Neuropsychological stimulation for children living in low socioeconomic level suburbs from Guatemala City: A study protocol.

Pablo Rodríguez-Prieto
Universidad Loyola Andalucía

Ian Craig Simpson
University of Granada

Diego Gómez-Baya
University of Huelva

Claudia García de la Cadena
Universidad del Valle de Guatemala

Desirée Ruiz-Aranda
Universidad Loyola Andalucía

Joaquín A. Ibáñez-Alfonso (jaibanez@uloyola.es)
Universidad Loyola Andalucía

Method Article

Keywords: Neuropsychology, Childhood development, Vulnerability, Cognitive Stimulation, Emotion, Randomized Controlled Trials

Posted Date: July 14th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3082159/v2

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.
Neuropsychological stimulation for children living in low socioeconomic level suburbs from Guatemala City: A study protocol.

Pablo Rodríguez-Prieto\textsuperscript{a}, Ian Craig Simpson\textsuperscript{b}, Diego Gómez-Baya\textsuperscript{c}, Claudia García de la Cadena\textsuperscript{d}, Desirée Ruiz-Aranda\textsuperscript{a}, Joaquín A. Ibáñez-Alfonso\textsuperscript{*}

\textsuperscript{a}Universidad Loyola Andalucía, \textsuperscript{b}University of Granada, \textsuperscript{c}University of Huelva, \textsuperscript{d}Universidad del valle de Guatemala

Universidad Loyola Andalucía
Human Neuroscience Lab, University Clinic of Psychology, Department of Psychology
Avda. de las Universidades s/n
41704 Dos Hermanas, Sevilla (Spain)

University of Granada
Department of Experimental Psychology
Campus Universitario de Cartuja, CP 18071, Granada (Spain)

University of Huelva
Department of Social, Developmental and Educational Psychology
Campus de El Carmen, CP 21071, Huelva (Spain)

Universidad del Valle de Guatemala
11 calle 15-79 zona 15 V.H. III,
PBX: 2369 0791 al 95/ Tels: 2364-0336 al 40/ 2507-1500
Post n° 82, 01901 Guatemala, Guatemala C. A.

*Corresponding author:
Joaquín A. Ibáñez Alfonso
jaibanez@uloyola.es / Tel.: +34-955-641-600 (ext. 2483)
Neuropsychological stimulation for vulnerable children in Guatemala City

ABSTRACT:

**Background**: Guatemala remains one of the poorest countries in central America and suffers from high rates of social inequality and violence. Among other disadvantages, this unfavourable socioeconomic context poses a risk to children’s emotional and cognitive development. In addition to the negative impact that two years without attending school has had on Guatemalan children, the impact of the COVID-19 pandemic on the country’s economic stability has worsened the socioeconomic divide that these children face. This work presents a protocol for implementing a cognitive and emotional stimulation program with the goal of increasing the academic performance of these children and consequently improve their quality of life.

**Methods**: The protocol proposes the implementation of a randomized controlled trial to assess the efficacy of a 24-session-long stimulation program. It contains activities targeting the cognitive functions of attention, language, executive functions, and social cognition, using the digital neurorehabilitation platform NeuronUP. The participants ($n = 480$) will be randomly assigned to either the Experimental or Control group. Pre- and post-intervention assessments will be carried out, together with a follow-up in the next academic year, in which both groups will change roles.

**Discussion**: Mid- and long-term outcomes are still unknown, but effective interventions based on this protocol are expected to facilitate the following benefits for participants: (1) improved cognitive and emotional development; (2) improved academic performance; (3) improved well-being. We expect to create a validated neuropsychological stimulation program that could be applied in similar socioeconomically disadvantaged contexts around the world to help these children improve their life chances.

**Trial registration**: This project has been registered in the Open Science Foundation data base on the 10th of February 2022 ([https://doi.org/10.17605/OSF.IO/JVZ6W](https://doi.org/10.17605/OSF.IO/JVZ6W)).

**Keywords**: Neuropsychology, Childhood development, Vulnerability, Cognitive Stimulation, Emotion, Randomized Controlled Trials.
1. Introduction

The pandemic (Covid-19) represents an extremely great threat to the advancement of education in Guatemala because of the significant impact it has had at various levels. At a local level, educational centres were closed for the better part of two years, and more widely there has been an economic recession at the national and worldwide levels. The closures within the school system will cause a stagnation of learning, along with an increase in school dropout and a reduction in school attachment [1]. The country's economic crisis will affect the most vulnerable individuals, directly affecting their quality of life, and increasing the inequality that already exists within the country [2]. Consequently, it is necessary to make great efforts to counteract these effects. Some of the impacts on the students, who have been in a forced distance learning model for the past two years, are a worsening of their nutritional situation (due to not being fed at schools), deterioration of mental health, and a worsening of their vulnerable situation [1]. It is important to mention that child labour, abuse and unwanted pregnancies are problems that also manifest when the schooling becomes home-based.

Guatemala remains one of the poorest countries in the American continent with high rates of social inequality and violence, in which structural problems such as racial discrimination, gender inequality, extreme poverty and exclusion, an unstable political situation and an aberrant lack of access to justice, which constitute an obstacle to the full enjoyment of human rights. Additionally, racism and discrimination against indigenous peoples are deeply rooted. The indigenous population is in a more unfavourable condition than the non-indigenous, in terms of access to employment, health and education, as well as their average income, and rates of extreme poverty [2]. Guatemala is a diverse, multilingual, and multicultural country with 22 language communities. According to data from the last Census [3], the estimated Guatemalan population in 2020 was 16,858,333 inhabitants. The country’s gross domestic product per capita is around 39,043 quetzals, which would correspond to approximately 5 US dollars. It is the country in Latin America with the most chronic child malnutrition and the fourth worldwide, according to data from the World Bank [2]. In relation to the distribution of the country's inhabitants, it is significant that half of the population resides in rural areas, where three out of four inhabitants live in poverty [2]. The schools where the intervention will be carried out are in so-called high-risk areas: located in the department of Guatemala, these are areas where extreme violence, assaults, murders, and extortion are situations that happen daily, and the risk of dropping out of school is very high due to several reasons such as lack of money, child labour, or demotivation of the student [4].
Living conditions during childhood and adolescence affect the cognitive and emotional development of minors, resulting in important long-term effects during their adult life. The existing literature reports the risk of growing up in disadvantaged environments at the level of language development, attention, and executive functions. Additionally, growing up in this type of adverse context can also have an important negative impact in children’s social skills and emotional regulation [5–8]. The creation of this study protocol arises from the need to respond to some of the problems discovered after the conclusion of a previous project [9]. Its goal was to improve existing neuropsychological assessment tasks’ scores for children and adolescents in Guatemala, and studying how different factors found in their context could affect their cognitive development. The results obtained in this previous study revealed that the Guatemalan children and adolescents participating in the project needed effective support on multiple levels, due to living in a situation of vulnerability. In this study, vulnerability was defined as belonging to an especially disadvantaged socioeconomic context, both in terms of poverty and direct exposure to extreme violence. This showed that the hypotheses regarding the negative impact of growing up in disadvantaged socioeconomic environments (e.g., low educational level of caregivers, little intellectual stimulation in their environment, food insecurity) had on the cognitive performance of children and adolescents were confirmed in this population, especially at the attentional, executive functioning, and linguistic levels [10]. Additionally, it was possible to detect a series of mental health difficulties in some of the participants that couldn’t be left unattended. High levels of anxiety and depression were detected, prominently in children belonging to urban areas with high exposure to violence, which undoubtedly affected the psychological adjustment and the quality of life perceived by these children and adolescents [11]. As mentioned before, international scientific evidence indicates that living conditions during childhood and adolescence affect the cognitive and emotional development of children, having significant effects on their academic performance, which in turn tends to condition their long-term adult life [12–14]. Likewise, the stress associated with poverty causes a serious impact on the emotional and social development of these children, highlighting the urgent need to work on these areas.

Neuropsychological stimulation programs focused on both cognitive and emotional functions have a long tradition in the clinical field, being the treatment of first choice in various neurodevelopmental disorders [15]. Additionally, there are currently some previous experiences on the efficacy of neuropsychological interventions focused on specific cognitive domains in a non-clinical child population belonging to socioeconomically vulnerable
Neuropsychological stimulation for vulnerable children in Guatemala City

contexts [16–18]. These investigations seem to support the use of different agents and materials in cognitive intervention, with early intervention and a high number of sessions appearing to be more effective. Research shows that these children can also benefit from learning emotional regulation tools with which to constructively face the various risk situations to which they are frequently exposed in their daily lives [19]. However, the available scientific evidence on the efficacy of these neuropsychological stimulation programs in improving the cognitive and emotional skills of children at risk of social exclusion, and its expected impact on the academic performance and quality of life of these children, while solid, is still scarce [18,20,21].

These past experiences and the factors mentioned above have been a special motivation for the development of the following protocol for the neuropsychological stimulation program. It is considered very pertinent to implement a neuropsychological intervention program that stimulates both cognitive development (especially of those mental functions in which a greater negative impact of the socioeconomic context was detected), as well as emotional skills that reinforce the socio-emotional development of these children, an important protective factor against mood swings and other mental health disorders to which they are frequently exposed [22,23].

2. Material and methods

2.1. Participants and study setting

Students from 5th grade of primary school, from educational centres located in particularly vulnerable areas from Guatemala City’s suburbs will be invited to participate in the intervention program. The reason for choosing this grade is that the approximate age of the children in this school stage is the minimum that ensures they have acquired certain skills necessary for adequate participation on the intervention program (e.g., sufficient ability to sustain their attention, reading comprehension, etc.) and therefore may benefit more from the proposed intervention. It has been found that this is the optimal educational level for stimulation programs to succeed [24,25]. The following additional inclusion criteria will be considered:

- Being a proficient speaker of the Spanish language.
- Having acquired sufficient reading skills to understand the activities included in the intervention (percentile score > 5 in the Inter-American Reading Series L-3-DEs).
- Having a sufficient level of non-verbal intelligence to understand and interact with the activities included in the intervention (percentile score > 5 in the Non-Verbal Intelligence Test TONI-2).
- Not having a diagnosis of serious sensory or motor difficulties, or having one insufficiently corrected, that would prevent adequate performance in intervention activities.

Fe y Alegría is an international Jesuit NGO dedicated to creating schools and offering education in socioeconomically disadvantaged areas throughout many Spanish-speaking countries. In Guatemala, they currently have a country-wide network of educational centres consisting of 46 schools in total. Five centres located in the urban area have been chosen as a sample to represent the total population of their students due to the large logistical challenge of accessing more remote schools and because they have sufficient technical infrastructure (like adequate wi-fi network stability) to carry out the project. Three of the centres are in the suburbs of the department of Guatemala and two are in the Municipality of Villa Nueva. All of them are in colonias (neighbourhoods) characterized by a low socioeconomic level, aggravated by a very high exposure to violence; assaults, deaths, and extortions are daily situations in these communities which makes them especially vulnerable areas. Every child will have to give their oral consent to participate in this study, and their legal guardians must sign an informed consent document allowing the use of collected data for research purposes, after being extensively briefed about the goals, methods, and potential benefits of participation. To ensure that the size of the improvements realised by the intervention have a practical significance, we propose a minimum effect size of Cohen’s $d = 3.0$, which is a small-to-medium effect. Based on this, the minimum sample size we require for the study is $n = 352$. However, due to the difficult conditions of living that many of the families that live in these areas have (gang violence, climatological adversities, long distances from their residences to the school centres, etc.) we expect a large dropout rate. Therefore, we propose to recruit a total of 480 children as this would allow for slightly more than 25% of the sample to abandon the study yet still allow us sufficient statistical power to detect the target effect size. Furthermore, the figure of 480 represents approximately one-third of 5th grade students attending Fe y Alegría Guatemala centres. Thus, we would only need one in every three children to participate to achieve the necessary sample size.
2.2. Objectives and hypothesis

The main objective of this study protocol focuses on improving the cognitive performance and emotional competence of students at risk of social exclusion in vulnerable areas of Guatemala (due to their high exposure to violence and low socioeconomic level), and consequently improving their academic performance, psychological adjustment, and quality of life. The specific objective was the development of a comprehensive neuropsychological stimulation program in which the following cognitive and emotional functions were intervened: attention, language, executive functions, social cognition, and emotional competence. This comprehensive intervention responds to the needs detected in recent previous experiences, and we hypothesise that the strengthening of cognitive abilities and emotional competence will improve their overall health and well-being, as of previous studies have shown [16–18].

2.3. Instruments

The following assessment instruments will be used to obtain the baseline data of the participants and their subsequent cognitive and emotional performance after the intervention:

Neuropsychological assessment tests

- TOKEN Test, reduced version [26]. It measures the capacity to understand language in an order without redundancy. In this task, a series of shapes (big and small circles and squares of various colours) are laid out on the table in front of the participant, and then they will be told to touch or move them providing increasingly complicated instructions. In its reduced version it has 36 items and has a duration of about 10 minutes, with a maximum score of 36 and a minimum of 0.

- Verbal fluency test [27]. It measures phonological (words starting with “M”) and semantic (words included in the category “animals”) verbal fluency through the number of words produced by the person in each time (1 minute per condition). It takes about 4 minutes to complete. These tasks have a minimum score of 0 but don’t have a stablished maximum score because it depends on how many words can a person produce in 1 minute.

- Inter-American Reading Series (L-3-DEs) [28]. This is an assessment task that can be administered in groups and measures reading proficiency of children, having subscales for vocabulary, comprehension speed and comprehension level. The version used in this study is a commercial version culturally and linguistically adapted for the Guatemalan population. It has an average duration of 60 minutes and has a maximum
score of 125 and a minimum of 0. The scores of this task will be used as a screening for inclusion criteria. The participants will need to have at least a very basic ability to read and understand instructions for the program to influence them.

• Nesplora Aula School [29]. A virtual reality test for the evaluation of several abilities related to attention and self-regulation in children with an ecological approach. In this task the participants will be sitting in a classroom, and they will have to pay attention to the blackboard and the teacher. The task will present various stimuli and tell them to which ones they must react and which ones they must ignore. The set of instructions will change throughout the task. In this project we used these main variables: 1) Attention (total omission mistakes), 2) Inhibitory Control (total commission mistakes), 3) Impulsivity (mean reaction time while committing mistakes), and 4) Reaction speed (mean reaction time when emitting correct responses). It has an average duration of 15 minutes, and the results are given directly as percentiles scores depending on the participant’s age. It has an average duration of 15 minutes, and the results are given directly as percentiles scores depending on the participant’s age.

• Nesplora Ice Cream [30]. A virtual reality test for the evaluation of Executive Functions. In this task, people will have to attend customers in an ice cream shop, giving priority to the orders depending on how the customer is dressed. Customers will order different flavors and it is up to the participant to give them the correct one from a recipe book that changes mid-task. We used the main variables: 1) Working Memory (mean between total amount of correct responses and total processing speed), 2) Planification (mean between number of turns assigned and the average round duration), 3) Cognitive Flexibility (mean between the task interference - difference between correct responses in the two halves of the task-, perseverative behaviour - number of incorrect responses during the second half of the task, which were correct in the first half-, and switching - time increment between turns-), and 4) Learning interference (increment of recipe book checking in the second part of the task). It has an average duration of 30 minutes, and the results are given directly as percentiles scores depending on the participant’s age.

• Non-verbal Intelligence Test (TONI-2) [31]. It was developed as an intelligence measurement free of language influence, motor skills or reading capabilities, looking only for reasoning skills to solve abstract puzzles. It consists of 55 items of increasing difficulty, lasting approximately between 15-20 minutes. It has a maximum score of
Neuropsychological stimulation for vulnerable children in Guatemala City

55 and a minimum of 0. The scores of this task will be also used as a screening for inclusion criteria.

- NESPY-II Assessment Battery [32]. This exhaustive neuropsychological battery is designed for the cognitive assessment of children and adolescents. In this project we will use two subscales directly related to Social Cognition skills: 1) Emotion Recognition, and 2) Theory of Mind. The task Emotion Recognition measures the ability of children to correctly identify emotions in pictures of other children. It has 35 items and has a duration of about 5 minutes, with a maximum score of 35 and a minimum of 0. The Theory of mind task measures the ability of children to interpret and understand beliefs, intentions, faking and lies, emotions, and imagination in other people. It also measures if kids can understand social context and its relationship with emotions. It consists of 21 items and has a duration of about 5 minutes, with a maximum score of 28 and a minimum of 0.

- The Probabilistic Decision-Making Task [33] measures the risk aversion of children utilizing a Multiple Prices List [34]. To facilitate its comprehension by children, the number of decisions has been changed from 10 to 6 and the lotteries are represented as classic gumball machines. The risk aversion score is the number of safer options children make (between 0 to 6). Risk aversion has a correlation with human capital, entrepreneurship, and other socioeconomic variables. It has a duration of approximately 3 minutes.

- The Temporal Discount Task [33]. It measures the ability of children to discount a gain or a prize that isn’t immediate (delayed in time). This task is an adaptation from the original [35] that includes pictures and reduces the number of items from 11 to 6 to facilitate its comprehension by children. The number of times that children choose the delayed option (from 0 to 6) is the measurement of Patience (ability to delay gratification), which correlates with education, income, savings, and health. It has a duration of approximately 3 minutes.

*Emotional management, Mental Health, and Quality of Life questionnaires*

- The Childhood Depression Inventory, CDI [36]. In this study we will use the reduced 10 items version adapted to the Spanish language. It measures depressive symptoms in children and adolescents with 10 items divided in five subscales: negative mood, inefficacy, low self-esteem, social withdrawal, and pessimism. Each item has a score
from 0 to 2 depending on the severity. It has a duration of approximately 5 minutes with a maximum score of 20 and a minimum of 0.

- The Spence Children Anxiety Scale, SCAS [37], assess frequent anxiety symptoms in children divided into 6 subscales: Panic attacks/agoraphobia, separation anxiety, social phobia, general fears, generalised anxiety, and obsessions/compulsions. In this study we will use a condensed 12 items version adapted to the Spanish language focused only in two subscales: generalised anxiety and separation anxiety. Each item has a score from 0 to 3 depending on its frequency. It has an approximate duration of 5 minutes with a maximum score of 36 and a minimum of 0.

- The Multidimensional School Anger Inventory, MSAI [38]. In this study we will use a reduced 12 items version adapted to the Spanish language. It has three different subscales that measure anger experience, hostility, and destructive expression/anger management, in children and adolescents. Each item has a score from 1 to 4 depending on the level of emotional response of the child to the situation. It has an approximate duration of 5 minutes with a maximum score of 12 and a minimum of 4 for each of the 3 subscales.

- The Health-related quality of life scale, KIDSCREEN-10 [39]. In this study we will use the 10 items version of this scale adapted to the Spanish language. It asks the children various questions related to the subjective perception of their own physical, mental, and social health, each item has a score between 1 and 5. It has an approximate duration of 5 minutes with a maximum score of 50 and a minimum of 10.

**Socio-economic, clinical, and academic assessment**

- A sociodemographic questionnaire will be handed to families to give out information such as: names, age, occupation, and mean educational level of legal guardians (MLPE), number of people that live in the family household, or monthly income of the family household in Quetzals (Q).

- A clinical questionnaire will be administered asking if there were any health problems for the mother or child during pregnancy or childbirth, if the child needed to be in an incubator, if the child had any clinical diagnostic, and if it was or is currently under any pharmacological treatment.
• A language experience questionnaire that will assess the languages that both the legal guardians and the children can understand and speak, including their degree of proficiency.

• The previous school year marks of children will be recorded to establish a baseline for academic performance. To include all knowledge disciplines, an average score of all subjects will be used as the “average marks” variable. An average of all subjects at the end of this academic year will be calculated as the post-intervention variable. The subjects imparted at Fe y Alegría Guatemala schools are communication and language, mathematics, natural sciences, social sciences, artistic expression, physical education, civic education, productivity and development, and musical education.

• The Latin-American and Caribbean Latin-American Food Security Scale (ELCSA)[40], validated by the Food and Agriculture Organization of the United Nations. This scale is composed of two different parts answered by the caregivers. First, caregivers are asked how safe they feel in relation to the food they can provide to the family. The assessment of this part offers a score between 1 to 15 in which higher scores reflect higher food insecurity. The second section asks how many days per week the family consumes a certain type of food like vegetables, meat and fish, sugary foods, etc.

• The VEX-R PLUS Self-Reported Violence Assessment Questionnaire [41]. Created to measure the exposure of children to violence, it has a version for children and parents. In this study we will only use the children version that has a total of 30 items (4 neutral examples and 26 violent situations) covering many types of violence plus an extra 4 covering sexual violence. Each item has a score between 0 and 4 depending on the level of exposure, having a maximum score of 104 and a minimum of 0.

Cognitive and Emotional Intervention Program

The intervention program will be carried out using tablets with access to the digital neurorehabilitation platform NeuronUP [42], an internationally validated neuropsychological rehabilitation, stimulation, and session management tool [43–45]. The sessions themselves will be divided into 30 minutes of stimulation time and 15 minutes for distributing the tablets at the beginning, logging in to the students’ accounts and collecting them at the end. Since this stimulation program will be carried out through the use of this app, there are no health risks involved for the participants while receiving the intervention, it is a totally non invasive method of cognitive stimulation prepared to promote participant engagement on the task and
reduce frustration through the presentation of the exercises as mini-games. The sessions will be programmed by specialists in neuropsychology from the research team using the NeuronUP2GO functionality, an online application that allows managing the stimulation sessions of users located anywhere around the world. Remote monitoring provides continuous control thanks to the fact that all activities and results are stored on the platform itself. In addition, using NeuronUP2GO, the professional can adapt the sessions based on the progress of each user, thus achieving a controlled and personalized intervention. In this project, the stimulation program will be designed so that it will have 3 levels of difficulty (easy, medium, and hard) (see Figure 1).

[FIGURE 1] (If possible, color should be used to print this figure)

This also makes it possible to apply the program in a flexible way to entire class groups in which there are usually small differences in age, as well as different rates of development and special needs. It allows kids who take longer to adapt the time they need develop the intended capabilities more gradually while trying to give every child the same level of stimulation, so they can keep a steady advance for all the class. The administration of the tablets to the participants in each session will be carried out by personnel duly trained and appointed by the management team of the educational centres (normally academic tutors or those responsible for the computer area). Which will still get supervised periodically by the neuropsychology and educational psychology specialists from the project in case any problems or questions arise. Activities and tasks will be divided equally between the four target areas, cycling between different cognitive domains so the participants will be able to work on improving them all at the same pace. There will be two activities for each cognitive skill at every difficulty level. Every activity will be different from the others of the same category but still targeted the same set of skills the program is aimed at improving.

There are several benefits that the intervention may bring to the participants. They will enjoy around an hour per week of digital exercises created to stimulate and strengthen cognitive functions and emotional management. These functions are essential for proper child development and have a significant impact on their social and academic performance. It is important to outline the fact that this study won’t have a passive control group, as it is
demarcated inside an international cooperation project and all children need to receive some kind of intervention. The control group will use the time dedicated to the intervention sessions to carry out a reading motivation program that is regularly used in these schools (it will be as a “therapy as usual” control group). This program has been proposed by Fe y Alegría to train reading proficiency while learning about a variety of topics, such as gender equality, sexuality, and many other social topics. They will also perform regular academic activities that the responsible teaching staff considers pertinent.

2.4. Procedure

The design of this study protocol follows the guidelines of the CONSORT revised recommendations for improving the quality of reports of parallel group randomized trials [46]. The study has been pre-registered with the Open Science Foundation. Ideally, children should be randomly allocated to either the control or the experimental group. However, this protocol requires the use of at least two rooms at the same time, along with a high level of logistical organization in terms of moving the children to their correct room for each session. Given the nature of the schools involved, we don’t believe it is realistic to expect that these resources will always be available. Hence, we propose that the study will be carried out through a multicentre randomized controlled trial in which two groups (classes) will be taken from each participating school, with one group randomly designated as the control group, and the other serving as the experimental group. Effort should be made to ensure as close to a 1:1 ratio of students between groups as is possible. The class designated as the experimental group will receive the intervention. The second group will be made up of the students who will form the control group and consequently be put on a waiting list to receive the intervention during the following academic year. The study will therefore be divided into two blocks, a first block of prior and posterior assessment of their cognitive and emotional abilities, and the implementation of the intervention program in between, during year 1. In the second block of the study, the control and experimental groups will change roles to observe changes in the response of the participants and assess whether there is a maintenance of the benefits obtained by the experimental group during the first block, with a final assessment round (during their 6th grade period). Therefore, a general assessment will be carried out at the end of the year 1 and at the end of the year 2 (see Figure 2). All assessments will be carried out by professional neuropsychologists and educational psychologist, duly trained to administer the assessment tasks.
Neuropsychological stimulation for vulnerable children in Guatemala City

[FIGURE 2]

Figure 2. Sequence of the study.

Note. Under the intervention sections, the boxes highlighted in grey represent the experimental group and the boxes in white represent the control group.

The program will take place during the second half of the academic year, at a rate of 2 sessions per week, with an estimated duration of about 45 minutes per session. Participants will do the two weekly sessions on different days of the week, depending on the school they attend, but always with at least one rest day in between. If for some reason there are participants that miss one of the sessions, they would have to recover it during the same week to avoid the risk of falling behind their classmates. If participants miss a session and can’t recover it within the same week that it is planned, they will skip it and continue the first session planned for the following week, but the missed session will be registered as lost. The justification for this decision is that sometimes access to schools or a stable internet connection won’t be guaranteed in the context of the study. Hence, this protocol will avoid participants lagging behind their classmates and avoids having participants completing different sessions in the same classroom. An additional reason for taking this decision is that at the end of the program, we will be able to analyse the percentage of completion for each participant and determine the minimum completion percentage to ensure the program’s effectiveness.

The results will be explored via a comparative analysis of baseline and post intervention measures divided by experimental and control groups. We will also perform different analysis considering different subgroups of participants. We will explore the differences between the “normative” group (participants between the ages of 10 and 12, without any clinical diagnosis and with scores over the inclusion limit in the screening assessment tasks), and the “non normative” group (participants 13 years old and above, having any clinical diagnosis, or with scores under the screening tasks limit). This last separation will be done to explore the impact the program may have in children with additional difficulties, even though they will be excluded from the main analysis assessing the program’s efficacy. Since this study is included within the framework of an international cooperation project, all children must receive an intervention, and thus we want to explore the effects this program may have on the children that don’t meet the inclusion criteria. Due to the nature of the intervention, it is impossible to implement it in a manner which allows both participants and the personnel
Neuropsychological stimulation for vulnerable children in Guatemala City

administering the intervention to participate in blind manner. However, the personnel assessing the outcomes will be blinded to group assignment to ensure as much unbiased outcomes as possible. The interpretation of the data will also have to consider the group assignment to conclude the efficacy of the program.

3. Discussion

This study protocol focuses on improving cognitive and emotional competence of students from especially vulnerable areas of Guatemala City, and consequently achieves to improve their academic performance and quality of life. After assessing their baseline cognitive and emotional abilities, a comprehensive neuropsychological stimulation program will be implemented to train their cognitive and emotional skills. As they participate in the program, those who are part of the experimental group will enjoy more than an hour per week of exercises tailor made to stimulate and strengthen the specific cognitive functions and social cognition skills that are the target of this program. In fact, the stimulation exercises that they will have the opportunity to do have been created by a group of professionals specialised in the field of neuropsychology, and are commonly used in clinical practice, because of their demonstrated efficacy. In addition, as the participants are minors living in very adverse socioeconomic conditions, they will have the opportunity to learn how to use electronic devices that they wouldn’t normally have access to, such as tablets or virtual reality headsets. Given the current situation with the COVID-19 pandemic, this knowledge can be beneficial to effectively face the educational challenges that schools currently face.

This study will contribute to improving the living conditions of Guatemalan children through innovative actions designed to respond to the specific needs of children in vulnerable contexts. In the first place, the previous study on socioeconomic status and cognitive development has allowed us to know which areas need greater reinforcement [11]. Therefore, the exercises developed using tablets, which have already proven to be successful in other contexts, will be adapted to the reality of the group with which we will work. In addition, the previous study has found anxiety and depression symptoms that are higher than expected and higher than the average, especially in urban-marginal sectors. For this reason, actions to strengthen emotional intelligence are included. Scientific evidence shows that, in addition to improving concentration and academic performance, this type of intervention promotes the prevention of the appearance of violent, addictive behaviours, and other behaviours
Neuropsychological stimulation for vulnerable children in Guatemala City

associated with impulsiveness and difficulty in long-term planning, thus contributing to personal and collective empowerment of these children [18,20,21].

There is a great educational gap between students caused by the wildly varied situations in their homes. The closure of schools due to the COVID-19 emergency has widened this gap, as most of these vulnerable students do not have access to computers or the internet in their family homes. In addition, the low level of education of their relatives and the fact that they tend to live in small and overcrowded houses have a significant impact on their academic performance. The introduction of tablets has the secondary benefit of making it possible to reduce the digital gap between households, while strengthening the capacity for teaching teams to allow the design of distance and face-to-face mixed education methodologies that increase the skill levels of students, thus reducing the educational gap. An equitable education is at the base of the exercise of rights and the increase of opportunities in the long term.

If the results of this proposed program successfully make the expected impact, it might make a big difference in the future of this children, giving them a chance to develop their cognitive and social abilities to previously unachievable levels, balancing the playing field with other children of their age. This program has been created with the intention to be applied in similar low-level socioeconomic contexts, which means that it might become a reliable tool to help children in similar conditions around the world. If the program is effective, there are plans to transfer the knowledge derived from the application of the comprehensive neuropsychological stimulation program in vulnerable areas of Guatemala to particularly disadvantaged contexts in Andalucía (Southern Spain), were 15 of its neighbourhoods are amongst the poorest in Spain based on the most recent report of Urban Indicators (Urban Audit) published by the National Institute of Statistics [47].

The long-term goal of this project is to create a tested and validated cognitive stimulation program, so that it can be integrated into the academic curriculum of educational centres that work with people belonging to this type of population. It is intended to be implemented by the teaching staff of said centres and supervised in parallel by neuropsychology professionals throughout the process. It aims to offer children who live in vulnerable areas the opportunity to receive the support that they may lack during their development in the school phase and allow them to develop to their maximum cognitive and emotional potential. Meaning that they will be able to increase their academic performance, gain more tools to better manage
their mental health and the situations they face living in their communities, and hopefully increasing their quality of life.

DECLARATIONS

Ethics approval

This study protocol was approved by the Ethics Committee from the Faculty of Social Sciences of Universidad del Valle of Guatemala. It was approved as Protocol approval #56 on May 31st of 2021 and renewed on December 4th of 2022. This renewal was required due to multiple delays caused by the global situation of the COVID-19 pandemic and to the ongoing nature of this project. This study does not carry any risks or potential prejudicial effects for its participants and all methods were performed in accordance with the relevant guidelines and regulations of the recognized international standards from the declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to the ongoing nature of this study, but if desired can be obtained from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research has been funded by the Andalusian Agency for International Cooperation and Development (AACID, in Spanish) from the Junta de Andalucía Government, Spain, under the project “Mejora del rendimiento académico y la calidad de vida de menores vulnerables de Guatemala: programa integral de estimulación cognitiva y emocional, desarrollo de huertos escolares y fortalecimiento de la docencia a distancia ante el reto del COVID-19” [Improvement of the academic performance and quality of life in vulnerable minors from Guatemala: Integral cognitive and emotional stimulation program, development of school orchards, and strengthening of distance teaching amidst the challenge of COVID-19], file number 0C138/2020.

Author’s contribution
Neuropsychological stimulation for vulnerable children in Guatemala City

Pablo Rodríguez-Prieto: Software, Investigation, Data curation, Formal analysis, Writing—Original draft preparation, Visualization, Project administration. Ian Craig Simpson: Conceptualization, Methodology, Formal analysis, Writing—Review & Editing, Visualization. Diego Gómez-Baya: Conceptualization, Methodology, Resources, Writing—Review & Editing, Visualization. Claudia García de la Cadena: Conceptualization, Methodology, Resources, Writing—Review & Editing, Visualization. Desirée Ruiz-Aranda: Conceptualization, Methodology, Resources, Writing—Review & Editing, Visualization. Joaquín A. Ibáñez-Alfonso: Conceptualization, Methodology, Resources, Writing—Review & Editing, Visualization, Supervision, Project administration, Funding acquisition.

All authors read and approved the final manuscript.

Acknowledgements

This study was conducted in collaboration with Fe y Alegría Guatemala. We wish to thank Ana Lucía Isabel Linares Palma, Susset Fernández Menéndez, Claudia Ayala Cano, and Diego Jacobs Pivaral for their great work and support, and to all the personnel, families, and participants from the schools that are part of the project. We would also like to thank Mª José Vázquez, Alicia Tortosa García, and Michela Accerenzi from the ETEA Foundation, Development Institute of Universidad Loyola Andalucía, for their technical support.

References


Neuropsychological stimulation for vulnerable children in Guatemala City


Neuropsychological stimulation for vulnerable children in Guatemala City


Neuropsychological stimulation for vulnerable children in Guatemala City


Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:
Contributions to the literature

1. Guatemala's socioeconomic context poses a significant risk to children's cognitive and emotional development, exacerbated by the impact of the COVID-19 pandemic on economic stability and educational access. This research aims to implement a cognitive and emotional stimulation program to improve academic performance and enhance the quality of life for children in Guatemala. We propose a randomized controlled trial as a robust methodology to assess its efficacy, making it a notable contribution to the field.

2. The study will involve 480 fifth-grade participants, who will engage in a 24-session-long program targeting cognitive functions encompassing attention, language, executive functions, and social cognition. To execute the program, the digital neurorehabilitation platform NeuronUP will be utilized, a widely recognized professional tool employed in clinical settings, that now will be applied within the classroom environment. Pre- and post-intervention assessments will be administered, with a subsequent follow-up in the ensuing academic year to ensure sustained benefits for all participants.

3. While the outcomes in the mid- and long-term are yet to be determined, successful implementation of the program is anticipated to yield substantial benefits. These benefits encompass the advancement of cognitive and emotional abilities beyond previous levels, improved academic performance, and augmented access to resources and life opportunities. Consequently, the program has the potential to alleviate negative effects of vulnerability in childhood development and enhance the prospects of these children. If the program demonstrates its anticipated benefits, there are plans to extend the intervention to support children in similar circumstances globally.
Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CONSORTChecklist.docx