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Fluid intelligence in refugee children. A cross-sectional study of potential risk and resilience factors among Syrian refugee children and their parents

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ABSTRACT

We assess fluid intelligence of 6–18 year-old children growing up in families that have fled from Syria and reside in Turkish communities (100 families, 394 individuals). We demonstrate that fluid intelligence of refugee children is related to maternal fluid intelligence and to the amount of time mothers spend reading to their child. These factors stood out in the analysis even when controlling for a large range of other factors such as demographics, parental mental health, parental fluid intelligence, home environment, and a large array of potential enrichment factors.

The psychological development of children is often negatively affected by their parents' mental health problems (Garthus-Niegel, Ayers, Martini, von Soest, & Eberhard-Gran, 2017; Parfitt, Pike, & Ayers, 2014). With >10% of children in the world living in areas affected by armed conflict (UNICEF, 2015), it is particularly troubling that parental war-related Post Traumatic Stress Symptoms (PTSS) is associated with lower levels of well-being, higher levels of internalization, and more behavior problems in refugee children (Leen-Feldner et al., 2013). The active components that allow parents' traumatic experiences to impact future generations is assumed to be a combination of environmental factors, such as increased harshness and conflict within the family, parental withdrawal, and lower levels of parental warmth (Eltanamly, Leijten, Jak, & Overbeek, 2021; Leen-Feldner et al., 2013; Sack, Clarke, & Seeley, 1995), as well as genetic and epigenetic factors that create differential degrees of resilience (Howie, Rijal, & Ressler, 2019). Together these factors create a transfer over generations where parental mental health impacts the psychological development of infants (Parfitt et al., 2014; Slone & Mann, 2016; van Ee, Kleber, & Mooren, 2012) and children (Gredebäck et al., 2021; van Ee, Kleber, Jongmans, Mooren, & Out, 2016). These associations remain even when controlling for the corresponding psychological ability in parents, their war-related potentially traumatic experiences (Gredebäck et al., 2021), and the children's own experiences with potentially traumatic events (Leen-Feldner et al., 2013).

More specifically, several studies have reported that parents' war-related PTSS (and underlying experiences) are related to the cognitive development and intelligence of children. A study by Daud, af Klinteberg, and Rydelius (2008), for example, with refugees from Iraq living in Sweden demonstrates that children whose parents were traumatized by torture had approximately 1 standard deviation lower IQ scores than children of non-traumatized parents (86 points, for children with both high and low levels of PTSS using WISC-III, compared to 102 points [SD = 15]). A national cohort study from the same country demonstrated that parental PTSD (Post Traumatic Stress Disorder) had a strong negative association with children's school performance (even when controlling for co-morbidity of PTSD). Notably the effect was larger for parental PTSD than several other psychological disorders such as depression, bipolar, or psychotic disorder (Berg, Charboti, Montgomery, & Hjern, 2019).

Support for a link between parental PTSS and potentially traumatic events on the one hand and child intelligence on the other can also be found in the larger literature assessing the early foundations of intelligence in the general population. It has been estimated that about 50–70% of intelligence is heritable but that there are substantial environmental contributions as well (Deary, Johnson, & Houlihan, 2009) such as SES (Hillemeier, Morgan, Farkas, & Maczuga, 2011; Lawlor et al., 2005), cognitive stimulation (Kagitcibasi, Sunar, & Bekman, 2001), and mental health of parents (van der Waerden et al., 2017), for reviews see (Liu et al., 2017; Walker et al., 2007). Furthermore, children's intelligence has been reported to be associated with their parents' education and intelligence (Bradley & Corwyn, 2002), the quality of the home environment (Zhou, Baghurst, Gibson, & Makrides, 2007), and the

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quality and manner in which parents and children interact with each other (Makharia et al., 2016; Obradović, Yousafzai, Finch, & Rasheed, 2016; Ritchie, Bates, & Plomin, 2015). These factors closely resemble the mechanisms reviewed above, assumed to be responsible for the generational transfer to occur in the first place.

With all of these negative associations that tie child intelligence to the context in which their families live (Graham, Minhas, & Paxton, 2016), it is worth noting that there are multiple developmental pathways for children that have experienced war and/or live as refugees (Laor, Wolmer, & Cohen, 2001; Sack, Him, & Dickason, 1999; Zwi et al., 2017). The central research question for the field, at this point, might not be if children's intelligence is impacted by the context in which they are brought up, but rather to map out what factors contribute to, and hinder, the development of intelligence in different contexts.

In this paper we take a closer look at the factors that impact refugee children's fluid intelligence, relating children's performance on a fluid intelligence test to parental factors (age, sex, education, duration of displacement, SES prior to fleeing and currently, as well as potentially traumatic experiences and PTSS), child characteristics (age, sex), quality of the home environment (structure/chaos, discipline, and whether family members eat meals together), and potential enrichment factors (reading to the child, child activities, media usage, values towards school, and support with school work/home schooling). We assess this in a group of 100 families (233 children and 174 adults) from Syria (the vast majority from Aleppo) that reside in Turkish communities (outside refugee camps). To date the majority of studies that have included Syrian refugee children have focused on families living in local refugee camps (i.e., close to Syria), in Europe, or the US, despite the fact that most refugees live in local communities in neighboring countries (Vossoughi, Jackson, Gusler, & Stone, 2016).

A recent meta-analysis (Lambert, Holzer, & Hasbun, 2014) provides recommendations for how to conduct high-quality research that focus on generational transfer effects in refugee children. They argue that I) both parents should be included in the same study in order to separate out the unique effect of maternal and paternal PTSS. II) That multilevel modeling is used to evaluate complex interactions between family members (by including a random intercept for family in a nested design). III) That analysis investigating the impact of parental PTSS on children's development take age and sex into account. IV) That culture is further emphasized so that clinical applications can be specifically tailored to the needs of local communities. The current study follows all of these recommendations.

Furthering our understanding of the factors that are associated with a strong development of intelligence in refugee children is important for several reasons. On a global level, refugee children's lives are often marked by poverty, poor access to health care and education, and the insufficient meeting of basic needs such as food and clean water (Kadir et al., 2018). As intelligence is positively associated with future income, labor market success and educational attainment (Strenze, 2007), finding routes to improve the developmental trajectory of children can have a profound impact on an individual's ability to make a transition away from poverty. Identifying correlational associations related to intelligence in Syrian refugee children is a first step towards approaching cost-effective, high-precision interventions that target the factors that really matter for this large group of future adults.

1. Method

1.1. Participants

A sample of 174 adults (Age: M = 39.8, SD = 7.8, range = [22,60]; Sex: 55.7% women) and 233 children (Age: M = 12.2, SD = 3, range = [6,18]; Sex: 42.5% girls), from 100 families participated in the study. The median number of children in each family was 2 (range [1, 8]). At the time of the study, they all lived in apartments in local communities in the town of Konya in Turkey. Most families originate from Aleppo (n = 82) with remaining families originating from Ar Raqqah (n = 1), Deir al-Zour (n = 2), Homes (n = 1), Idlib (n = 4), and Lattakia (n = 6). The majority of families had left their homes during the period 2014–2016 (79%) and at time of the study (December 2019 – January 2020), families had been refugees for an average of 4.9 years (SD = 1.4 years).

1.2. Procedure and design

Local research assistants, fluent in Arabic and Turkish, conducted home visits between October 2019 and January 2020. As records of refugee families living in local communities are not publicly available, an opportunistic sampling procedure was used where participating families recommended the study to other families. The entire family participated in the study at the same time, using individual computers (DELL Vostro 3568, 15′ screen) and headphones with active noise reduction. Each session started with tea and biscuits brought by the research assistants. This allowed the family to familiarize themselves with the assistants and the study. This was followed by verbal and written consent from all participants prior to participation.

Parents completed a series of experimental tasks (listed in Table 1) and answered several questionnaires (listed in Table 2) with instructions and questions in Arabic. The children only conducted the experimental tasks (due to an otherwise high work load for the child and the fact that some questions might trigger negative feelings and anxiety, something that we were not equipped to provide adequate support for in the field).

The study lasted approximately 60 min for adult participants and 30 min for children. Assistants ensured that parents were able to fill out the questionnaires in private (through seating arrangements) and that they could help their children understand the instructions and task requirements (they did not help them complete the computerized tasks). Given the size of the family and the amount of instructions needed the length of the sessions were highly variable, but all the data from a single family was collected in a single session and most often all family members conducted the tasks simultaniously. The study was approved by the regional ethics review board in Sweden (2018–395) and the Necmettín Erbakan Universitesi in Turkey (2019/17). Each family received a monetary compensation equivalent of 10 Euro per participant for participation.

Fluid intelligence was measured using the non verbal Matrix Reasoning task adapted from a subscale of the WASI (Wechsler, 1999). On each of the 34 trials (presented in a fixed order with increasing difficulty), participants were presented with a matrix of four squares, three of which contained a figure and one of which contained a question mark. Participants were asked to find the figure, among five filler figures, which belonged in the empty square. The rule for which figure belonged in the empty squared varied over trials. The testing procedure was stopped when the participant had completed all 34 trials or had answered a total of four (4) items incorrect. For each participant, we calculated the total number of correctly solved items and related this score to the questionnaire data and/or other family members' item level

Table 1
Experimental tasks performed by all participants performed in the order listed and whether the task was included in this analysis or not.

Process	Task	Reference	Included
Fluid intelligence	WASI Matrix reasoning	(Wechsler, 1999)	YES
Attention	Visual search with emotional primes	(Haas, Amso, & Fox, 2017)	NO
Social cognition	Emotional processing	(Gredebäck et al., 2021)*	NO
Proactive/ reactive control	AX-CPT	(Gonthier, Zira, Colé, & Blaye, 2019)	NO
Risk-taking	BART	(van Ravenzwaaij, Dutilh, & Wagenmakers, 2011)	NO

Note: Gredebäck et al. (2021) is based on the current data set.

Table 2
Questionnaires filled out by parents, in the order listed, including information on whether or not items from the questionnaire was included in the current analysis.

Focus area	Questionnaire	Abbreviation	Reference	Included
Demographics	Custom	DEM	n.a.	YES
Post-Traumatic Growth	PTGI-Short form	PTGI	(Cann et al., 2010)	NO
Home Environment	CHAOS	CHAOS	(Matheny, Wachs, Ludwig, & Phillips, 1995)+	YES
Home Environment	HOME-SF	HOME	(Mott, 2004)*	YES
Psychosocial Environment	FPSQ	FPSQ	(Garg & Dworkin, 2011)*	YES
Traumatic Experiences	HTQ - part 1	HTQ	(Mollica et al., 1992)	YES
Post-Traumatic Stress	PCL-C short form	PCL	(Lang & Stein, 2005)	YES

Note: * Minor adaptations done to better fit the cultural context and test situation. + Responses were given an a 4 point scale from very much like your home – not at all like your home, the original CHAOS scale use yes/no responses.

performance on the same task (see Tables 3 and 4 for more information on all variables used). The estimated split-half reliability was 0.90 and 0.89 for the adult and child samples, respectively.[1]

Post-Traumatic Stress Symptoms (PTSS) was assessed using the PCL-C Abbreviated (Lang & Stein, 2005), including 6 questions asking about the presence of disturbing memories, negative emotions, avoidance of situations that remind the respondent of stressful experiences, distance to other people, irritation, anger, and concentration difficulties (presented in the order listed). Each question was rated on a 5-point Likert scale asking if the respondent had been bothered by each problem in the last month, ranging from not at all to extremely often. The resulting variable was the total score ranging from 6 (not at all) to 30 points (extremely bothered by all problems during the last month). The scale exhibited a Cronbach alpha of 0.75 in the current sample.

Potentially traumatic events were assessed using HTQ (Mollica et al., 1992), including 16 questions asking about different war-related experiences, more specifically lack of food or water, ill health without medical care, lack of shelter, imprisonment, physical abuse, serious injury, combat situation, indiscriminate shelling or bombing, being close to death, forced evacuation, forced separation from family, murder of family or friend, unnatural death of family or friend, murder of stranger or strangers, kidnapped, torture (presented in the order listed). For each item respondents were asked if they had experienced this category of events or not prior to arriving in Turkey. The resulting variable was the sum of different events that participants had experienced. Cronbach's alpha for the scale was 0.74 in the current sample.

Socioeconomic status (SES) was assessed with a single item where participants rated their own relative position in society, in terms of social and economic status, compared to those who are Worst off (0) and those who are Best off (10). Participants were asked to make this estimate for their country of origin and for the Turkish society, respectively.

Parents also responded to a series of questions regarding the home environment (e.g., chaos, discipline, and the number of joint meals) and enriching activities done with the children (e.g., reading, listening to music, and going to museums). The questions used to measure home environment and enriching activities are described in descriptive Tables 3 and 4. Cronbach's alpha for the two multi-item scales (chaos and discipline) was 0.42 and 0.41, respectively.

1.3. Statistical analysis

We investigated the factors that impact intelligence separately for adults and children. For both adults and children we used Linear Mixed Models (LMM, implemented using the *lmer* (Bates, Mächler, Bolker, & Walker, 2015) and *lmerTest (*Kuznetsova, Brockhoff, & Christensen, 2017*)* package in R). The main reason for using LMM was to be able to account for the fact that the same family could consist of several adults and/or children. Thus, when predicting fluid intelligence of the child, data points are not independent. We accounted for this non-independence by specifying a random intercept for family in all models reported below.

Furthermore, the data matrix is in some cases sparse due to missing data, particular for the children. More specifically, not all children have data reported from both parents because a family could consist of only one parent or only one of the two participating parents reported data for a specific child. Running LMM with list-wise deletion due to missing data would thus result in very few complete cases. To account for the missing data, and accordingly retain and use as much of the collected data as possible, we used a multiple imputation approach. More specifically, we generated 50 multiple imputations of the data matrix using the multivariate imputations by chained equations method implemented in the R-package *mice* (Buuren & van Buuren & Groothuis-Oudshoorn, 2011). This was done for the adult and child data matrix separately. The method imputes each incomplete variable by a separate model. The per-cent of missing data was 2% and 18% for the adult and child data matrix, respectively. All models reported below were run on the same 50 imputations and parameters were estimated by averaging the estimates over all models using Rubin's rule (Campion & Rubin, 1989).

With the imputed data sets, we conducted our analysis in steps. For each step, we retained all predictors that had a p-value of 0.1 or less. We used this approach in an effort not to include too many variables, and thus saturate the model, at each step (for information on variables retained and dropped, see Table 5). Admittedly, this is an exploratory approach that does not allow for confirmatory hypotheses tests. However, our goal was not to test a specific hypothesis but rather to explore potential predictors of children's fluid intelligence. Furthermore, we reasoned that the data could not sustain the complex models that would be the result of including all predictors at once.

2. Results

2.1. Adults

Descriptive statistics for all variables in the adult sample are summarized in Table 3 (see Supplementary Table 1 for complete correlation matrix). On average, adult participants correctly solved 14.1 ($SD = 7.6$) out of 34 trials on the WASI Matrix reasoning task, measuring fluid intelligence. To investigate predictors of adults' fluid intelligence, we constructed a baseline model to investigate the effect of age, sex, level of education, year of leaving Syria and SES in Syria and Turkey on intelligence. Next, we investigated the impact of mental health in a model including, in addition to any significant or marginally significant predictors from the baseline model, PTS and HTQ as fixed factors. The intraclass correlation (ICC) for the adult model was 0.54.

In the baseline model, education was the only significant predictor ($b = 1.961$, $p < .001$) with a higher level of education related to better performance on the WASI matrix reasoning task. In the next step, we included, in addition to education, PTS and HTQ to the model. This

[1] We estimated the reliability of the WASI using a bootstrapping, split-half approach. This approach was used, rather than e.g. Cronbach's' alpha, due to the number of attempted items varying between participants. For each bootstrapping sample, we randomly split each participants data into two halves and calculated the number of correctly solved items for each half. We then calculated the correlation between the score for the two halves. This procedure was repeated 2000 times and the average correlation over all 2000 iterations was used as an estimate of the reliability.

Table 3
Summary statistics for all variables except sex (see Participants) in the adult sample.

	Source	n	M	SD	MED	Min	Max	Skew	Kurtosis	note
Age (9-point scale)	DEM	174	39.79	7.75	39.5	22	60	0.15	−0.39	0 = 0–17 years, 4 = 45–54 years, 8 = 85+ years
Highest level of education (6-point scale)	DEM	174	3.24	1.36	3.0	1	6	0.50	−0.21	1 = no formal education, 6 = 12+ years
When did you leave Syria (14 levels)	DEM	172	10.06	1.40	10.0	6	14	0.46	0.79	1 = 1994 or earlier, 7 = 2012, 14 = 2019
SES Syria (11-point scale)	DEM	174	5.81	2.05	5.0	0	10	0.04	−0.03	0 = worst off, 10 = best off
SES Turkey (11-point-scale)	DEM	174	5.04	2.74	5.0	0	10	0.33	−0.76	0 = worst off, 10 = best off
HTQ (16 categories, binary)	HTQ	174	7.37	2.78	8.0	1	15	−0.06	0.19	n categories experienced
PTS (6 statements, 5-point scale)	PCL	174	17.60	5.47	18.0	6	30	−0.04	−0.71	1 = not at all, 3 = moderately, 5 = extremely

model revealed, in addition to education ($b = 1.807, p < .001$) still being significant, that neither PTS ($p = .456$) nor HTQ ($p = .493$) were significant predictors of fluid intelligence. The result of the second model is summarized in Table 6.

2.2. Children

Descriptive statistics for all variables in the child sample are summarized in Table 4 (see Supplementary Table 2 for complete correlation matrix). On average, the child participants correctly solved 13.6 ($SD = 7.5$) out of 34 trials on the WASI matrix reasoning task. We explored impacts on children's fluid intelligence in four steps. First, we constructed a baseline model to investigate the effect of age and sex on intelligence. Next, we investigated the impact of parents' mental health in a model including parental PTS and HTQ as fixed factors. This model also included parental fluid intelligence as a fixed factor. In a third step, we included variables pertaining to the child's home environment (chaos, discipline, and joint meals). Our fourth model included enriching activities that the parents might engage in with the child. For each new step, we retained any predictors that that were marginally significant ($p < .10$) for the next step. For this reason, we also built a final model containing only the significant predictors after the fourth step described above. The interclass correlation (ICC) for the child model was 0.62.

From the baseline model, only age was retained as a marginally significant predictor ($b = 0.264$, $p = .058$) with older children performing better on the matrix reasoning task. In the next step, we included, in addition to age, parental fluid intelligence, PTS, and HTQ in the model. We entered mothers' and fathers' performance and responses as separate predictors. This model revealed, in addition to age ($b = 0.247, p = .081$) still being marginally significant, mothers' intelligence ($b = 0.276, p = .011$) as a significant predictor.

The third model included, in addition to the retained variables age and mothers' fluid intelligence, additional variables related to the child's home environment. These were variables of reported chaos, the use of discipline measures, and the number of joint meals, in the family. The model revealed no additional significant or marginally significant predictors beyond age and mothers' intelligence.

In our fourth model, we added predictors related to various enrichment activities. Again, we modeled fathers' and mothers' reports separately. The results indicated two additional, marginally significant predictors, the extent to which mothers' reported reading to their children ($b = 0.803, p = .078$) and mothers' reports of children's media usage during weekends ($b = 0.784$, $p = .073$).

We used the findings from the prior models to build a final model, including previously significant and marginally significant predictors. Thus, our final model included age, mothers' intelligence, mothers‘ reported reading to their children, and mothers’ reports of children's media usage during weekend days as fixed factors and with a random intercept for family. The final model is summarized in Table 7. As is evident from the table, the final model contains three significant predictors; age, mothers' fluid intelligence, and mothers' reported reading to their children. Thus, children's fluid intelligence increased with age and mother's intelligence as well as with how much the child was read to (mean (SD) intelligences score (WASI) for the five levels of reported reading where: 0: 10.8 (6.7), 1: 9.3, (4.5), 2: 11.8 (5.8), 3: 15.5 (7.1), and 4: 15.7 (8.3)), as reported by the mother. Fig. 1 illustrates the relation between each significant predictor and the outcome in the final model.[2]

In the final model, both the effect of the mother's fluid intelligence (η^2 (partial) = 0.09) and mother's reported reading to the child (η^2 (partial) =0.05) were of medium size in a statistical sense. In comparison, the effect of age (η^2 (partial) =0.02) was small and less than half that of the other two significant predictors (see also standardized regression coefficients in Tables 6 and 7).

3. Discussion

In this study we demonstrate that fluid intelligence of Syrian refugee children, living with their families in Turkish communities, can be related to maternal fluid intelligence (which, in turn, is related to maternal education) and to the amount of time mothers spend reading to their child. These factors stood out in the analysis even when controlling for a large range of other factors such as demographics, parental mental health, parental fluid intelligence, home environment, and a large array of potential enrichment factors. Three main knowledge gains can be drawn from this result.

First of all, we suggest, based on the lack of association between intelligence and parental traumatic experiences and mental health, that fluid intelligence in children is a robust ability that is not easily impacted by parental mental health or the family's experiences of war, at least in this context and in this group of refugees. According to this interpretation intelligence might be robust and resilient to contextual factors associated with between-family variation in exposure to war atrocities and subsequent war-related mental health issues.

Secondly, we identify a factor that support the growth of, or is correlated with, fluid intelligence in children. The association between reading habits and intelligence is consistent with prior work from non-war related contexts. A recent meta-analysis of shared book reading (19 RCTs and > 2500 children Dowdall et al., 2020) demonstrates that the frequency and quality of parental reading is related to children's

[2] In an effort to investigate the robustness of our results, particularly with respect to non-significant effects, we re-ran all models using Bayesian Linear Mixed Models (BLMM). The model results are summarized in the supplementary materials, Tables S3 to S9. In these analyses, we used the 95% credibility interval to determine if a predictor should be included in subsequent models and if a predictor could be said to have an effect on our outcome variable, intelligence. For each fixed effect, we also calculated BF01 to quantify the support for the null hypothesis. The use of BLMM did not change the interpretation of any of the models with respect to which variables should be kept for subsequent models or which predictors influenced child intelligence.

Table 4
Summary statistics for all variables except sex (see Participants) in the child sample.

	Source	n	Mean	SD	MED	min	max	Skew	Kurtosis	note
Age	DEM	233	12.21	3.03	12	6	18	0.04	−0.99	years
Number of years in school rated by mother	DEM	208	6.15	2.64	6	1	13	0.44	−0.37	years
Number of years in school rated by father	DEM	162	6.07	2.48	6	2	13	0.47	−0.13	years
Intelligence (34 items)	WASI	212	13.60	7.53	11	0	34	0.68	−0.61	n correct
Home chaos rated by mother (15 questions on 4-point scale)	CHAOS	182	37.36	4.90	37	28	48	0.25	−0.34	higher value = more chaos
Home chaos rated by father (15 questions on 4-point scale)	CHAOS	227	40.56	4.10	41	27	50	−0.39	0.53	higher value = more chaos
Types of discipline used by mother (7 types)	HOME	227	3.13	1.19	3	1	7	0.30	−0.76	n types used
Types of discipline used by father (7 types)	HOME	182	3.45	1.70	3	1	7	0.24	−0.08	n types used
Meals together rated by mother (6-point scale)	FPSQ	208	4.90	0.42	5	3	5	−4.19	15.93	0 = never, 3 = once a week, 5 = once per day or more
Meals together rated by father (6-point scale)	FPSQ	162	5.00	0.00	5	5	5			0 = never, 3 = once a week, 5 = once per day or more
Reading to child rated by mother (5-point scale)	FPSQ	208	2.54	1.56	3	0	4	−0.68	−1.07	0=never, 2 = several times / month, 4 = everyday
Reading to child rated by father (5-point scale)	FPSQ	162	2.52	1.72	3	0	4	−0.61	−1.39	0=never, 2 = several times / month, 4= everyday
Organized activities with child rated by mother (binary)	HOME	208	0.18	0.39	0	0	1	1.63	0.66	0 = no, 1 = yes
Organized activities with child rated by mother (binary)	HOME	162	0.35	0.48	0	0	1	0.64	−1.60	0 = no, 1 = yes
Museum visits in past year rated by mother (5-point scale)	HOME	208	0.53	0.71	0	0	4	1.69	4.49	0 = never, 2 = several times, 4 = once a week
Museum visits in past year rated by father (5-point scale)	HOME	162	0.44	0.71	0	0	3	1.49	1.36	0 = never, 2 = several times, 4 = once a week
Music/theater in past year rated by mother (5-point scale)	HOME	208	0.46	0.63	0	0	3	1.13	0.71	0 = never, 2 = several times, 4 = once a week
Music/theater in past year rated by father (5-point scale)	HOME	162	0.32	0.60	0	0	2	1.67	1.63	0 = never, 2 = several times, 4 = once a week
Social gatherings in the past year rated by mother (5-point scale)	HOME	208	0.40	0.93	0	0	4	2.81	7.59	0 = never, 2 = several times, 4 = once a week
Social gatherings in the past year rated by father (5-point scale)	HOME	162	0.48	0.81	0	0	3	1.26	−0.04	0 = never, 2 = several times, 4 = once a week
TV/smartphone usage per weekday rated by mother (hours/week)	HOME	205	2.46	1.68	2	0	8	1.02	1.08	0–8 h
TV/smartphone usage per weekday rated by father (hours/week)	HOME	162	2.20	1.90	2	0	8	0.90	0.74	0–8 h
TV/smartphone usage per weekend day rated by mother (hours/week)	HOME	208	3.11	2.10	3	0	8	0.54	−0.58	0–8 h
TV/smartphone usage per weekend day rated by father (hours/week)	HOME	162	2.95	2.28	3	0	8	0.49	−0.40	0–8 h
Encourage hobbies rated by mother (binary)	HOME	208	0.65	0.48	1	0	1	−0.64	−1.60	0 = no, 1 = yes
Encourage hobbies rated by father (binary)	HOME	162	0.91	0.28	1	0	1	−2.92	6.55	0 = no, 1 = yes
Importance of school performance rated by mother (4-point-scale)	HOME	208	2.41	0.86	3	0	3	−1.43	1.21	0 = no importance, 4 = very important
Importance of school performance rated by father (4-point-scale)	HOME	162	2.85	0.50	3	0	3	−4.09	18.24	0 = no importance, 4 = very important
Help with school work in Turkey rated by mother (5-point-scale)	HOME	208	1.31	1.72	0	0	4	0.68	−1.38	0 = never, 2 = 1–2 h / week, 4 = everyday
Help with school work in Turkey rated by father (5-point-scale)	HOME	162	2.45	1.79	3	0	4	−0.51	−1.59	0 = never, 2 = 1–2 h / week, 4 = everyday
Help when child struggle in school rated by mother (5-point-scale)	HOME	208	0.56	1.14	0	0	4	2.05	2.98	0 = never, 2 = 1–2 h / week, 4 = everyday
Help when child struggle in school rated by father (5-point-scale)	HOME	162	2.62	1.67	3	0	4	−0.72	−1.21	0 = never, 2 = 1–2 h / week, 4 = everyday
Amount of homeschooling for children outside school rated by mother (5-point-scale)	HOME	208	0.54	1.21	0	0	4	2.04	2.66	0 = never, 2 = 1–2 h / week, 4 = everyday
Amount of homeschooling for children outside school rated by father (5-point-scale)	HOME	162	2.42	1.73	3	0	4	−0.48	−1.53	0 = never, 2 = 1–2 h / week, 4 = everyday
Musical instrument in home rated by mother (binary)	HOME	208	0.11	0.31	0	0	1	2.55	4.50	0 = no, 1 = yes
Musical instrument in home rated by father (binary)	HOME	162	0.15	0.36	0	0	1	1.90	1.61	0 = no, 1 = yes

Note: Dem = demographics, WASI = WASI Matrics Reasoning, HOME = HOME-SF, FPSQ = Family Psychosocial Questionnaire.

later reading ability in several different cultural contexts and SES segments (including for example low to middle income families in Brazil, South Africa, and Turkey). At the same time a large twin-study (>1800 twin pairs) documents an association between reading ability and later intelligence in an age range that closely resembles the one used in current study (7–16 years; Ritchie et al., 2015). We do not measure quality of reading in this study but a dose-response is evident in Fig. 1, similar to what has been demonstrated for reading comprehension (Dowdall et al., 2020), suggesting that the amount of reading has an impact on children's fluid intelligence. It is difficult to elaborate on the mechanism by which reading impacts non-verbal fluid intelligence. Prior work has suggested that reading, and being read to, might positively impact abstract thinking (Cunningham & Stanovich, 1998; Ritchie et al., 2015), an ability that is at the heart of the WASI test. Though speculative at this point, it can serve as a working hypothesis to be assessed in future studies.

Thirdly, data from this group consistently demonstrate that mothers carry the load of raising the children and it is her actions and capacities

Table 5
Included variables in Adult and Children models and the extent to which each variable was retained for the final analysis for adults or children. For both the Adult and Children models, intelligence (WASI) was the dependent variable.

Model	Step	Factor	Retained	Variable
Adult	1	Demographics	No	Age
			No	Sex
			Yes	Highest level of education
			No	Year of leaving
			No	SES Syria
			No	SES Turkey
	2	Final model		Highest level of education
				HTQ
				PTS
Child	1	Demographics	Yes	Age
			No	Sex
	2	Parents mental health and intelligence	Mother's intelligence	Parents intelligence
			No	Parental HTQ
			No	Parental PTS
	3	Home environment	No	Chaos
			No	Types of discipline used
			No	Meals together
	4	Enrichment	Mother's rating	Reading to child
			No	Organized activities
			No	Museum visits
			No	Music/theater
			No	TV/smartphone usage per weekday
			Mother's rating	TV/smartphone usage per weekend day
			No	Importance of school performance
			No	Help with school work
			No	Help when children struggle in school
			No	Amount of homeschooling
			No	Social gatherings
			No	Encourage hobbies
			No	Musical instruments at home
	5	Final model		Age
				Mother's intelligence
				Reading to Child
				TV/smartphone usage per weekend day

Note: see Tables 3 and 4 for more information on the variables included in the analysis.

Table 6
Summarized results of final model for adult data predicting intelligence (WASI) as the dependent variable.

	Estimate	β	SE	p-value
(Intercept)	8.69		2.64	0.001
Highest level of education	1.81	0.29	0.45	0.000
HTQ	0.14	0.05	0.2	0.493
PTS	−0.08	−0.05	0.10	0.456

that impact the development of future generations. The reasons for this can be numerous. Surely the presence of a strong patriarchal system might account for some portion of the observed effect. Embedded in this is not only an expectation that mothers should tend to the children but perhaps also the expectation and real need for fathers to secure income, often working long hours and potentially in faraway places. Future work would benefit from looking more into the reasons for the clear gender differences that we see. But as it currently stands, disregarding the ontology of these differences, it is clear that directed support to mothers' well-being, both in terms of resources and empowerment, might be a targeted way to reach entire families.

Table 7
Summarized results of final model for child data predicting intelligence (WASI) as the dependent variable.

	Estimate	β	SE	p-value
(Intercept)	3.209		2.408	0.184
Age	0.293	0.12	0.155	0.060
Maternal intelligence	0.296	0.31	0.088	0.001
Reading to Child	0.969	0.20	0.316	0.003
TV/smartphone usage per weekend day	0.391	0.07	0.240	0.105

The current study complements prior work from the same population documenting a relation between maternal mental health and social cognition, where a small (4%) reduction in maternal PTSS is equal in size to a one-year development of children's ability to process emotional information (Gredebäck et al., 2021). By combining the findings from these two studies it is possible to conceive of programs that support mothers and at the same time facilitate reading and high-quality interactions. Our current results tentatively suggest that such an intervention could be beneficial both for maternal mental health and reading practices, leading to enhancements in children's social cognition, language development, abstract thinking, and fluid intelligence.

Prior work suggests that the social cognitive effect described above is mediated by discipline type, physical punishment appear to be an active ingredient that ensure a transmission from maternal mental health to child development. The same study also suggests that this is most prominent in families with young mothers, that experience downward mobility, and discrimination (Peltonen, Gredebäck, Pollak, Lindskog, & Hall, 2022). Future work should, in a similar manner, investigate the factors that impact how much mothers read to their children, but this is outside the scope of the current paper.

Before concluding some caveats are important to mention. The correlational nature of the study does not allow us to make firm claims about the direction of the observed effects related to book reading. It is possible that mothers read more to children that are more intelligent. In that case, the causal relation is determined by the child's capacity, not by the mother's interactions. Existing experimental work with children in non-war contexts, however, suggest that this is not the primary direction of the effect (Dowdall et al., 2020), but without direct evidence it is difficult to make firm generalizations to this population.

It is also possible that effects of parental, or maternal, PTSS exist but that we lack power to detect these effects. However, the fact that effects of maternal PTSS previously have been reported in this sample (Gredebäck et al., 2021) suggests that we might have sufficient power to detect an effect, if present.

In the current study the average reading frequency was low, ranging from never to several times per week with an average close to several times per month (scale: never, less than several times per month, several times per month, several times per week, everyday, see Table 4), this is quite a lot lower than the intense day-to-day training in the book sharing RCTs mentioned above. However, this highlights the importance of cumulative experience and suggests that a small change in family practices might have a clear impact on child development. It is possible that mothers reading (though sometimes limited in frequency) kick-start a positive loop where reading to children enhances children's own reading abilities and the propensity for children to read themselves (a link supported by study with >12.000 children; van Bergen et al., 2018). Perhaps this positive feedback loop results in a cumulative reading experience (that includes both own reading and maternal reading directed towards her child) that is substantial enough to impact fluid intelligence. This is of course a speculative argument as children's own reading was not assesses or followed over time.

It is possible that there are covariates that we have not accounted for, and that the results would evolve differently if other questions had been

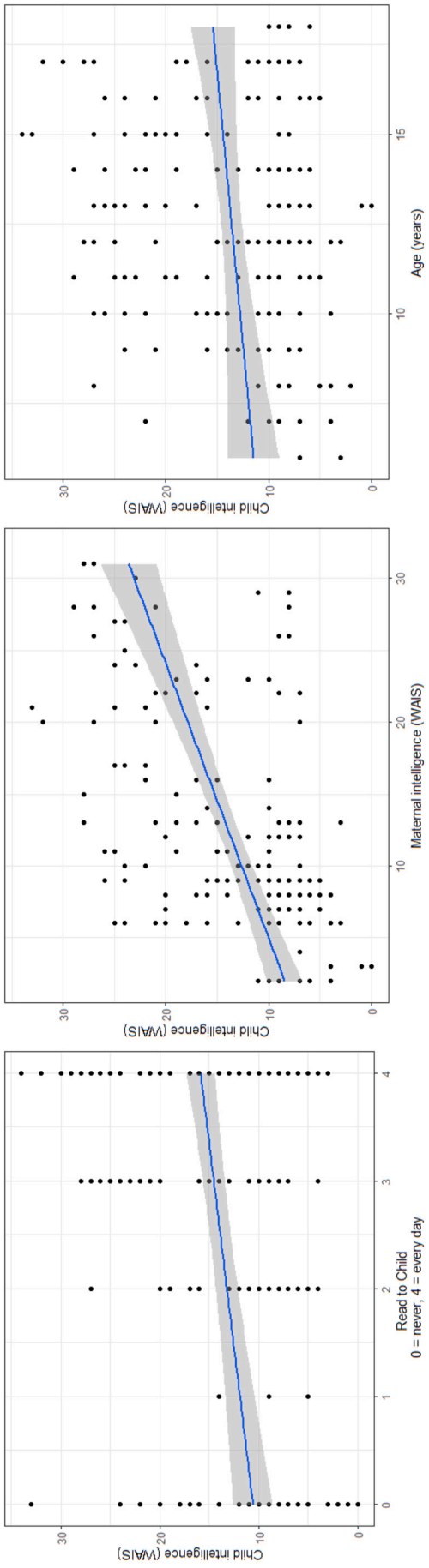

Fig. 1. Unique contribution of each of the significant factors (final model) in relation to intelligence in Syrian refugee children.

asked. This is always a possibility, but we believe the questionnaires covered the most essential aspects previously associated with war exposure and refuge. One thing that we should have asked about though, given the results, are forms of verbal transmissions other than reading that could have complemented the book reading question. One common verbal tradition in many Arabic communities, including Aleppo, is storytelling, both as a communal activity and a family activity focusing on tales and actual history. It is possible that this tradition provides similar value to book reading for children but the questionnaire did not adequately capture this verbal tradition that sometimes involve books, other times are recited from memory, or improvised (Harvey & Robinson, 2012; Skeiker, 2010).

It would have been highly valuable to include a control-group from the same cultural context where parents are not affected by war-related traumatic events and to combine this with a longitudinal design. The current work could be seen as an initial assessment into these questions, and more work is clearly needed before we have a full grasp of how children's intelligence is impacted by growing up in war and during refuge.

We note that while the reliability of HTQ, PTS, and the two outcome measures (adult and child intelligence) are reasonable to high (0.74, 0.75, 0.90, 0.89), the reliability for the CHAOS and Discipline scales are rather low (0.42 and 0.41, respectively), in this sample. Thus it is possible that the lower reliability for the CHAOS and Discipline scales might have restricted the size of those effects. Importantly, it will be an important task for future research to not only investigate relations in populations like the one in the current study, but also to continue to develop and validate scales that are both reliable and valid.

We suggest that children's intelligence is robust against war-related parental trauma. At the same time, it is possible that all participating families are impacted to such a large degree that no correlations can be found (a ceiling effect). We argue against this interpretation, as the variation in potentially traumatic events experienced by families is very large. There are individual adults in the sample that have experienced enormous atrocities (15 out of 16 different potentially traumatic event categories) and others that are much more spared (with a single potentially traumatic event category), with an average of approximately 7 different potentially traumatic even categories per adult (see Table 3). Asking about the number of different event categories does not directly inform us about the frequency of these experiences, nor is it possible to imagine the individuals' experiences without having been exposed to something similar oneself. As such, we approach these data humbly. What we do believe we can say is that we should be able to detect associations, if present, given the variance among experiences reported.

Last but not least, there is a lot of variability in children's and adults' performance on the fluid intelligence test, and for children, the increase in performance with increased age is less clear than what might be expected from Western non-war related samples. It is quite possible that there is a cultural dimension to these tests (Gonthier, 2022; Greenfield, 1997; Nisbett, 2020; Sternberg, 2004) even though they are largely non-verbal. Individual differences in the ability to think in abstract terms and to understand the task provided might impact results and introduce noise that mask a part of the age-related increase in intelligence. In this regard it is worth noting that it is difficult to separate out fluid intelligence from abstract thinking and experience with deductive problem solving (Sternberg, 1999). Though the cultural dimension of intelligence tests must be considered when comparing sample characteristics across populations, this is less of a concern when comparing test results within a culture and when focusing on risk and protective factors for children within a sample. A cautious conclusion is that parent's war experience and PTSS impact children's performance on fluid intelligence tests that assess intelligence, abstract thinking and/or deductive problem solving. At the same time, reading to children is associated with enhanced performance on the same test. This finding motivates the inclusion of reading in intervention programs targeting refugee families.

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