Spring 5-15-2020

Estimating Predictors of Mental Well-Being Through Analysis of Children's Drawings: The Case of Syrian Refugees

Stephanie Smith
University of San Francisco, sjsmith4@dons.usfca.edu

Estimating Predictors of Mental Well-Being Through Analysis of Children's Drawings: The Case of Syrian Refugees

Stephanie Smith

Department of Economics
University of San Francisco
2130 Fulton St.
San Francisco, CA 94117

Thesis Submission for the Masters of Science Degree
in International and Development Economics

E-mail: *sjsmith4@dons.usfca.edu*

May 2020

Abstract: There are currently over 65 million individuals that have been forcibly displaced globally. The cumulative trauma that comes from the refugee experience and exposure to violence has proven to have long-term negative psychological outcomes and thus negative impacts on human capital in the long run. Given that over 50% percent of the global refugee population are children, the ability to efficiently and accurately assess their mental well-being is of critical importance. Using data from over 2000 refugee children in Jordan, I use machine learning techniques to find key predictors of psychological distress, PTSD, and exposure to violence found in children's drawings. Results show that there are multiple consistencies across the predictors chosen and indicators highlighted in the psychology literature. This provides empirical evidence for the possibility of children's drawings to be used as a low-cost assessment tool of mental well-being for a refugee population.

I would like to give a special thank you to Bruce Wydick of USF for guidance on this thesis paper. Additionally I would like to thank Sarah Baird of University of Washington and Rafael Panlilio for the opportunity to collaborate in research and access to their collected data.

1. Introduction

In every part of the world, displaced persons and refugees have experienced multiple forms of traumas and stresses, persecution, loss and isolation, uprooting and violent experiences (Stein, 1986). The cumulative trauma that is part of the refugee experience can lead to long term negative impacts on mental health, which is seen in higher rates of anxiety, post-traumatic stress disorder and depression among refugee populations in comparison to the general public.

Children and adolescents are especially vulnerable to the negative impacts of continual exposure to violence as they are at a crucial period for developing and maintaining emotional habits for mental well-being. The World Health Organization reports that the more risk factors adolescents (10-19 years) are exposed to, the greater the potential impact on their mental health. Thus the population of refugee children face the greatest risk of developing mental health conditions due a number of factors, including exposure to conflict, forced displacement, and socioeconomic difficulties faced after relocation. This paper will explore possible predictors of child refugee mental health as found through the analysis of their drawings, and in doing so will further examine the use of child's drawings as mental health assessment method.

As of 2019 there are 29.5 million refugees who are under the age of 18, and they make up over 50% of the refugee population (UNHCR 2019). Given the limited resources and financial constraints present when working with a refugee population, researchers are faced with an even greater challenge when trying to assess the psychosocial health of these children without the use of costly and invasive psychological examinations. One solution to these challenges is the use of children's drawings as a possible assessment tool of mental well-being. Established in the field of psychology, projective drawing exercises are thought to be able to reveal information on a child's psyche that might be otherwise be difficult to obtain through traditional questionnaires. Thus it has potential to be an incredibly efficient screening method for a child refugee population. While the use of children's drawings as an assessment tool in the field of clinical psychology is common, there have been few empirical studies on the accuracy of such assessments.

For the purpose of this research, I focus on the child refugee population that has sought refuge in Jordan. Since the start of the Syrian Civil War in 2011, Jordan has seen a large influx of refugees who now account for roughly 10% of Jordan's population (UNHCR 2019). With over half of the estimated 2 million refugees being children, there is a dire need for accessible mental health services. Early detection of mental reactions to trauma is crucial for children and

adolescents as poor mental health is strongly related to long term health and development outcomes such as lower education achievements, increase in risk-taking behavior, and poorer labor market outcomes (Patel et al. 2007).

This research ultimately explores the following objectives: 1) Determine the strongest predictors of psychological distress, PTSD and exposure to violence as found in the drawings of refugee children and explore its consistency with the psychology literature. 2) Test the validity of using machine learning methods in its ability to predict exposure to violence based off children's drawing indicators by using two separately coded datasets. 3) Test if drawing-based measures of anxiety, depression, and PTSD are significantly correlated with traditional survey methods.

The model selects a number of drawing characteristics which are consistent with the psychology literature. Additionally I find that the analysis of child's drawings as an assessment tool may be better at screening for anxiety and depression than PTSD. Furthermore I find that the consistency between child drawing measurements and validated survey measurements differs when comparing PTSD and psychological distress measurements.

The rest of this paper is organized as follows: Section 2 provides a summary of relevant literature related to this research. Section 3 is an overview of the datasets used. Section 4 details the methodology used and description of the variables constructed. Section 5 describes the machine learning and econometric specifications used. Section 6 summarizes the analysis of the primary findings. Section 7 includes final discussions and concludes.

2. Literature Review

In examining the current state of knowledge on the subject, there are three important areas of background literature. In section 2.1 I examine the relationship between mental health and human capital accumulation. Section 2.2 focuses on the impacts of the refugee experience on children. Section 2.3 summarizes the current challenges in assessing refugee mental health. In section 2.4 I examine papers which contribute to the research on projective drawing exercises. Finally, section 2.5 briefly describes this study's contributions to the literature at large.

2.1 Psychological Impacts on Human Capital in the Long term

The trauma from forced displacement and war experienced as a child can have lasting impacts into adulthood. Savin et al. (1993) found that 39% of a 99 sample of Khmer refugees whom had fled Cambodia as children met the diagnostic criteria for PTSD 6-10 years after displacement.

Additionally, the literature shows that long-term psychological impact can vary depending on the magnitude and length of exposure (Weaver & Clum 1995) and impacts increase in proportion to time spent in the situation of trauma (Norris et al., 2003; Kaysen et al. 2003).

Established by Gary Becker (1964) human capital theory corresponds to any stock of knowledge or characteristic an individual has that contributes to his or her productivity. This can include assets such as level of education, training, skills, health as well as individual attributes. Human capital accumulation is vital for economic success on an individual level, as any negative impact on human capital may lead to increased risk of poverty traps through poorer labor and education outcomes (Becker 1962, Mincer 1974).

The literature shows that trauma experienced at a young age can lead to lower self-esteem, lower self-efficacy and increased risky behavior in adulthood. When examining the relationship between mental health and adult health risk behaviors, Chartier et al. (2009) found increases in levels of smoking, alcohol abuse, and higher rates of suicide for individuals who had experienced high levels of violence as a child. Furthermore exposure to violence and other traumatic events have been found to impact education outcomes through a number of different channels, such as: excessive absenteeism, higher dropout rates, lower performance (Fry et al. 2018), as well as formations of behavioral disorders that interfere with their ability to learn (Morton 2018). Additionally impacts continue from the education market to the labor market, with higher rates of unemployment, reduced labor supply, lower perceived workplace productivity and reduced earnings (Currie and Vogl 2012).

These impacts are exacerbated due to the limited access to health and educational services that refugees often face, therefore it's crucial to have early and effective detection of psychological reactions geared toward children and adolescents in order to deter any negative impacts on long-term human capital accumulation.

2.2 Psychological Impacts of the Refugee Experience on Children

While historically the majority of literature on the effect of exposure to violence through war has focused on adults, a number of studies have documented these effects on children and adolescents. The consensus of this research being that there is a higher prevalence rate of mental disorders among children exposed to conflict than among the general population (Attanayake et al., 2008; Smith et al., 2001). Mental disorders, however, is broadly defined as the stressors involved in warfare vary from conflict to conflict (e.g., distance of violence,

exposure amount, direct life threat, losses). Consequently, the resulting psychosocial effects can be difficult to determine.

Much of the research finds that greater exposure to war trauma has been associated with higher levels of PTSD (Saigh et al., 1996). PTSD diagnostic criteria can be found in the Diagnostic and Statistical Manual of Mental Disorders (DSM) as defined by the American Psychiatric Association. A diagnosis of PTSD requires exposure to an upsetting traumatic event followed by one or more of the following symptoms: 1. Intrusive thoughts 2. Avoiding reminders 3. Negative thoughts and feelings 4. Arousal and reactive symptoms. Symptoms can vary in severity but must last for more than a month after exposure to a traumatic event.

Dyregrov et al. (2000) find evidence of this with their study of psychological reactions to genocide among Rwandan children and adolescents. Through interviewing 3030 children aged 8-19 the authors found that more than two-thirds of the children showed symptoms of PTSD through intrusion symptoms: thinking about the event often when they did not want to, and avoidance: often trying to stay away from situations or things that reminded them of the event. Many of the children also reported increased reactive symptoms such as an inability to concentrate or pay attention. Similar results can be found over a variety of cultures and countries as well. Palestinian children (aged 10-18) in the Gaza Strip who were exposed to chronic traumatic experiences showed varying degrees of PTSD in the forms of intrusive thoughts, feelings of sadness and nervousness, increases in aggressive behavior and inability to focus in school (Altawil et al., 2008).

Other psychological outcomes besides PTSD have been studied less thoroughly, but there is some evidence for increases in rates of depression and anxiety among child survivors of war and displacement (Chimienti, Nasr, and Khalifehi 1989; Mghir et al., 1993). Due to the multiple and diverse stressors that can be caused from a refugee experience, it can be difficult to disentangle the multiple psychological reactions. Macksound and Aber (1996) attempts to confirm the relationship between exposure to war trauma and depression in children in Lebanon by using the Child Behavior Inventory (CBI) a specifically designed survey to measure mental health symptoms in aggression, depression and anxiety. The authors found a positive relationship between war trauma and depression dependent on type of trauma the child was exposed to, as children who were separated from parents reported more depressive symptoms while children who witnessed violent acts exhibited more PTSD symptoms.

2.3 Current Assessment Techniques and Limitations

In a systematic review of mental health screening and measurement tools used with refugee children, Gadeberg et al. (2017) found that the most common assessment tools were questionnaires, interviews, and youth self-reported instruments, with the amount of questions ranging from 15 items to over 100. While these methods can provide intensive detail, there implementation is not without challenges, the extent of which varies depending on a range of factors including where the refugees have come from and the amount of time they have spent in the host country (Sandhu et al., 2013). Challenges include: (1) Language barriers, as many refugees have a poor command of the language of the host country, they may require an interpreter during consultation. (2) Belief systems, which may hinder mental health assessments and conflict with the practitioners' understanding. (3) Cultural expectations, refugees may have different views on what to expect from mental health care and on what kind of information they disclose. (4) Establishing trust, refugees may be particularly distrustful of services and authorities because of previous experiences in their country of origin. Additionally, they may be unfamiliar with the health care system in the host county. (Giacco et al. 2014) Children especially may be reluctant to participate in assessments that force them to relive traumatic experiences.

The literature suggests several principals important to the quality of mental health assessments of refugees, including a systemic approach, the use of interpreters and cultural brokers, and regular screening (Kronick 2018). However due the scarcity and inequitable distribution of services, the difficulties in coordinating national and international efforts, and financial constraints, it is not feasible that all refugees with mental health needs will gain access to full in-depth assessments. The use of children's drawings may be able to be used as source of low-cost assessments until full assessments are available.

2.4 Psychological Analysis of Children's Drawings

In the field of psychology children's drawings have consistently been utilized to assess emotional disorders, aggressive behaviors, and stress disorders (Goodenough 1926; Koppitz 1968; DiLeo 1970; Furth 2002). Human figure drawings and free drawings can be a particularly useful assessment tool as they are quick, inexpensive, and nonthreatening to children and can often yield insightful information into the emotional state of children that is more difficult to obtain accurately from direct survey questions (Skybo et al., 2007). Considered a projective technique, when a child is asked to draw (vs. a spontaneous drawing), the drawing can be used

as a method of communication and represents an individual's self-concept, anxiety, attitude or conflict (Koppitz 1984).

While the literature reflects that children's drawings are a common measurement that is used in clinical psychology practice and research, it has not often been used in a development context. A previous use of this projective drawing exercise was utilized to analyze the psychological impact of a child sponsorship program in Indonesia. Glewwe, Wydick, and Rutledge (2013) collected drawings from 542 children both participating and not participating in a child sponsorship program by asking them to draw a self-portrait of themselves in the rain. The authors observed the presence or absence of characteristics within drawings such as frowning/crying, smiling, cheery or dark colors, and used factor analysis to yield three orthogonal factors related to children's psychological well-being: happiness, self-efficacy, and hopelessness. Sponsored children scored 0.203 higher on the happiness factor, 0.221 higher on the self-efficacy factor, and 0.338 lower on the hopelessness factor.

Research that has focused on using psychoanalysis of drawings with children exposed to violence has shown varying results. A study by Tibbetts (1989) examined the impact of exposure to civil and military violence in Northern Ireland in children and adolescents aged 6-17. The participants were interviewed and asked to draw a picture of their choice. The author found that depictions of violence in the drawings increased with the amount of violence the child was exposed to as measured through characteristics including fixation on traumatic events, lack of background integration, and depressive indicators. The results in this case were validated using the DSM criteria for PTSD. On the other hand, Magwaza et al. (1993) did not find children drawings to be a clear predictor for PTSD when researching the impacts of chronic violence on preschool children in South Africa. A sample of 148 children were supplied with a sheet of blank paper and pencil and asked to draw pictures of something that had happened to them; in which 84% drew action figures associated with violence. However, when combined with PTSD questionnaire data, the authors found that children with many emotional indicators in their drawings were less likely to exhibit systems of PTSD, where as those children with relatively few emotional indicators in their drawings were more likely to be categorized as suffering from moderate to severe PTSD.

It is clear that the projective drawing technique works best when combined with validated PTSD or additional emotional health survey data. Most importantly one should keep in mind that in all cases drawings are not a sole diagnostic tool, but rather an easy, cost

efficient emotional trauma measure that can provide strong cues for follow up assessment and intervention.

2.5 Contributions

This study aims to contribute to the literature by providing additional empirical analyses on the use of children's drawings is a valid measurement technique. To my knowledge this is the first study to utilize the LASSO model in the specific context of study pertaining to a refugee population. The use of the LASSO model will allow me to determine which drawing predictors stand out when attempting to assess mental health. Additionally, the use of two data sets has the ability to provide a certain level of validity to the technique.

3. Data

In order to determine the predictors for the two main outcomes: Psychological distress and PTSD, I use data as described in section 3.1. For the third outcome: exposure to violence, I use data from both section 3.1 and 3.2

3.1 Gender and Adolescence: Global Evidence (GAGE) Jordan Dataset 2018-2019

I perform my empirical analysis using data collected by the Overseas Development Institute for their long-term research and evaluation study: Gender and Adolescence: Global Evidence. Starting in 2018, GAGE has collected data from over 3,600 vulnerable children in Jordan, including Palestinian, Syrian and Yemeni refugees. The specific data I am using for analysis contains information on 1,929 children aged 10-13 from the Zaatari refugee camp as well as from host communities and informal tented settlements across multiple governorates[1] of Jordan. Detailed household level information was collected from each participant including age, gender, family size, location of origin in Syria and the date of displacement. The children of this study were asked to participate in a projective drawing exercise as outlined in section 4.1. In addition to the free drawings that were collected, the adolescents were also asked to participate in multiple mental health measurements as outlined in section 4.

3.2 Children from Syrian Refugee Families USF Dataset 2016

The second sample of children's drawings comes from a survey of Syrian refugee families collected by Rafael Panlilio[2] in July to September of 2016. This data set contains drawings from

[1] Jordan is divided into 12 governorates. Governorates are considered as an administrative division within the country, similar to states.

[2] This data was collected for Rafael Panlilio's IDEC thesis in association with the University of San Francisco. All drawings collected in this dataset were manually coded by Rafael.

1,231 children, aged 5-12. From the families and participants, the following basic socioeconomic and familial information was gathered: age, gender, location of origin in Syria, date of arrival in Jordan, father's occupation in Syria, family size, number of brothers, and number of sisters. Among the sample, 707 of the children in the sample lived in the Zaatari refugee camp and 524 were members of Syrian families that had been re-integrated into Jordanian society. This dataset is limited in that it does not contain any additional mental health assessments besides the projective drawing exercise.

4. Methodology

4.1 Projective Drawing Exercise

As stated in section 3.1 and 3.2, all children included in the sample were asked to participate in a projective drawing exercise as an attempt to measure levels of PTSD, and psychological distress. The drawing exercise was implemented as follows using the advised set up established by Koppitz (1968). Participants were given a set of colored pencils and blank pieces of paper and then asked to "Draw a picture of whatever you feel like". Prior to the actual exercise facilitators were briefed on the following guidelines: All drawings were to be done by the child and the child alone. All children were to perform the drawing exercise free from distraction and criticism. No prompt or suggestion was to be given on how or what to draw. The decision to draw was up to the child, in the incidences where a child would decide not to take part in the drawing exercise, they were not included in the sample.

Once drawings were collected they were manually coded using drawing indicators taken from psychology literature that are considered indicators of either PTSD, depression or anxiety. Table 1 shows the full list of the 13 indicators chosen. Each drawing indicator was coded as a dummy variable: a code of 1 if the characteristic is present in the drawing and a code of 0 if the characteristic is absent in the drawing. Drawing indicators were chosen before any analysis of the drawings, and none were added or dropped after empirical analysis began.

4.2 Psychological Distress Measurement

In order to measure psychological distress, the General Health Questionaire-12 (GHQ-12) is used. GHQ-12 is an extensively used self-reported questionnaire that is noted for being a reliable measure of mental health and is used to help screen for psychological disorders, including anxiety and depression.(Goldberg 1970). The GHQ-12 consists of 12 items (such as, "Have you recently – been able to concentrate? Been feeling unhappy or depressed? Lost sleep

over worry?") each assessing the severity of a mental problem over the past two weeks using a 4-point scale (from 0-3). The score was used to generate a total score ranging from 0 to 12, with higher scores indicating worse conditions. A separate binary variable was then constructed in which participants who scored a 3 or higher were assigned a 1 to indicate psychological distress[3] and participants who scored a 2 or lower were assigned a 0 to indicate a lack of psychological distress.

4.3 PTSD Measurement

In order to measure PTSD, a survey constructed based off the Harvard Trauma Questionnaire (HTQ) is used. The HTQ asks about a variety of traumatic events as well as the emotional symptoms considered to be uniquely associated with trauma. The version used consists of 18 symptoms possibly experienced, such as recurrent nightmares, or outbursts of anger. Each item is scored on 1-4 scale with 1 corresponding to the participant not at all experiencing the symptom and 4 corresponding to the participant experiencing the symptom at an extreme level. A total score from 1-4 is generated with higher scores indicating worse conditions. A separate binary variable was then constructed in which participants who scored a 2.51 or higher were assigned a 1 to indicate symptomatic of PTSD and participants who scored a 2.5 or lower were assigned a 0 to indicate non-symptomatic of PTSD.

4.4 Exposure to Violence Measurement

In order to generate the variable measuring exposure to conflict, both the datasets utilize the Syrian Revolution Martyr Database. This database provides a measure of the number of individuals killed as a result of the Syrian Civil War and provides statistics on death counts by age, gender, province from 2011 to 2016. The number of deaths that occurred per month within each governorate of Syria were combined with information of the city of origin and departure date from Syria of each participant in order to create a variable that is equal to the total number of conflict-related deaths that occurred within a participant's region of origin[4] prior to their departure from Syria. This value was then logged, and normalized to set the values between 0 and 1. From this, the dependent variable for Exposure to Conflict was generated with 0 indicating

[3] In this case psychological distress can be considered as symptomatic of anxiety, depression or a combination of both.

[4] Note that the data on number of deaths per month is on the governate level not on the city level. Ideally, I would match city level deaths with city of origin of the participant, however this is not possible due to information constraints.

no to low exposure to violence and 1 indicating high exposure to violence. In the absence of a validated survey technique, this variable can be thought of as a measurement of trauma.

5. Empirical Strategy

In order to estimate which drawing indicators most accurately predict psychological distress, PTSD and exposure to violence I use a Least Absolute Shrinkage and Selection Operator (lasso) regression analysis method. (Tibshirani 1996). The lasso minimizes the residual sum of squares subject to a constraint on the absolute size of the coefficient estimates[5]. This shrinks some coefficients and sets others to 0, thus it allows for model selection. The lasso estimate is defined by:

$$(\hat{\beta}, \widehat{\beta_0}) = \arg min \left\{ \sum_{i=1}^{n} \left(y_i - \beta_0 - \sum_j \beta_j x_{ij} \right)^2 \right\} \quad subject\ to \sum_j |\beta_j| \leq \lambda$$

Where $\lambda \geq 0$ is the tuning parameter that controls the strength of the L1 penalty and thus controls the amount of shrinkage that is applied to the estimates. When $\lambda = 0$, no coefficients are eliminated. As lambda increases, more and more coefficients are set to zero and are removed from the model. For my analysis, lambda is determined by a 10-fold cross-validation.

The purpose of cross-validation is to assess the out-of-sample prediction performance of the estimator. With a 10-fold cross-validation, the data is divided into 10 groups of approximately equal size. Let $n(k)$ denote the number of observations in the kth data partition with $k = 1, \ldots, 10$. The first fold is treated as the validation dataset and the remaining 9 folds act as training data. The model is fit to the training data for a given value of lambda with the resulting estimate denoted as $\hat{\beta}_{(1,\lambda)}$ The mean-squared prediction error is then calculated as:

$$(1) \qquad MSPE_{(1,\lambda)} = \frac{1}{n_1} \sum_{i=1}^{n} \left(\left[y_i - x_i' \hat{\beta}_{(1,\lambda)} \right]^2 \right)$$

[5] This is an L1 penalty. Lasso uses L1 regularization as defined by Tibshirani (1996).

For all i in the first group. n_1 denotes the number of observations in the first group. Step (1) is repeated for $k = 2, \ldots, 10$, thus generating $MSPE_{(k,\lambda)}$ for each fold. The 10-fold cross-validation estimate of the MSPE which measures the prediction performance is calculated as:

$$(2) \qquad CV_\lambda = \frac{1}{K}\sum_{i=1}^{K} MSPE_{(k,\lambda)}$$

In this case $K = 10$. The program Stata[6] is able to repeat steps (1) and (2) 100 times. Therefore we have 100 different estimates of the MSPE which are based off 100 different initial values of lambda. The model that is ultimately chosen is the one that has the smallest mean-squared prediction error, therefore ensuring it has the best out-of-sample prediction performance.
The lasso method is being used to estimate the following linear probability model:

$$(3) \qquad Y_i = \beta_0 + \beta_1 DrawingIndicators_i + B_2 X_i + e_i$$

In which

- Y_i represents the one of the three possible measurements of mental well- being: psychological distress, PTSD, and exposure to violence.
- $\beta_1 DrawingIndicators_i$ represents the 13 drawing indicators that were manually coded. A 1 indicates the presence of the characteristic in the drawing and 0 indicates a lack of the characteristic.
- $B_2 X_i$ includes demographic controls including: age, sex, household size, and number of years spent in Jordan since flight from Syria.

The lasso will select drawing indicators by excluding the indicators whose estimated coefficients are zero (as determined by lambda) and will include the drawing indicators whose estimates are not zero. By choosing the estimation that has the lowest MSPE, I am ensuring that the coefficients that have been shrunk to zero can be considered irrelevant to the model. Therefore I am able to predict the probability of a child's mental well-being as a linear function of the indicators found in their drawings.

[6] The program used for all cross-validation and lasso estimates for this research was Stata 15.

Specifically the model allows me to answer the following three questions:

1. Which drawing indicators best predict if a child refugee is suffering from psychological distress?
2. Which drawing indicators best predict if a child refugee is symptomatic of PTSD?
3. Which drawing indicators best predict if a child refugee has been exposed to a high level of violence?

6. Results

6.1 Summary Statistics

Table 2 provides summary statistics for key demographic variables as well as summary statistics for all drawing indicators used across both datasets. The participants of the GAGE data collection are on average slightly older and have lived in Jordan a year longer than compared to the USF participants. Another difference to note is 39% of participants from the GAGE dataset live in a refugee camp or ITS[7], while 57% of participants from the USF dataset live in a refugee camp, as opposed to living in a host community or being fully reintegrated.

When looking at the summary statistics for the drawing characteristics, the biggest differences in presence of indictors come from 'Lack of concern with integrating background' (39% vs. 13%), 'Drawn in a single color (8.6% vs. 20%) 'Drawn in light colors' (52% vs. 15%) and 'Symbol of hope' (41% vs. 60%). Excluding indicators that were not used across both datasets, all other indicators are in close proportion to one another.

Table 3 provides summary statistics for the three mental health measurements. It's important to note that not every child was able to participate in both mental health questionnaires, and in some cases not enough information was obtained to assign an exposure violence measurement, thus observation levels are different for each measurement. Out of 1,899 participants 30.8% were considered to have some form of psychological distress. Out of 1,714 participants 36.2% were considered to show symptoms of PTSD. Out of 1,080 participants 71.9% were considered to have been exposed to a higher than average amount of violence. As stated the USF dataset only used the exposure to violence measurement, out of 1,231

[7] Informal tent settlements

participants 75.5% were considered to have been exposed to a higher than average amount of violence.

6.2 Predictors of Psychological Distress

First, I use the lasso method to determine which drawing indicators are the best predictors of psychological distress in refugee children. As stated in section 4.2, the dependent variable psychological distress, is determined based off participant responses to the GHQ-12. Table 4 shows the variables selected as a result of the lasso method, as well as the post-estimated OLS coefficient results[8]. Because of the tradeoff between variance and bias when using penalized estimation, the resulting standard errors do not provide significant hypothesis interpretation. However in order to provide a general assessment of the variance of the estimates, standard errors calculated by bootstrap resampling are shown in column three. At a lambda value of 20.7, 8 characteristics were chosen by the model and 5 were shrunk to zero (out of 13 total indicators). The four control variables (age, sex of participant (equal to 1 if female), household size, and years spent in Jordan) are not subject to the penalization term and therefore are always included in the model when determining the predicators. The first column in table 4 displays the coefficients that were obtained when taking the lambda penalty function into account. The second column displays the post-OLS which are obtained by running a regular regression with no penalty but just on the variables that lasso has retained. The use of a political slogan or political imagery in a drawing is the strongest predictor of psychological distress in a child refugee. The corresponding coefficient can be interpreted as such: The presence of a political slogan or political imagery in a child's drawing is associated with a .129 probability increase in the child suffering from psychological distress. This is followed by the following characteristics: lack of details, drawn in a single color, lack of concern with integrating background, figure drawn, and focus on memories of trauma. All which increase the likelihood of being diagnosed with psychological distress. These findings are consistent with the psychology literature as 1 of the chosen characteristics is an indicator of anxiety/depression and 4 of the chosen characteristics indicate PTSD.

However the model also presents several inconsistencies as it indicates that a picture drawn in dark colors as well as the presence of a symbol of despair are negative predictors of

[8] Post-OLS coefficients are obtained by running the same model using OLS but only including the regressors as chosen by the lasso method. Post-OLS coefficients are considered to help alleviate bias that can arise from penalized regression methods.

psychological distress which is the opposite relationship that a demonstrated in psychology literature. Figure 1 displays the magnitude of the 8 chosen indicators.

6.3 Predictors of PTSD

The second estimation of the lasso method is used to determine which drawing indicators are the best predictors of PTSD in refugee children. In this case only 2 out of 13 drawing characteristics were determined to be relevant predictors (Table 5). The presence of an aggressive action figure indicates a .212 probability increase of a child demonstrating symptoms of PTSD. This is consistent with the literature. If the drawing contains a human figure, this indicates a .069 probability increase of a child demonstrating symptoms of PTSD. In this case the lambda value that resulted in the lowest MSPE was 48.6 The low number of variables chosen by the lasso model indicates that most of the coefficients are considered to be very weak or irrelevant predictors of PTSD in a child refugee. This may provide evidence that the most severely traumatized children are not able to express their emotional trauma through a projective drawing exercise.

6.4 Predictors of Exposure to Violence

In an attempt to find consistency within the predictors chosen by the lasso method I look at which drawing indicators are the strongest predictors of exposure to violence across both the GAGE and USF datasets. Table 3a shows the results for the GAGE data and Table 3b shows the results for USF dataset. As described in section 4.4 the variable for exposure to violence was calculated based off the number of war-related deaths that occurred in the participant's region of origin.

Table 6a presents the predictors chosen by the lasso method using the GAGE dataset. Figure 3a shows each chosen drawing indicator and their magnitude in relation to one another. 4 were chosen, however only the presence of a monster in the drawing is associated with an increase in probability of a child refugee being exposed to violence with a lasso coefficient of 0.039. The remaining 3 indicators, focus on memories of trauma, drawn in a single color, and lack of details, all show a negative relationship with exposure to violence.

Table 6b presents the predictors chosen by the lasso method using the USF dataset. In this case 7 variables were chosen, with 6 of them indicating a positive relationship and 1 variable indicating a negative relationship. The presence of aggressive action figures in a drawing is the strongest predictor of whether a child has been exposed to violence with a lasso

coefficient of 0.125. This is followed by political slogans or imagery, and drawn in a single color.

When comparing the output across the two data sets we see differing results. The only indicator that is consistent across both estimations is 'monster picture', although the magnitude of the effect is smaller in the USF dataset when compared the GAGE dataset (0.008 vs. 0.039). The only other drawing indicator that was chosen in both cases is 'drawn in a single color', however in the GAGE dataset it is determined to decrease probability of a child having been exposed to violence while in the USF dataset it is determined to increase probability.

6.5 Overview of Results

When looking at the results across all three outcome variables, one can see that there are multiple consistencies between the chosen predictors of exposure to violence and predictors of both psychological distress and PTSD. Political slogans or imagery, aggressive actions figures, lack of concern with integrating background and monster pictures are the most consistent indicators as well as the strongest in magnitude. These indicators consistently had positive coefficients which coincides with the psychology literature. Specifically the presence of political slogans or imagery stands as one of the stronger predictors of both psychological distress and exposure to violence. Considering that exposure to violence can be thought of as link to level of trauma this provides additional evidence that use of child drawings can be a consistent technique.

6.6 Correlation Between Measurements

Additionally, I estimate the correlations between the drawing-based measures and the scores on both the GHQ-12 and the Harvard Trauma Questionnaire. Utilizing principal component analysis I created two separate indices for PTSD and psychological distress as measured by the child drawings. The scores from the GHQ-12 and the HTQ are standardized and then regressed on the child drawing measurements.

Table 7a shows the results for the psychological distress measurements, which are the GHQ-12 and child drawings. With a coefficient of .055 there is a positive correlation between child drawing indicators of anxiety and depression and the participants GHQ-12 score. The coefficient is significant at the 5% level and includes the control variables: age, sex, household size, and years spent in Jordan. This indicates that there is significant correlation between the drawing-based measurements of distress and the validated GHQ-12 responses.

Table 7b shows the estimated correlations between the PTSD measurements, which are the HTQ and child drawings. In this case there is a positive correlation between child drawing indicators of PTSD and the participants HTQ score with a resulting coefficient of .048, however it is not significant. The results are consistent with the lasso estimates, in that it indicates that it is challenging for PTSD to be consistently measured through drawing analysis.

7. Conclusion

This paper aims to provide empirical research on the use of children's drawings as a mental well-being assessment tool. In order to accomplish this I used the machine learning technique, lasso method, in order to find which drawing characteristics are the most accurate predictors of psychological distress, PTSD, exposure to violence. Additionally I look for consistencies in the chosen predictors across outcome variables as well as with the psychology literature.

My analysis indicates that the strongest predictors are political slogans or imagery, aggressive actions figures, lack of concern with integrating background, and monster pictures. These results have real world significance in that they provide empirical evidence for the analysis of children's drawings. If the above listed indicators are present after participating in a projective drawing exercise, this would allow for those children to be flagged as a high priority for further assessment. In the context of a refugee camp, this may be a valuable first step that is low-cost, non-invasive, and can be administered to many children at once in order to overcome the multiple constraints that are faced by refugee population.

Additionally the results that may be considered inconsistent with the psychology literature (negative coefficients on memories of trauma) can provide insight into the assessment of children's mental health, this along with the results outlined in section 6.6 indicate that it is difficult for PTSD specifically to be picked up on through a projective drawing exercise. As highlighted in other studies, this may be a result of the difficulties in externalization that PTSD often causes. To put it simply, children that are the most severely traumatized may not be able to express that through a projective medium. This highlights the importance of utilizing both children's drawings as well as traditional assessment questionnaires in order to ensure no child falls under the radar.

In closing, this paper presents results of a machine learning based analysis of drawings from a sample of child refugees in Jordan. I find empirical evidence for which drawing

characteristics are the strongest predictors of mental well-being, and thus which characteristics should be looked for when implementing a projecting drawing exercise. These findings suggest that there is value in the analysis of children's drawings, specifically in the assessment of general psychological distress. When used in conjunction with additional mental health treatments, projective drawing analysis can be a valuable tool when working with vulnerable populations.

References

Belloni, Alexandre, Victor Chernozhukov, and Christian Hansen. 2014. "High-Dimensional Methods and Inference on Structural and Treatment Effects." *Journal of Economic Perspectives*, 28 (2): 29-50.

Carswell, Kenneth, Pennie Blackburn, and Chris Barker. 2011. "The Relationship Between Trauma, Post-Migration Problems and the Psychological Well-being of Refugees and Asylum seekers." *International Journal of Social Psychiatry*, 57(2), 107-119.

Chartier, Mariette, John Walker and Barbara Naimark. 2018. "Health Risk Behaviors and Mental Health Problems as Mediators of the Relationship Between Childhood Abuse and Adult Health." *American Journal of Public Health*, 99 (5): 847-854.

Cohen, Judith, Michael Scheeringa. 2009 "Post-traumatic Stress Disorder Diagnosis in Children: Challenges and Promises." *Dialogues in Clinical Neuroscience*, 11 (1): 91-99.

Di Leo, J.H. 1983. "Interpreting Children's Drawings." New York, NY: Routledge.

Farokhi, M. and M. Hashemi. 2011. "The Analysis of Children's Drawings: Social, Emotional, Physical, and Psychological Aspects," *Procedia: Social and Behavioral Sciences*, 30: 2219–2224.

Furth, G. M. 2002. "The Secret World of Drawings: A Jungian Approach to Healing through Art." Toronto: Inner City Books.

Giordano, Francesca, Alessandra Cipolla, Fausto Ragnoli, and Federico Brajda Bruno. 2019. "Transit Migration and Trauma: The Detrimental Effect of Interpersonal Trauma on Syrian Children in Transit in Italy." *Psychological Injury and Law*, 12: 76-87.

Gadeberg, AK, Montgomery E., Frederkisen HW, and Norredam M. 2017. "Assessing Trauma and Mental Health in Refugee Children and Youth: A Systematic Review of Validated Screening and Measurement Tools." *European Journal of Public Health* 27(3): 439-446.

Glewwe, Paul, Phillip Ross, and Bruce Wydick. 2018. "Developing Hope among Impoverished Children: Using Child Self-Portraits to Measure Poverty Program Impacts." *Journal of Human Resources*, 52(2), 330-55.

Goldberg DP, Blackwell B. 1970. "Psychiatric illness in general practice. A detailed study using a new method of case identification." *British Medical Journal*, 1:439–443.

Hameed, Sameena, Asad Sadiq, and Amad Din. 2011. "The Increased Vulnerability of Refugee Population to Mental Health Disorders." *Kansas Journal of Medicine*, 11 (1): 20–23.

Kling, Jeffrey R., Jeffrey B. Liebman, and Lawrence F. Katz. 2007. "Experimental Analysis of Neighborhood Effects." *Econometrica*, 75 (1):83–119.

Koppitz, E.M. 1968 "Psychological Evaluation of Children's Human Figure Drawings" New York: Grune & Stratton.

Kronick, Rachel. 2018. "Mental Health of Refugees and Asylum Seekers: Assessment and Intervention." *The Canadian Journal of Psychiatry*, 63 (5): 290-296.

Magwaza, A., Killian, B., Petersen, I., & Pillay, Y. 1993. "The Effects of Chronic Violence on Preschool Children Living in South African Townships." *Child Abuse & Neglect*, 17(6), 795-803.

Murray, Kate, Graham R. Davidson and Robert D. Schweitzer. 2010. "Review of Refugee Mental Health Interventions Following Resettlement: Best Practices and Recommendations." *American Journal of Orthopsychiatry*, 80 (4): 576-585.

Nader, K. O., Pynoos, R. S., Fairbanks, L. A., Al-Ajeel, M., & Al-Asfour, A. 1993. "A Preliminary Study of PTSD and Grief Among the Children of Kuwait following the Gulf Crisis." *British Journal of Clinical Psychology*, 32: 407–416.

Panlilio, Rafael. 2017. "Drawings from Syria's Lost Generation: Psychological Impacts of the Refugee Crisis" Thesis Submission for the Masters of Science Degree, University of San Francisco M.S. program in International and Development Economics.

Patel, Vikram, Alan J. Flisher, Sarah Hetrick, and Patrick McGorry. 2007. "Mental Health of Young People: A Global Public-Health Problem." *The Lancet*, 369 (9569): 1302-1313.

Riley, Andrew, Andrea Varner, Peter Ventevogel, M. M. Taimur Hasan, and Courtney Welton-Mitchell. 2017. "Daily stressors, trauma exposure, and mental health among stateless Rohingya refugees in Bangladesh." *Transcultural Psychiatry*, 54(3), 304-331.

Smith, P., Perrin, S., Yule, W., & Rabe-Hesketh, S. 2001. "War exposure and maternal reactions in the psychological adjustment of children from Bosnia- Hercegovina." *Journal of Child Psychology and Psychiatry*, 42: 395-404.

Tibbetts, T. J. 1989. "Characteristics of Artwork in Children with Post-Traumatic Stress Disorder in Northern Ireland." *Art Therapy*. 6(3), 92-98.

UNICEF. 2018. Child Displacement. https://data.unicef.org/topic/child-migration-and-displacement/displacement/

Wadeson, H. 1971. "Characteristics of Art Expression in Depression." *Journal of Nervous and Mental Disease*. 153: 197-204.

World Health Organization (WHO). 2014. "Health for the world's adolescents: a second chance in the second decade of life." Geneva: WHO.

Appendix: Tables & Figures

Table 1: Drawing Indicators

Characteristic of Drawing	Possible Indicator	Reference
Lack of details	PTSD	Tibbetts (2013)
Focus on symbols or memories of trauma	PTSD	Tibbetts (2013)
Lack of concern with integrating background into drawing	PTSD	Tibbetts (2013)
Monster pictures	PTSD	Tibbetts (2013)
Aggressive action figures	PTSD	Tibbetts (2013)
Political slogans or imagery	PTSD	Tibbetts (2013)
Multiple figures draw	PTSD	Magwaza (1993)
Drawn in dark colors	Anxiety, depression	Wadeson (1971)
Drawn in single colors	Anxiety, depression	Wadeson (1971)
Symbol of despair or sadness	Anxiety, depression	Furth (2002)
Figure drawn	Low anxiety, depression	Magwaza (1993)
Drawn in light or cheery colors	Low anxiety, depression	Wadeson (1971)
Symbols of hope	Low anxiety, depression	Furth (2002)

Table 2:
Summary Statistics for Controls & Drawing Indicators Across Both Datasets

	GAGE (std. dev.)	USF (std. dev.)
Age	11.190	8.763
	(0.765)	(1.992)
Sex (1 if female)	0.521	0.574
	(0.500)	(0.495)
Household Size	7.164	6.981
	(2.185)	(1.910)
Years Spent in Jordan	4.688	3.011
	(1.940)	(0.647)
Lack of details	0.209	0.303
	(0.407)	(0.460)
Focus on memories of trauma	0.022	0.080
	(0.148)	(0.271)
Lack of concern with integrating background	0.393	0.131
	(0.489)	(0.338)
Monster Picutres	0.012	0.053
	(0.109)	(0.224)
Aggressive action figures	0.009	0.018
	(0.096)	(0.133)
Political slogans or imagery	0.051	0.024
	(0.221)	(0.153)
Multiple figures drawn	0.060	x
	(0.238)	
Drawn in dark colors	0.192	0.155
	(0.395)	(0.362)
Drawn in a single color	0.086	0.200
	(0.280)	(0.399)
Symbol of despair or sadness	0.054	0.069
	(0.227)	(0.253)
Figure drawn	0.256	x
	(0.436)	
Drawn in light or cheery colors	0.529	0.154
	(0.499)	(0.361)
Symbol of hope	0.419	0.601
	(0.494)	(0.490)
Observations	1,929	1,231

x indicates that this particular drawing characteristic was not used when manully coding the drawings for that dataset.

Table 3:
Summary Statistics for Mental Health Measurments Across Both Datasets

	GAGE (std. dev.)	USF (std. dev.)
Pyschological Distress	0.309	x
	(0.462)	
PTSD	0.362	x
	(0.481)	
High Violence	0.719	0.755
	(0.449)	(0.430)

x indicates that this particular measurment was not used in data collection.

Table 4
Chosen Predictors of Psychological Distress (GAGE)

	Predictor	Lasso Coefficient	Post-est OLS Coefficient	Standard Error
Non-Penalized Terms:	Age	0.003	0.001	0.018
	Female	0.021	0.025	0.026
	Household size	0.012	0.011	0.005
	Years in Jordan	0.009	0.009	0.008
Selected Terms:	**Political slogans or imagery**	0.086	0.129	0.070
	Lack of details	0.084	0.102	0.037
	Drawn in a single color	0.053	0.095	0.053
	Lack of concern with integrating background	0.050	0.062	0.027
	Human figure drawn	0.047	0.069	0.033
	Focus on memories of trauma	0.035	0.104	0.093
	Drawn in dark colors	-0.066	-0.108	0.028
	Symbol of despair	-0.007	-0.044	0.055
Non-Selected Terms:	Monster pictures, Aggressive action figures, Multiple figures drawn, Drawn in light colors, Symbol of hope			

Observations: 1,870

Lambda: 20.745

Variables: age, female, household size, years in Jordan are not subject to the penalization term.

Dependent Variable: Score on GHQ-12 indicates Psychological Distress (=1)

Note: This table shows the selected and non-selected variables for the lambda value of 20.745. This value was determined by 10-fold cross-validation and out of 100 different lambda values was determined to minimize the MSPE. At this penalization value 8 (out of 13) drawing terms were retained in the model. This indicates that an increase in their coefficient value corresponds to a comparable decrease in the residual sum of squares (RSS) and thus contributes to the overall fit of the model. An increase in the coefficients of the 4 non-selected terms (listed above) do not lead to a decrease in the RSS and thus they are shrunk to zero and are not included in the model.

Table 5
Chosen Predictors of PTSD (GAGE)

	Predictor	Lasso Coefficient	Post-est OLS Coefficient	Standard Error
Non-Penalized Terms:	Age	0.043	0.042	0.215
	Female	-0.043	-0.041	0.029
	Household size	-0.002	-0.001	0.007
	Years in Jordan	-0.004	-0.004	0.008
Selected Terms:	**Human figure drawn**	0.026	0.069	0.032
	Aggressive action figure	0.017	0.212	0.161

Non-Selected Terms: Lack of details, Focus on trauma, Lack of concern w/ background, Monster pictures, Political imagery, Drawn in dark colors, Drawn in a single color, Symbol of despair, Drawn in light colors, Symbol of hope, Multiple figures drawn

Observations: 1,714

Lambda: 48.607

Variables above the line (age, female, household size, years in Jordan) are not subject to the penalization term.

Dependent Variable: Score on HTQ indicates symptomatic of PTSD (=1)

Note: This table shows the selected and non-selected variables for the lambda value of 48.607. This value was determined by 10-fold cross-validation and out of 100 different lambda values was determined to minimize the MSPE. At this penalization value 2 (out of 13) drawing terms were retained in the model. This indicates that an increase in their coefficient value corresponds to a comparable decrease in the residual sum of squares (RSS) and thus contributes to the overall fit of the model. An increase in the coefficients of the 11 non-selected terms (listed above) do not lead to a decrease in the RSS and thus they are shrunk to zero and are not included in the model.

Table 6a
Chosen Predictors of High Exposure to Violence (GAGE)

	Predictor	Lasso Coefficient	Post-est OLS Coefficient	Standard Error
Non-Penalized Terms:	Age	-0.001	0.000	0.016
	Female	-0.022	-0.031	0.024
	Household size	-0.020	-0.020	0.005
	Years in Jordan	-0.158	-0.159	0.009
Selected Terms:	**Monster picture**	0.039	0.191	0.077
	Focus on memories of trauma	-0.078	-0.172	0.095
	Drawn in a single color	-0.036	-0.077	0.046
	Lack of details	-0.020	-0.048	0.028

Non-Selected Terms: Lack of concern w/ background, Political imagery, Drawn in dark colors, Aggressive action figure Symbol of despair, Drawn in light colors, Symbol of hope, Human figure, Multiple figures

Observations: 1,060

Lambda: 30.184

Variables above the line (age, female, household size, years in Jordan) are not subject to the penalization term.

Dependent Variable: Experienced higher than average number of deaths (=1)

Note: This table shows the selected and non-selected variables for the lambda value of 30.184. This value was determined by 10-fold cross-validation and out of 100 different lambda values was determined to minimize the MSPE. At this penalization value 4 (out of 13) drawing terms were retained in the model. This indicates that an increase in their coefficient value corresponds to a comparable decrease in the residual sum of squares (RSS) and thus contributes to the overall fit of the model. An increase in the coefficients of the 9 non-selected terms (listed above) do not lead to a decrease in the RSS and thus they are shrunk to zero and are not included in the model.

Table 6b
Chosen Predictors of High Exposure to Violence (USF)

	Predictor	Lasso Coefficient	Post-est OLS Coefficient	Standard Error
Non-Penalized Terms:	Age	-0.008	-0.007	0.006
	Female	0.096	0.102	0.027
	Household size	-0.043	-0.043	0.007
	Years in Jordan	-0.019	-0.018	0.021
Selected Terms:	**Aggressive action figure**	0.125	0.155	0.090
	Political slogans or imagery	0.069	0.103	0.059
	Drawn in a single color	0.061	0.108	0.049
	Drawn in light colors	0.051	0.068	0.033
	Lack of concern with integrating background	0.012	0.024	0.037
	Monster picture	0.008	0.024	0.048
	Drawn in dark colors	-0.083	-0.139	0.050
Non-Selected Terms:	Lack of details, Focus on trauma, Symbol of despair, Symbol of hope			

Observations: 1,156

Lambda: 12.249

Variables above the line (age, female, household size, years in Jordan) are not subject to the penalization term.

Dependent Variable: Experienced higher than average number of deaths (=1)

Note: This table shows the selected and non-selected variables for the lambda value of 12.249. This value was determined by 10-fold cross-validation and out of 100 different lambda values was determined to minimize the MSPE. At this penalization value 7 (out of 11) drawing terms were retained in the model. This indicates that an increase in their coefficient value corresponds to a comparable decrease in the residual sum of squares (RSS) and thus contributes to the overall fit of the model. An increase in the coefficients of the 5 non-selected terms (listed above) do not lead to a decrease in the RSS and thus they are shrunk to zero and are not included in the model.

Table 7a
Correlation between the GHQ-12 and Drawing Measurements (GAGE)

Variables	GHQ-12 Score
Psychological Distress	0.0551**
	(0.0281)
Age	0.0123
	(0.0364)
Female	-0.0653
	(0.0569)
Household size	0.0194
	(0.0123)
Years in Jordan	0.0133
	(0.0146)
Constant	-0.2660
	(0.4260)
Observations	1,299
R-Squared	0.007

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table shows the correlations between the GHQ-12 responses and psychological distress as measured by the child drawings.

Table 7b
Correlation between the HTQ and Drawing Measurements (GAGE)

Variables	HTQ Score
PTSD	0.0489
	(0.0311)
Age	0.0863**
	(0.0371)
Female	-0.131**
	(0.0586)
Household size	-0.0222*
	(0.0125)
Years in Jordan	0.0007
	(0.0152)
Constant	-0.718*
	(0.4350)
Observations	1,199
R-Squared	0.015

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: This table shows the correlations between the HTQ responses and PTSD as measured by the child drawings.

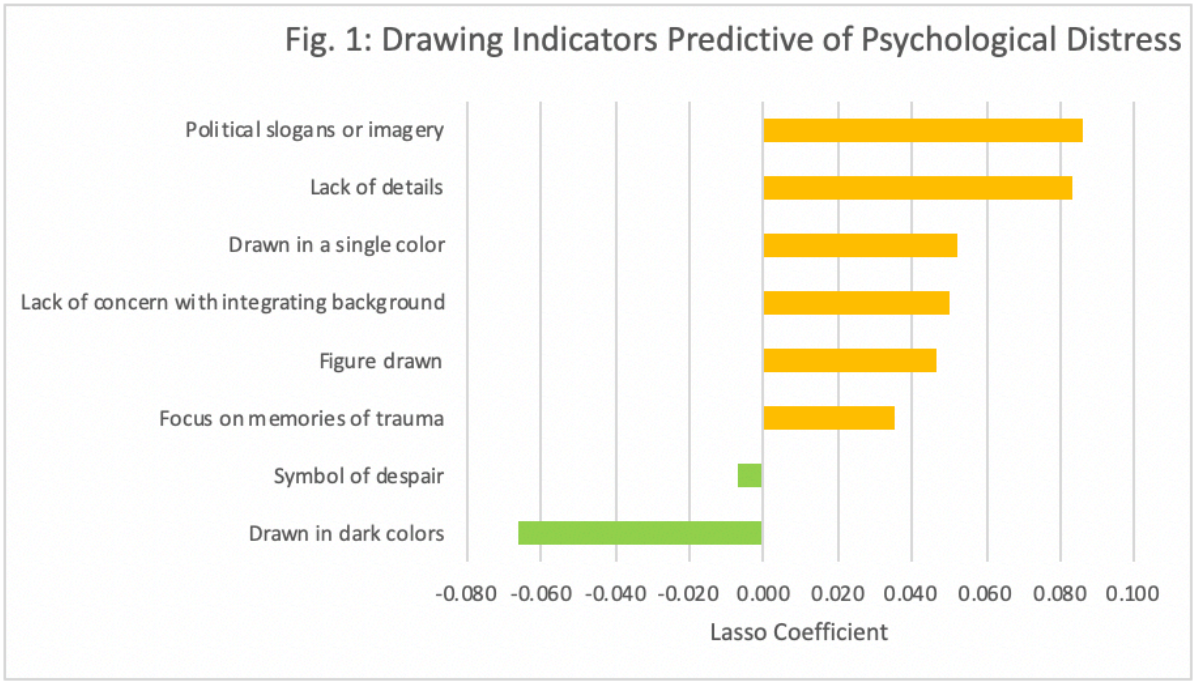
Fig. 1: Drawing Indicators Predictive of Psychological Distress
Political slogans or imagery
Lack of details
Drawn in a single color
Lack of concern with integrating background
Figure drawn
Focus on memories of trauma
Symbol of despair
Drawn in dark colors
-0.080 -0.060 -0.040 -0.020 0.000 0.020 0.040 0.060 0.080 0.100
Lasso Coefficient

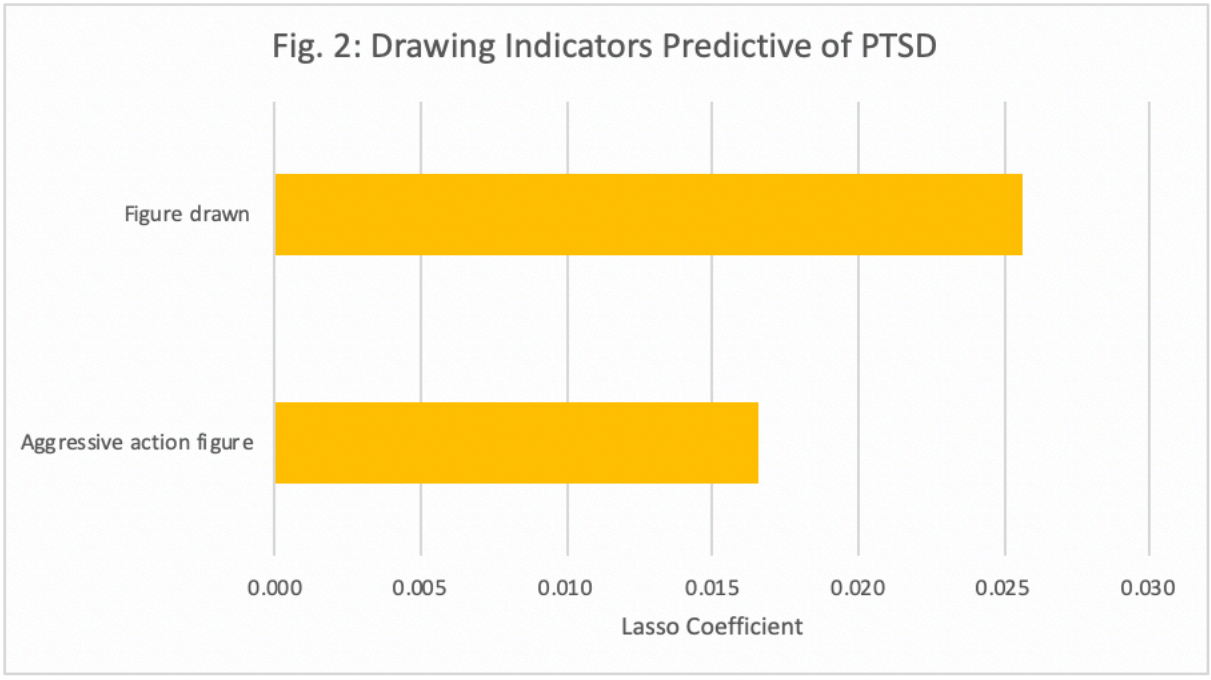
Fig. 2: Drawing Indicators Predictive of PTSD
Figure drawn
Aggressive action figure
0.000 0.005 0.010 0.015 0.020 0.025 0.030
Lasso Coefficient

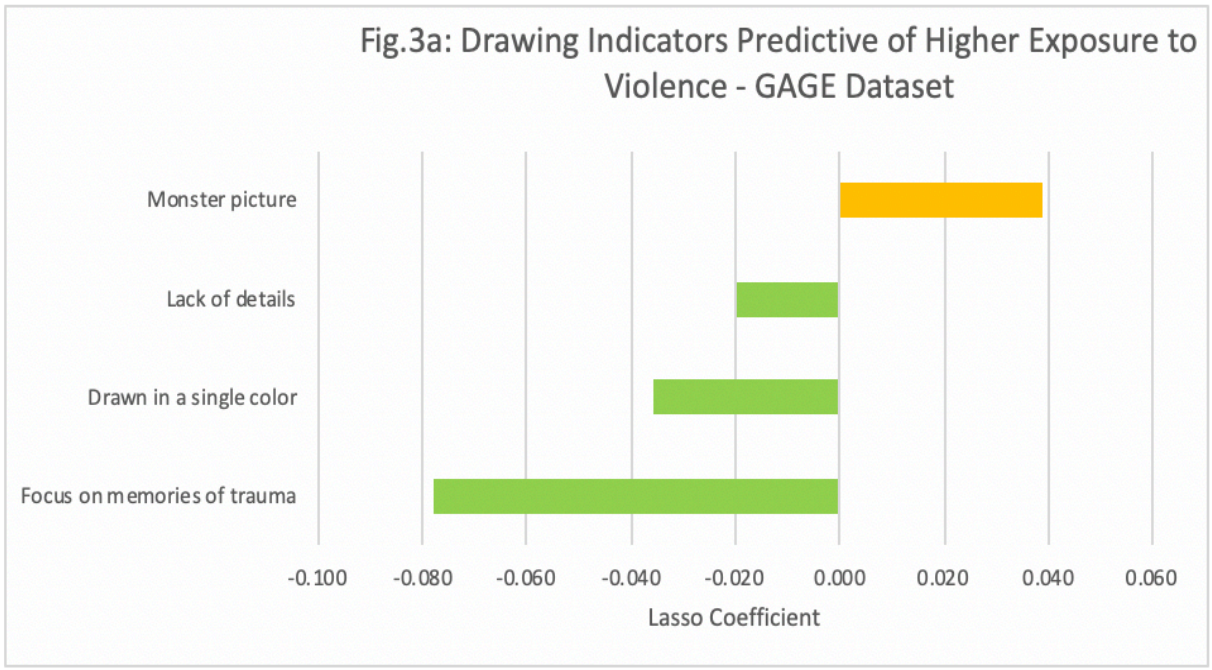
Fig.3a: Drawing Indicators Predictive of Higher Exposure to Violence - GAGE Dataset
Monster picture
Lack of details
Drawn in a single color
Focus on memories of trauma
-0.100
-0.080
-0.060
-0.040
-0.020
0.000
0.020
0.040
0.060
Lasso Coefficient

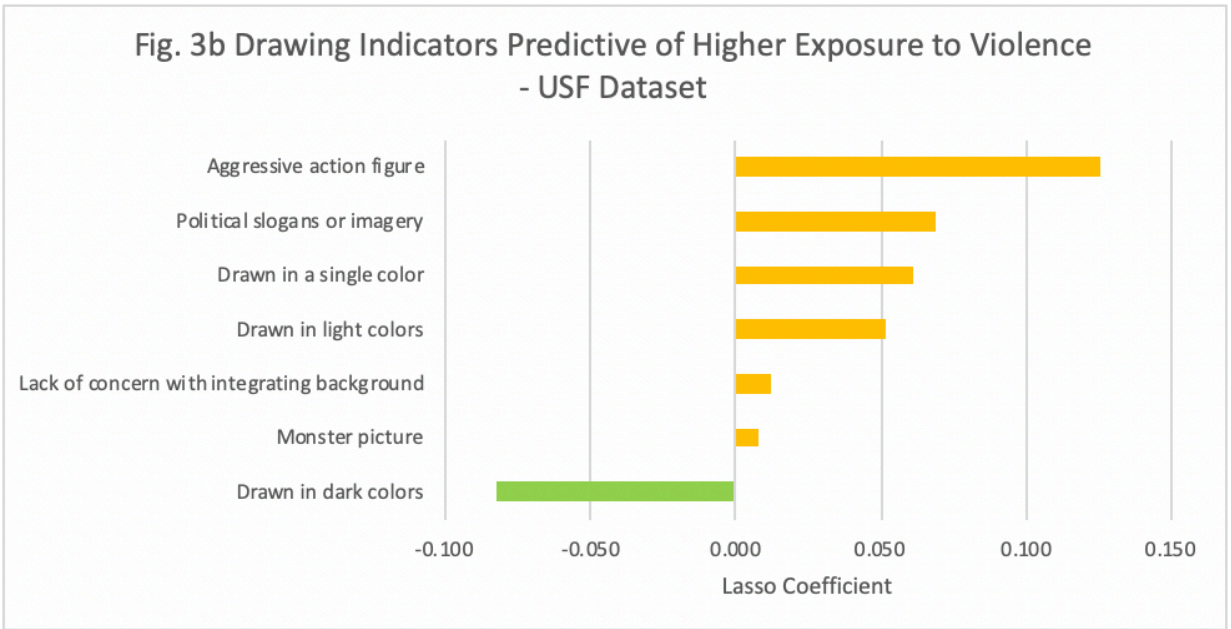
Fig. 3b Drawing Indicators Predictive of Higher Exposure to Violence - USF Dataset
Aggressive action figure
Political slogans or imagery
Drawn in a single color
Drawn in light colors
Lack of concern with integrating background
Monster picture
Drawn in dark colors
-0.100
-0.050
0.000
0.050
0.100
0.150
Lasso Coefficient