Good Contribution			
	All	Blood-related	Parents	Mothers
	(1)	(2)	(3)	(4)
Standardized digit ratio (-)	-0.076***	-0.075***	-0.081***	-0.089**
	(0.025)	(0.025)	(0.028)	(0.033)
Child controls	Y	Y	Y	Y
Caregiver and peer controls	Y	Y	Y	Y
Sub-county fixed effects	Y	Y	Y	Y
Observations	440	438	351	189
R^2	0.057	0.056	0.053	0.105

Standard errors corrected for school level clustering (42) are in parentheses.
Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.
Child controls: Age, Female, Age × Female;
Caregiver controls: Age, Female (excluding column 4), Age × Female (excluding column 4), Acholi, Education;
Peer controls: Proportion of excluded peers, Class dummies.

Table A.9: Excluding mothers, caregiver trauma still predicts lower digit ratios in children

	2D:4D			
	(1)	(2)	(3)	(4)
PTSD	-0.360**	-0.368**		
	(0.153)	(0.177)		
Trauma factor			-0.135**	-0.146**
			(0.061)	(0.065)
Child controls	N	Y	N	Y
Caregiver controls	N	Y	N	Y
Sub-county fixed effects	N	Y	N	Y
Observations	252	251	252	251
R^2	0.030	0.072	0.020	0.065

Standard errors corrected for school level clustering (42) are in parentheses.
Confidence: *** ↔ 99%, ** ↔ 95%, * ↔ 90%.
Child controls: Age, Female, Age × Female, Class dummies;
Caregiver controls: Age, Female, Age × Female, Acholi, Education.

B Figures

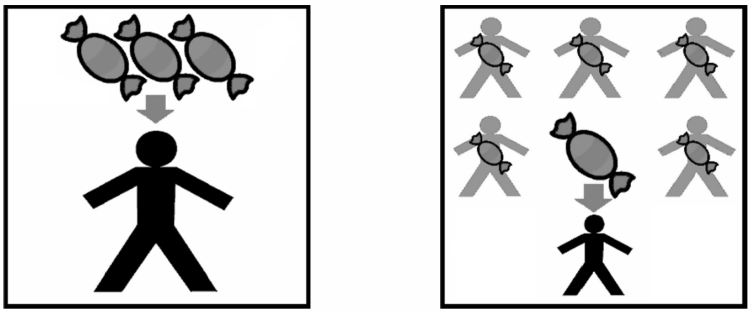


Figure A.1: Private and group cards in the public goods game for children

C Variable definitions

2D:4D. A child level measure of the relative length of the index finger of the right hand with respect to the ring finger (in cm).

Standardized digit ratio (-). A child level variable derived by standardizing the 2D:4D (z-score). The negative sign is added for ease of interpretation.

Public good contribution (child and caregiver). An individual level dummy for both child and caregiver representing the individual choice in the public good game: "group card" or "private card". The choice "group card" takes value 1, 0 otherwise.

Age (child and caregiver). Age of respondent (child and caregiver) i in years, rounded down to the last birthday.

Female (child and caregiver). Individual level dummy taking value of 1 if respondent (child and caregiver) is female, 0 otherwise.

Class dummies (P2, P4, P6). Child-level dummies indicating the current school grade of child i.

Height-for-age. The height of child i standardized for his age class (de Onis et al., 2007).

BMI-for-age. The body-mass-index of child i standardized for his age class (de Onis et al., 2007).

IQ-for-age. The IQ of child i, measured using standard Raven's matrixes and standardized for his age class (in sample).

Time preferences. A child level dummy taking value of 1 if child prefers to receive two candies at the end of the survey rather than one half way, 0 otherwise.

Risk preferences (child). A dummy equal to 1 if the child consistently chooses for the riskier option in a two dichotomous lottery choices; 0 otherwise.

Risk preferences (caregiver). A dummy equal to 0 if the caregiver chose the least risky one of several lottery options; 1 otherwise.

War exposure (child and caregiver). A caregiver level victimization index derived from answers to 23 war witnessing questions (see Macksoud, 1992). The postnatal war exposure of child i is proxied by the war exposure of the caregiver multiplied by the fraction of violent conflict events that took place after the birth of child i.

Education level. A caregiver level variable indicating the number of completed years of education of respondent i.

PTSD. A caregiver level measure of post-traumatic stress disorder, calculated using the PCL-civilian checklist.

Christian. A dummy taking value of 1 if the caregiver is Christian by religion, 0 otherwise.

Acholi. A dummy taking value of 1 if the caregiver is ethnically Acholi, 0 otherwise.

Household size. The number of people sharing the same roof and sharing the same pot.

Assets index. A principal factor (see Sahn and Stifel, 2003) of assets possessed by the caregiver's household.

D Survey and game instruments (child)[27]

		Name	ID	Date		
!!!	Region		⌊__⌋			
!!!	District		⌊__⌋⌊__⌋			
!!!	County		⌊__⌋⌊__⌋⌊__⌋			
!!!	Sub-county		⌊__⌋⌊__⌋⌊__⌋			
!!!	Parish		⌊__⌋⌊__⌋⌊__⌋			
!!!	School		⌊__⌋⌊__⌋			
	Pupil		⌊__⌋⌊__⌋⌊__⌋			
	Teacher		⌊__⌋⌊__⌋⌊__⌋			
!!!	Enumerator		⌊__⌋⌊__⌋⌊__⌋	D D	M M	Y Y Y Y
	Controller		⌊__⌋⌊__⌋⌊__⌋	D D	M M	Y Y Y Y
	Field supervisor		⌊__⌋⌊__⌋⌊__⌋	D D	M M	Y Y Y Y
	Data clerk 1		⌊__⌋⌊__⌋⌊__⌋	D D	M M	Y Y Y Y
	Data clerk 2		⌊__⌋⌊__⌋⌊__⌋	D D	M M	Y Y Y Y
	Data supervisor		⌊__⌋⌊__⌋⌊__⌋	D D	M M	Y Y Y Y

!!!	Class			
!!!	Section			
!!!	Class type	⌊__⌋	1. Single-grade 2. Multi-grade	

[27] The survey and game instruments were used for a larger impact evaluation project focused on school performance. Only the parts relevant to the present paper are presented here, the rest being available from the authors upon request.

Please remember that when dealing with children you have to be extra careful and playful. If a child feels at ease and is not scared (s)he will be more helpful and you will be able to finish faster and better! You should never keep a child against their will: if necessary take a break from the activities and talk/play for a little. This concept will not be repeated throughout the protocol sheets, but should always be taken in high consideration; the well-being of children is our first goal. It is important to establish a playful and relaxed rapport with the children to be assessed, via some simple initial conversation about topics of interest to the child (see example below). The child should perceive the following assessment almost as a game to be enjoyed rather than a severe situation.

Good morning. My name is _____ and I live in _____. I'd like to tell you a little bit about myself. [Number and ages of children; pets; sports; etc.]

1. Could you tell me a little about yourself and your family? [*Wait for response; if student is reluctant, ask question 2, but if they seem comfortable continue to verbal consent*].

2. What do you like to do when you are not in school?

Verbal Consent

- **Let me tell you why I am here today. I work with Makerere University and we are trying to understand how children learn. You were picked by chance, like in a raffle or lottery, as you may have seen this morning in class.**
- **We would like your help in this.**
- **We are going to play some games and ask you some questions.**
- **This is NOT a test and it will not affect your grade at school.**
- **This morning, as you know, I have asked other questions to your family.**
- **You do not have to participate if you do not wish to. Once we begin, if you would rather not answer a question, that's all right.**
- **During today's activities we will give you some candies if you behave well**
- **Do you have any questions? Shall we get started?**

Check box if verbal consent is obtained: ☐ ***YES***

- Tell the child that if (s)he needs to go to the toilet or is feeling uncomfortable in any other way (s)he should tell you. The child should not worry, as the activities can stop and start again when (s)he feels more at ease

1. Starting Questions

NO.	QUESTION	ANSWER	CODING CATEGORIES	SKIP
100	How old were you at your last birthday?	└┴┴┘ years		
101	IS THE PUPIL A BOY OR A GIRL?	└┴┘	1. Boy 2. Girl	
102	Do you speak the same language at home as you speak at school?	└┴┘	1. Yes 2. No	➔ 104 ➔ 103
103	What language do you speak at home? *[Multiple responses are allowed]*			
104	Did you go to a nursery or pre-school before P1?	└┴┘	1. Yes 2. No	
105	What grade were you in this year?	P └┴┘		
106	This year, were you absent from school for more than one week continuously?	└┴┘	1. Yes 2. No	
107	Do you have the school reading textbook?	└┴┘	1. Yes 2. No	
108	Apart from your schoolwork, are there other books, newspapers or other things to read at your house?	└┴┘	1. Yes 2. No	➔ 109 ➔ 111
109	What is there to read in your house? *[Multiple responses are allowed]*			
110	What language(s) are these books or other materials in? *[Multiple responses are allowed]*			
111	IS THE SCHOOL SUPPOTRTED BY WAR CHILD?	└┴┘	1. Yes 2. No	➔ 112 ➔ 2.
112	Are you involved in War Child's IDEAL? *[Make sure the kid knows what you mean!]*	└┴┘	1. Yes 2. No	

Region	District	County	Sub-county	Parish	School	Respondent
⌊__⌋	⌊__⌋__⌋	⌊__⌋__⌋__⌋	⌊__⌋__⌋__⌋	⌊__⌋__⌋__⌋	⌊__⌋__⌋	⌊__⌋__⌋

2. BMI

a. Height

- Ask the child to remove his/her shoes (if applicable)
- Ask to stand against a clear, flat, wall
- Place the clipboard on top of his/her head, perpendicular to the ground
- Mark a sign on both sides of the clipboard were the wall intercepts the bottom part of the clipboard
- Use the tape-measure to measure the distance from the ground till the center of the mark on the wall, making sure the tape-measure is perpendicular to the ground
- Tell the child how tall (s)he is
- Appreciate the child's collaboration and show satisfaction before passing to the next activity
- Report the height in centimeters (cm), including one decimal

201	Height in cm	⌊__⌋__⌋__⌋ . ⌊__⌋

b. Weight

- Before the child puts on his/her shoes, ask him/her to step on the scale
- Wait until the scale stops oscillating and report the weight in kilograms (kg)
- Inform the child about his/her weight in a jubilating manner before passing to the next activity
- Ask the child to put the shoes on again

202	Weight in kg	⌊__⌋__⌋

3. Digits Ratio

a. Second digit (index finger)

- Ask the child to place his/her right hand on a flat surface (table) with the palm of the hand facing upwards
- Place the clip-board at the topmost point of the index finger (fingertip), perpendicular to the table and parallel to the bottom crease, where the finger joins the hand
- Place the end-point of the tape-measure perpendicular to the clip-board from the fingertip and measure the distance to the central point of the bottom crease.
- Report the measure in centimeters (cm), including one decimal

301	Index finger length in cm	⌊__⌋.⌊__⌋

b. Fourth digit (ring finger)

- Ask the child to keep his/her right hand on the flat surface (table) with the palm of the hand facing upwards
- Place the clip-board at the topmost point of the ring finger (fingertip), perpendicular to the table and parallel to the bottom crease, where the finger joins the hand
- Place the end-point of the tape-measure perpendicular to the clip-board from the fingertip and measure the distance to the central point of the bottom crease.
- Report the measure in centimeters (cm), including one decimal

302	Ring finger length in cm	⌊__⌋.⌊__⌋

5. IQ test

- Tell the child that now you are going to solve some puzzles together
- Find a comfortable seating for both you and the child
- Take out the first laminated matrix and the possible answers
- Tell the child that at the end of this activity (s)he will receive at least one candy or even more
- Ask the kid which of the six answer pieces (s)he thinks should be added (1: C) and praise them for their choice if correct, otherwise give the following feedback:
- "Are you sure... I think this one would fit better", show how the right piece fits the matrix but do not explain why it does, end with "you see, let's try another one"
- If the child answers correctly, report a 1 on the record sheet (a simple vertical bar like this |). If the answer is incorrect report the chosen answer in CAPITAL LETTERS (e.g.: ABCDEF)
- The record sheet might therefore look something like this:
  "... | F E | A | | | B | B B B ..."
- At the end write down the number of correct answers in the box, in our example the child answered 6 times correctly
- Notice that after 3 consecutive wrong answers you MUST stop the test
- This is to prevent the child from getting frustrated and to limit the number of right answers "by chance".
- The test therefore will not necessarily be comprised of 19 questions, but of the number of questions the kid answers before making 3 consecutive mistakes
- At the end of the test, jubilate about the completion of the test and say that in a moment (s)he will get a candy

	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519
Matrix	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Correct	C	E	B	F	A	F	B	D	F	A	C	B	B	A	E	D	D	B	D
Answer																			

520	Total Correct Answers:	⌊_⌊_⌋

Region	District	County	Sub-county	Parish	School	Respondent
⌊__⌋	⌊__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋	⌊__⌋__⌋__⌋

6. Now or Later Game

- Tell the child that (s)he can receive a candy now and one at the end of the next activity
- Tell the child that (s)he can also decide to postpone the candy (s)he can get now, and wait until the end of the next activity
- Tell the child that if (s)he does so, at the end of the next activity (s)he will receive not only the candy of now and the candy of later, but also another candy, so a total of 3 candies!
- Let the child decide and report the answer
- Give the candy if applicable

601	⌊__⌋	1. Now 2. Later

Region	District	County	Sub-county	Parish	School	Respondent
⌊__⌋	⌊__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋	⌊__⌋__⌋__⌋

8. Now or Later Game continued

a. If the child had chosen for a candy immediately

- Provide another candy and ask to proceed for some other similar questions

b. If the child had chosen to wait and get 3 candies later

- Give three candies to the child and tell him/her (s)he can start eating them immediately or whenever they want
- Ask to proceed for some other similar questions

Region	District	County	Sub-county	Parish	School	Respondent
⌊__⌋	⌊__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋__⌋__⌋	⌊__⌋__⌋	⌊__⌋__⌋__⌋

12. Group Game

- Tell the child that now you are going to play another game
- This time (s)he will play this game in a group of 6, him/her and 5 of the other children being interviewed today
- The other five children are not present here, but are being asked the same questions right now
- Take out the two "cards", one with six people each receiving one candy, and one with one child receiving 3 candies
- Explain: "the card with one child and 3 candies represents you yourself receiving 3 candies. The card with six children represents you and the other children playing with you, each one of you including yourself receiving 1 candy".
- Tell the child that the other children in the group are right now facing the same decision, they have to give one of the two cards to you: if a child selects the card with one kid, (s)he will receive 3 candies at the end of the activities. If a child selects the card with 6 kids, everybody in the group will receive 1 candy
- "So if you select the card with one kid, you will be sure to get 3 candies at least, plus 1 other candy from every child that has decided to select the other card"
- "If you select the card with the entire group, then you will be sure to get 1 candy, plus another candy from every other child that has selected the same card"
- "If every one of the six children selects the card with the entire group, there will be six cards like that at the end, each one counting 1 candy per child, so each child will receive 6 candies"
- "If on the other hand you are the only one selecting that card, and every other child selects the card with one kid, then they will receive 3 candies plus one candy each from your card, so 4 candies in total, while you will receive only the 1 candy from your card"
- "Do you understand how it works? You need to think carefully what would be the right choice for you to take"
- Ask the child to think carefully and select one of the two cards to be put aside
- Explain again that to know the exact number of candies (s)he will receive you first need to see what the other kids have selected, and that is why you will not give the candies now but at the end of the activities
- Ask the child if (s)he is happy with her decision. If not so, let him/her swap the cards (DO NOT TURN THEM)
- Only now you can turn the card and record the outcome

NO.	QUESTION	ANSWER	CODING CATEGORIES
1201	SWAPPED?	⌊__⌋	1. Yes 2. No
1202	WHICH CARD WAS FINALLY HANDED OVER?	⌊__⌋	1. One child 2. Six children

17. Possibilities Game

a. First game

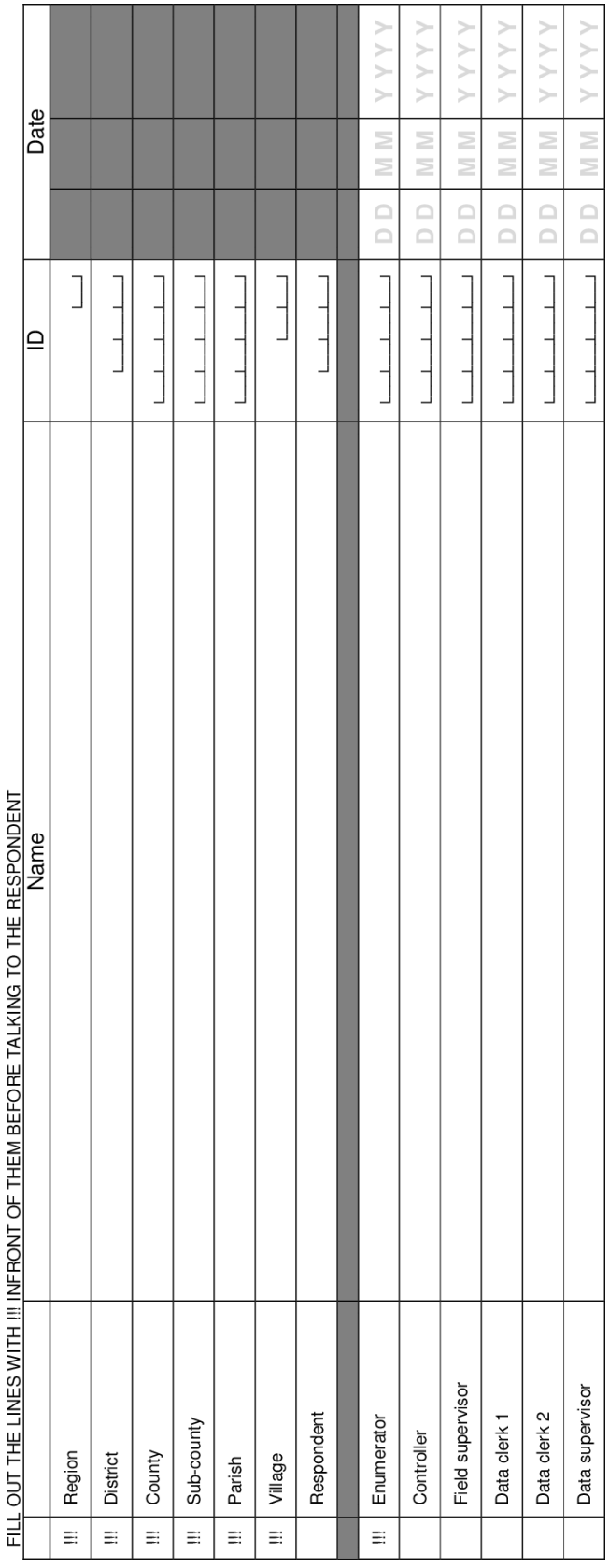
- Take out the two Possibilities Game bags (orange and purple)
- "In the bags there are two balls, one yellow and one blue"
- Explain to the child that (s)he will have to draw one ball from one of the bags
- The number of candies (s)he will get now depends on his/her choice of bag and the type of ball (s)he will extract
- If they select the orange bag, the yellow ball is worth 3 candies while the blue ball is worth 4
- If they select the purple bag, the yellow ball is worth only 2 candies, but the blue ball is worth 5
- Make sure they understand the concept
- Tell the child to choose the favorite bag
- Before playing the game, ask the child to think carefully again if that is his/her final decision
- Report the choice
- Let the child pick one of the balls in the chosen bag, making sure there is no biasing of the lottery
- Remind the child about the outcome of the lottery (number of candies won)

b. Second game

- Ask the child if (s)he would like to play a similar game one more time
- Remove the yellow and blue balls from the bags, and present the red and green balls
- Put one ball of each color on top of each bag
- This time, the orange bag has ball values of 2 for the red and 3 for the green
- The purple one has values 1 for the red and 6 for the green
- Tell the child to choose the favorite bag
- Before playing the game, ask the child to think carefully again if that is his/her final decision
- Report the choice
- Let the child pick one of the balls in the chosen bag, making sure there is no biasing of the lottery
- Remind the child about the outcome of the lottery (number of candies won)
- Give the sum of candies of the two lottery outcomes to the child

		Bag		Ball		Candies
1701	Lottery 1	⌊__⌋	1. Purple 2. Orange	⌊__⌋	1. Yellow 2. Blue	⌊__⌋
1702	Lottery 2	⌊__⌋		⌊__⌋	1. Red 2. Green	⌊__⌋
1703	Total candies					⌊___⌋___⌋

E Survey and game instruments (caregiver)[28]



[28] The survey and game instruments were used for a larger impact evaluation project focused on school performance. Only the parts relevant to the present paper are presented here, the rest being available from the authors upon request.

NO.	QUESTIONS AND FILTERS	ANSWER	CODING CATEGORIES	SKIP
001	PROBE: IS THE RESPONDENT THE PERSON WHO TAKES THE MOST CARE OF _____, THE CHILD YOU WILL WORK WITH LATER,?	⌊__⌋	1. Yes 2. No	➔ 002 ➔ FIND CORRECT PERSON
002	PROBE: WHAT IS THE RESPONDENT'S RELATIONSHIP TO THE CHILD?	⌊__⌋	1. Parent 2. Grandparent 3. Uncle/aunt 4. Sibling 5. Other relative 6. Not related	
003	Hello. My name is _____ and I am working with Makerere University. Together with Wageningen University from the Netherlands, we are conducting a survey about school quality and parenthood issues. It will help us evaluate the performance of some of the development projects in Uganda financed by the Dutch government. We would very much appreciate your participation in this survey. The survey will not take long to complete. Participation in this survey is voluntary, and if we should come to any question you don't want to answer, just let me know and I will go to the next question; or you can stop the interview at any time. However, we hope that you will participate in this survey since your views are important. At this time, do you want to ask me anything about the survey? May I begin the interview now? Signature of interviewer: _____ Date: _____			
004	DOES THE RESPONDENT AGREE TO BE INTERVIEWED?	⌊__⌋	1. Yes 2. No	➔ 005 ➔ END
005	RECORD THE TIME	HH MM		
006	PROBE: IS THE RESPONDENT BLOOD RELATED TO _____?	⌊__⌋	1. Yes 2. No	
007	PROBE: FOR HOW LONG HAS THE RESPONDENT BEEN THE MAIN PERSON TAKING CARE OF THE CHILD?	⌊__⌋⌊__⌋ years	RECORD "0" if less than one year IF ALWAYS, RECORD AGE OF CHILD	

1. Informed Consent

Before we begin, I would like to take a minute to explain why I am inviting you to participate and what I will be doing with the information you provide to me. Please stop me at any time if you have any questions. After I've told you a bit more about my project, you can decide whether or not you would like to participate.

This research is being conducted by Makerere University in collaboration with researchers from Wageningen University. We will be interviewing about 480 people in Uganda. The researchers will use the information we collect in articles that might be published, as well as in academic presentations. _____ has been selected randomly, like in a lottery extraction, to participate in the research.

If you agree, we would like to ask you some questions this morning, and ask _____ some other questions this afternoon. Participation is on a purely voluntary basis. You will be asked to participate in an activity, consisting of either questions about your child and yourself or a task. At the end of each task you are asked to make a decision. The information we collect today is private and confidential. We will not share any details from the survey about you, your friends or family with anyone besides the research team from Makerere and Wageningen University. Any information you share will be treated anonymously. The tasks will require you to make some simple choices about how to "invest" money. You will be asked to do several tasks, and at the end, we will select one of them through a lottery. This is the task for which you will be rewarded. Depending on your choices and on the choices of other people in your village, you can earn between 500 and 17.000 USh if you complete the tasks properly. If you keep quiet about the payment you receive at the end, there are virtually no risks involved in participating. The money you will have won will be given to _____ in a sealed envelope at the end of the day, in the form of MTN airtime. This airtime is yours: you can keep it or sell it or do whatever you wish with it. Also, _____ will be given some candy for him/herself, as appreciation for the fulfilment of the questions and tasks.

None of the questions we will ask _____ will be sensitive, but some of the questions we will ask you might be sensitive for you. If at any time and for any reason, you would prefer not to answer any questions, please feel free not to. If at any time you would like to stop participating, please tell me. We can take a break, stop and continue at a later time, or stop altogether. You will not be penalized in any way for deciding to stop participation. The tasks should take about 1 hour to be completed.

If you have questions, you are free to ask them now. If you have questions later, you may contact me by calling the survey coordinator Jan Duchoslav at 0774901787. You may also contact the researchers at Wageningen University. Professor Erwin Bulte is the researcher responsible for this project, and he can be reached in the following ways:

Erwin Bulte
Department of Development Economics
Hollandseweg 1, Wageningen, 6706 KN, The Netherlands
Telephone: +31317-485286 E-mail: erwin.bulte@wur.nl

If you agree to participate, I will ask you to please sign this form twice, either by signature or thumbprint, to indicate that you participated voluntarily. One copy of this paper will stay with you, one copy will be sent to Wageningen University.

Location:_____ Sign:

Date: └─┴─┘ └─┴─┘ └─┴─┴─┴─┘

Region	District	County	Sub-county	Parish	School	Respondent
⌊__⌋	⌊__⌋⌊__⌋	⌊__⌋⌊__⌋⌊__⌋	⌊__⌋⌊__⌋⌊__⌋	⌊__⌋⌊__⌋⌊__⌋	⌊__⌋⌊__⌋	⌊__⌋⌊__⌋⌊__⌋

2. Socio-economic module

NO	QUESTIONS AND FILTERS	ANSWER	CODING CATEGORIES	SKIP
201	IS THE RESPONDENT MALE OR FEMALE?	⌊__⌋	1. Male 2. Female	
202	In what month and year were you born?	MM YYYY	RECORD THE DATE. IF THE RESPONDENT DOESN'T KNOW, ENTER 99 / 9999	
203	How old were you at your last birthday? COMPARE WITH 202 IF CONSISTENT. PROBE UNTIL CONSISTENT.	⌊__⌋⌊__⌋ years	ENTER AGE IN COMPLETED YEARS.	
204	Are you married? PROBE FOR THE RESPONDENT'S MARITAL STATUS	⌊__⌋	1. Single 3. Married 5. Separated 2. Engaged 4. Divorced 6. Widowed	
205	Have you ever attended school?	⌊__⌋	1. Yes 2. No	➔ 206 ➔ 209
206	What is the highest level of school you attended?	⌊__⌋	1. Primary 3. Upper secondary (A) 2. Lower secondary (O) 4. Tertiary / University	
207	What is the highest grade you completed at that level?	⌊__⌋	RECORD GRADE	
208	How often do you read a newspaper?	⌊__⌋	1. Almost every day 3. Less than once a week 2. At least once a week 4. Not at all	
209	How often do you listen to the news on radio or on television?	⌊__⌋	1. Almost every day 3. Less than once a week 2. At least once a week 4. Not at all	
210	What tribe do you belong to?	⌊__⌋⌊__⌋	1. Muganda 5. Munyarwanda 9. Acholi 13. Karamojong 2. Muteso 6. Mukiga 10. Lugbara 14. Other, 3. Musoga 7. Lango 11. Munyoro specify: 4. Munyankole 8. Mugisu 12. Mutoro _____	
211	What is your religion?	⌊__⌋	1. Christian 3. Traditional 2. Muslim 4. Other, specify: _____	
212	How many people live in this household, including yourself and the child?	⌊__⌋⌊__⌋	RECORD TOTAL NUMBER OF HOUSEHOLD MEMBERS	
213	How many rooms in your homestead are used by your household?	⌊__⌋	RECORD TOTAL NUMBER OF ROOMS, INCLUDING LIVINGROOM	
214	Do you or anyone in your household own any of the following? a. phone? b. radio? c. television? d. generator? e. bicycle? f. motorbike? g. car?	⌊__⌋ ⌊__⌋ ⌊__⌋ ⌊__⌋ ⌊__⌋ ⌊__⌋ ⌊__⌋	1. Yes 2. No	
215	What is the main material of your roof?	⌊__⌋	1. Thatch 3. Roof tiles 2. Iron 4. Other, specify: _____	
216	What is the main material of your walls?	⌊__⌋	1. Mud 3. Bricks 2. Mud block 4. Other, specify: _____	
217	What is the main material of your floor?	⌊__⌋	1. Mud / earth 3. Tiles 2. Cement 4. Other, specify: _____	

5. Possibilities Game

- Take out the Orange Possibility Bag
- "In this bag there are two balls, one Blue and one Yellow", show the two balls from your hand
- You will have to pick one of the balls from the bag, and that ball will determine how much money you will receive from this game
- Explain to the respondent that (s)he is given the chance to allocate 9.000 shillings and distribute them among the two balls
- "For example you can assign 4.000 shilling to the Blue ball and 5.000 to the Yellow one; or you can assign 7.000 to the Blue one and 2.000 to the Yellow one; or again all 9.000 to the Yellow one. It's up to you!"
- Explain that the only rule is that the total shillings assigned equals 9.000
- Use the 9 1.000 shilling cards to help the respondent make his/her decision
- Explain: "place as many cards as you wish the black ball to be worth next to it, and do the same for the white ball"
- Make sure they understand the concept
- Report the choice but DON'T LET THE RESPONDENT PLAY THE LOTTERY!!!

	501	502
Balls:	Blue	Yellow
Value assigned by participant (in thousand shillings)	⌊_⌋	⌊_⌋

Remember that the total must sum up to 9!

9. Group Game

- Tell the respondent that now you are going to play the last game
- This time (s)he will play this game in a group of 12, him/her and other 11 respondents among the parents participating in today's activities
- Take out the two "cards", one with 12 people, each one receiving 500 Ush, and one with one person, receiving 4,000 Ush.
- Explain: "the card with one person and 2 banknotes of 2,000 represents you yourself receiving 4,000. The card with 12 people represents you and the other participants, each one of you including yourself receiving 500".
- Tell the respondent that the other 11 participants in the group are right now facing the same decision, they have to give one of the two cards to you: if they select the card with one person, they themselves will receive 4,000 Ush at the end of the activities, if they select the card with 12 people, then everybody in the group will receive 500. The other people will face the same dilemma.
- "So if you select the card with one person, you will be sure to get 4,000, plus 500 from any other person that has decided to select the card with 12 people"
- "If you select the card with the 12 people, then you will be sure to get 500, plus 500 from any other person that has decided to select the card with 12 people"
- "If everybody in the group selects the card with 12 people, there will be 12 cards like that at the end, each one counting 500 per person, so each participant will receive 6,000"
- "If on the other hand you are the only one selecting that card, and every other participant selects the card with one person, then they will receive 4,000 plus 500 each from your card, while you will receive only 500 from your card"
- "Do you understand how it works? You need to think carefully what would be the right choice for you to take"
- Make sure the respondent understands the dilemma
- Ask the respondent to think carefully, select one of the two cards and hand it over to you face down, while the other card should be kept
- The card selected and put face down represents the card that the respondent does not want
- Ask the respondent if (s)he is happy with her decision. If not so, let him/her swap the cards (DO NOT TURN THEM)
- Only now you can turn the card and record the outcome
- After this, store the card given to you and put it away

NO.	QUESTION	ANSWER	CODING CATEGORIES
901	DID THE RESPONDENT SWAP THE CARDS?	⌊__⌋	1. Yes 2. No
902	WHICH CARD WAS FINALY KEPT?	⌊__⌋	1. One person card 2. Twelve people card

Region	District	County	Sub-county	Parish	School	Respondent
⌊__⌋	⌊__⌋⌊__⌋	⌊__⌋⌊__⌋⌊__⌋	⌊__⌋⌊__⌋⌊__⌋	⌊__⌋⌊__⌋⌊__⌋	⌊__⌋⌊__⌋	⌊__⌋⌊__⌋⌊__⌋

10. Trauma

- "Indicate how much you have been bothered by that problem in the last month"

NO.	QUESTION	ANSWER	CODING CATEGORIES
1001	Repeated, disturbing *memories, thoughts, or images* of a stressful experience from the past?	⌊__⌋	1. Not at all 2. A little bit 3. Very much
1002	Repeated, disturbing *dreams* of a stressful experience from the past?	⌊__⌋	
1003	Suddenly *acting* or *feeling* as if a stressful experience *were happening* again (as if you were reliving it)?	⌊__⌋	
1004	Feeling *very upset* when *something reminded* you of a stressful experience from the past?	⌊__⌋	
1005	Having *physical reactions* (e.g., heart pounding, trouble breathing, or sweating) when *something reminded* you of a stressful experience from the past?	⌊__⌋	
1006	Avoid *thinking about* or *talking about* a stressful experience from the past or avoid *having feelings* related to it?	⌊__⌋	
1007	Avoid *activities* or *situations* because they *remind you* of a stressful experience from the past?	⌊__⌋	
1008	Trouble *remembering important parts* of a stressful experience from the past?	⌊__⌋	
1009	Loss of *interest in things that you used to enjoy?*	⌊__⌋	
1010	Feeling *distant* or *cut* off from other people?	⌊__⌋	
1011	Feeling *emotionally numb* or being unable to have loving feelings for those close to you?	⌊__⌋	
1012	Feeling as if your *future* will somehow be *cut short*?	⌊__⌋	
1013	Trouble *falling* or *staying asleep*?	⌊__⌋	
1014	Feeling *irritable* or having *angry outbursts*?	⌊__⌋	
1015	Having *difficulty concentrating*?	⌊__⌋	
1016	Being *"super alert"* or watchful on guard?	⌊__⌋	
1017	Feeling *jumpy* or easily startled?	⌊__⌋	

11. War exposure

- " The next few questions are going to be about war. If they disturb you or you don't want too answer, please say so, I will move to the next question." Ask the respondent to answer Yes or No about his exposure to the war

NO.	QUESTION	ANSWER	CODING CATEGORIES
1101	Did any of your close family members go to fight in the war?	⌊_⌋	1. Yes 2. No 3. Don't want to answer
1102	Did you experience shooting at a very close distance?	⌊_⌋	
1103	Were you forced to leave your village or town?	⌊_⌋	
1104	Were you expelled from your home?	⌊_⌋	
1105	Were you ever in a situation where you thought you would be killed?	⌊_⌋	
1106	Did you see people who had been recently injured?	⌊_⌋	
1107	Was any one of your close family members injured during the war?	⌊_⌋	
1108	Were you separated from your close family members because of the war?	⌊_⌋	
1109	Was any one of your close family members killed during the war?	⌊_⌋	
1110	Did armed men ever forcibly enter your home?	⌊_⌋	
1111	Did you see a dead body?	⌊_⌋	
1112	Were you ever so hungry you thought you would die?	⌊_⌋	
1113	Did you see someone being killed?	⌊_⌋	
1114	Did you see someone being tortured?	⌊_⌋	
1115	Did anyone directly threaten to kill you during the war?	⌊_⌋	
1116	Were you ever held in detention during the war?	⌊_⌋	
1117	Did you help to carry wounded or dead people?	⌊_⌋	
1118	Did you see many people being killed at once?	⌊_⌋	
1119	Were you injured during the war?	⌊_⌋	
1120	Were you ever used as a human shield during the war?	⌊_⌋	
1121	Did you see someone being raped or sexually abused during the war?	⌊_⌋	
1122	Did you experience loss or destruction of property because of the war?	⌊_⌋	
1123	Was any one of your close family members killed during the war?	⌊_⌋	