

# An alternative model for development in childhood: extinction and interoperability

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## Abstract

More than 40% of children under 5-years-old in middle-low income countries are under risk of not reaching developmental potential for causes associated with poverty and psychosocial deprivation. The reason for that is probably associated with a low relevance of development as a biological decline more than an increasing process. A way to improve the life chances and opportunities of low-income children, families, and communities is described in a model of extinction and interoperability characteristics.

An original model for interoperability considers three levels of data exchange: facility-to-facility (macro-tier), intra-facility (meso-tier), and at the point of care (micro-tier). Focused in developmental-care, the model needs a transformation toward parent-child interaction-driven and institutional support in Children's Centres (CCs). To optimize our model, we use information from multiple sources, devices, and organizations across the development-care continuum.

A short-scaled interoperability model was designed and probed in Colombia. First components of this model include a baseline with previous measurement of developmental outcomes in children of two major geopolitical regions in a middle-low income country ( $n=1177$ ), and the use of a tool administrated by parents to report different items related to sociocognitive milestones. First analysis within a regression model founded 14 variables significant associated with a sociocognitive development index.

Second component is related to results obtained in a specific CC, where developmental screening indicates the effect of intra-facility activities as a positive factor that avoids the loss of development potential that can be expected in uncontrolled environments or institutions, such as those in the first sample ( $t(207)=-2.026$ ,  $p=0.044$ ). Finally, at the point of care, the use of a tool administrated by parents, a compilation of activities to report enhanced development (CARE®), denotes optimal psychometric properties for child development screening (Sensitivity = .80, Specificity = .76, LR+ = 3.8, LR- = .26) and significant changes in the risk indexes for a control group of children (Delayed items: Avr.= 4.5, SD = 3.8) compared with those who used the booklet with their parents or caregivers (Avr.= 1.2, SD = 1.1);  $t(17) = -2.82$ ,  $p = 0.012$ ).

**Key words:** Child development, Cognitive development, Interoperability, Developmental Screening.

## **Introduction**

More than 40% of children under 5-years-old in middle-low income countries are under the risk of not reaching developmental potential for causes associated with poverty and psychosocial deprivation (Black et al., 2016). Also, parents could underestimate just how early children can be affected by interaction and experiences, lacking the first year of life as a fundamental moment for enhancing their children development. The reason for that is probably associated with a low relevance of development as a biological decline more than an increasing process.

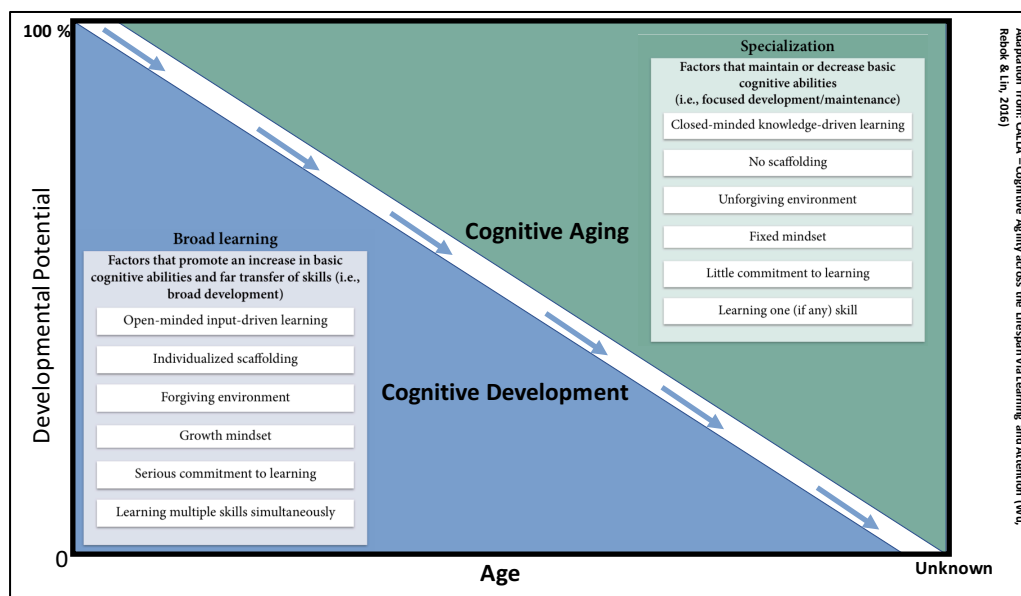
A way to improve the life chances and opportunities of low-income children, families, and communities is described in a model of extinction and interoperability characteristics.

## **Development as an extinction process: the relevance of caregiving**

A chance to avoid different sources of negligence for observation and intervention in early child development is in recognize cognitive development as an evolutive phenomena, like adaptation or extinction. Raup (1986) questioned the common view of extinction as a constructive force and remark the importance of main consideration in biological research, as recently some research shows up (Button et al., 2017). Raup (1986) insist in a view of extinction as a constructive force and remark the importance of consideration in biological research: "Extinction must therefore be important to the total evolutionary process; to ignore it would be as inappropriate as for a population biologist to ignore mortality or a sedimentologist to ignore erosion." (p. 231). In that way, brain development could be considered as an extinction process when, even with the early construction of complex cognitive pathways (Antognini & Daum, 2019), the synaptic overproduction in the newborn child is followed by a synaptic retraction and other decreasing biological functions (Thompson & Nelson, 2001).

Cognitive development follows a similar path in at least six critical factors for broad cognitive development (Figure 1): 1) open-minded input-driven learning, 2) individualized scaffolding, 3) growth mindset, 4) forgiving environment, 5) serious commitment to learning, and 6) learning multiple skills simultaneously (Wu, Rebok & Lin, 2016). These factors may interact with other factors (Wu et al., 2016), such as neural plasticity (Park &

Reuter-Lorenz, 2009) and quality of life (Noice, Noice & Kramer, 2014), turn in a difficult force the extinction and decreasing path in children affected with poor environmental and nurturing contexts, like the children in low income countries and under risk of not reaching developmental potential (Black et al., 2016).



**Figure 1. Cognitive development and aging balance model in Wu, Rebok & Lin (2016)**

A chance to avoid different sources of negligence for observation and intervention in early child development is to recognize cognitive development as mentioned concept: as an evolutive phenomena, like adaptation or extinction. Nevertheless, an issue to prevent with this model is the idea of Spam life cycle model.

The life spam view for development is an unsustainable model for sustainable development. The fundamental assumption of this perspective is to consider that human development occurs throughout the entire life of each individual (Nussbaum & Worthington, 2017). Under that terms, development would be limited to the physiological, biological, psychological and communication changes, relationships and spirituality that occur in the time of each individual and, consider those dimensions, every developmental process is extinction. For Nussbaum and Worthington (2017) the life spam development is best seen as a process of gains and losses, in which no specific period in life has supremacy over another life period (Baltes & Smith, 2003). This perspective, in addition

to being widely spread, has impacted for decades the work on various academic topics, such as the development of personality, intelligence and communication (Baltes, Lindenberger & Staudinger, 1998, Nussbaum, 2013). But to our infortune, there is more losses than gains in an extinction developmental process.

However, and to broaden this perspective, Bornstein et al. (2017) indicates a way to obtain unexpected gains: care and context. Care and context are linked to the cognitions and development of children. For Bornstein et al. (2017) care and context are requirements that should be included in any study of child development, along with all the possible scope of skills and learning during childhood and beyond.

This document do not extends the understanding of development as an extinction process, but indicates how a model of interoperability supported with developmental screening strategies conducted or informed by parents and others caregivers (DSPC) would work effectively using instruments with activities to report and enhance development, in three different levels to obtaining information of daily activities of interaction between parents or caregivers and mitigating the negative consequences of poverty and economic inequality in children with low income and at risk of not reaching their developmental potential.

### **Interoperability applied to Child development monitoring**

Interoperability is a well-known concept in health care systems for data exchange (Haux, 2018; Friedman, Rubin & Sullivan, 2017). An original and basic model of interoperability is into an IT information-transfer context that recognize a specific definition for interoperability (Provonost et al., 2018). Our version considers the same data exchanges' three levels but is focused in developmental-care transformation toward parent-child interaction-driven and institutional support in Children's Centres (CCs): facility-to-facility (macro-tier), intra-facility (meso-tier), and at the point of care (micro-tier). To optimize our model, we use information from multiple sources, devices, and organizations across the development-care continuum, that must be able to flow like original proposal: at the right time, to the right party, for the right child.

The principal process in the micro-tier level, are interactions in the point of care between caregivers and children. Those interactions have been immersed in what other authors call Home Learning Environment (Johnson & Kossykh, 2008; Melhuish et al., 2008b; Melhuish, 2010) and Domestic Environment for development (Biedinger, 2011). Studies of learning environments at home evaluate the quality of daily learning at home through different activities (routines, places, visits) and have been shown to predict cognitive development, linguistic competence and subsequent success child's school (Biedinger, 2011; Johnson & Kossykh, 2008; Melhuish et al., 2008b; Melhuish, 2010).

To our analysis of socio-cognitive development and in the words of Kagan (1999), under the periodic execution of the activities that belong to play or mother-child interactions, it is possible to understand different models of cultural cognitive evolution, including several adaptations from bipedal carrying to a more interactive and mutual child-parent care (Hodges, 2017). These models help us to understand the importance of multiple factors related to parent care and children cognitive development. But modern child-parent care sometimes is far from optimal condition. That is the reason to propose and interoperability model as an evolutionary-social-instrumental strategy to change opportunities of low-income children, families, and communities of children under 5-years-old in middle-low income countries are under risk of not reaching developmental potential for causes associated with poverty and psychosocial deprivation. We have an example of applying interoperability in developmental studies in a LMIC, Colombia.

### **A short-scaled model of interoperability in Colombia**

The first component of this model includes a baseline with the previous measurement of developmental outcomes in children of two major geopolitical regions in a middle-low income country (n=1177) and the use of a tool administrated by parents to report different items related to sociocognitive milestones. First analysis within a regression model founded 14 variables significantly associated with a development index (Table 1), including if the child is a girl, the educational level of the mother, the quality of gestation and give birth process, also attending a kindergarten was associated with better development results, and to perform physical activity outdoors, as well as the parent's perception and practice of autonomy with their children.

**Table 1.**

Variables associated with the Index of Sociocognitive Development (IDSC) of children of under 6 years of age in Cundinamarca and Boyaca, n=1171. (Source: Díaz, 2016).

| Factor in linear regression model associated with IDSC                                       | Effect | p-value | Reliability rank (95%) |       |
|--|--------|---------|------------------------|-------|
|  |        |         | Min                    | Max   |
| (1) Male   | -3.71  | .014    | -6.66                  | -0.77 |
| (2) Caregiver with undergraduate or post graduate formation                                  | 4.66   | .007    | 1.31                   | 8.0   |
| (3) Gives solid food to child before 6 months-old  | -10.48 | .032    | 0.93                   | 20.03 |
| (4) Extended give birth process (>12 hours)  | -4.24  | .014    | -7.63                  | -0.86 |
| (5) Attending an educational or caregiving community home or kindergarten: general question. | 4.25   | .007    | 1.18                   | 7.31  |
| (6) Feeding by someone else  | -5.18  | .001    | -8.31                  | -2.06 |
| (7) Mother's alcohol frequent consumption during gestation                                   | -14.96 | .029    | -28.36                 | -1.56 |
| (8) Father employed during gestation   | 4.06   | .043    | 0.13                   | 7.98  |
| (9) Attending an educational or caregiving community home or kindergarten: private.          | 7.43   | <.001   | 3.76                   | 11.10 |
| (10) Observed counting activity at home: medium  | -6.07  | .001    | -9.60                  | -2.54 |
| (11) Observed counting activity at home: low   | -5.87  | .001    | -9.44                  | -2.30 |
| (12) perform physical activity outdoors with their parents in last seven days                | 4.29   | .001    | 1.70                   | 6.88  |
| (13) Four or more gestational controls   | 7.54   | .022    | 1.10                   | 13.98 |
| (14a) "Children has own opinion, but can't make decisions"                                   | -6.44  | .018    | -11.75                 | 1.13  |
| (14b) "Children has own opinion, but make decisions according to grown moment"               | -8.06  | <.001   | -12.18                 | 3.94  |
| (14c) "Children has not own opinion and can't make decisions"                                | -11.67 | .014    | -21.0                  | 2.35  |

Note: R = 0.20

### Description of the study

The Project "Characterization of individual and family conditions, daily care practices, forms of participation and support networks that favor or limit health care for the comprehensive development of children from 0 to 5 years old in the Sabana-Centro region of Cundinamarca and 5 municipalities of Boyacá", had a cross-sectional design and a representative population sample from two regions of Colombia: 15 municipalities in the Sabana-Centro area of Cundinamarca and five municipalities in Boyacá.

For the design of the operation to obtain information in households, a probabilistic, stratified and conglomerate type sample design was used. The sample was assigned proportionally to the amount of population under 6 years old for each participating

municipality. In each municipality cartographic apples were selected and within these the framework of children under 6 was built to include them all and then select only one per household. The simple random sampling method without replacement was used for the selection of the apples. The rural sample was restricted to the population centers and was assigned proportionally to the population reported according to the National Administrative Department of Statistics of Colombia. The sample was calculated to be representative by region.

The adjustment of the sample and quantitative instruments was carried out jointly with the firm S.E.I. and with a pilot test in the municipality of Facatativá in the month of August 2013. The field operation for the survey and observation of the development was advanced by the firm S.E.I. with supervision of the researchers of the Parejo de la Vida program between November 2013 and February 2014. The observation of the socio-cognitive development was carried out in 1.177 girls and boys.

### Instruments

A structured survey on the characteristics of families and children under 6 was designed, with 9 modules and 158 questions that were answered by the mother or the main caregiver of the child, which were based on the National Survey of Demography and Health - ENDS (Profamilia, 2010) and the Colombian Longitudinal Survey - ELCA. The completion time of the survey was approximately 1 hour.

### *Instruments and methods for the observation of socio-cognitive development.*

After responding to the survey, the interviewer asked the mother about the availability of

the child and their acceptance to participate in the observation of socio-cognitive development. The time for the application of these tests was maximum 1 hour and 30 minutes per child. The Haizea-Llevant developmental observation table for children aged 0 to 36 months, which is a screening or monitoring test derived from the Denver Developmental Screening Test (Frankenburg, 1987; Frankenburg, 1987). Its application continued to maintain the protocol suggested in several studies (Iceta & Yoldi, 2002, Fuentes-Biggi, Fernandez & Alvarez, 1992).

From the 28-month-old group, the monitoring was completed with the observation and application of tasks related to the use of intra-specific representation systems or Core Knowledge Systems (Spelke, 2000). These central or core knowledge systems are described as "mechanisms to represent and reason about certain types of entities and events of ecological importance" (Spelke, 2000, p 1233) present in all infants of the species. There were also tasks related to socio-cognitive development (Callaghan et al., 2011) and five central systems: 1. to represent inanimate objects and their mechanical interactions, 2. agents and their actions directed to goals, 3. sets and their numerical relations of ordering, addition and subtraction, 4. places in a continuous spatial arrangement and their geometric relationships and 5. to identify members who belong to a social group in relation to members of another group and to guide social interactions with members inside and outside the group (Kinzler & Spelke, 2007, page 257).

### *Processing and analysis of information*

A verification and purification of the databases was carried out, as well as a quality control of the data collected. An exploratory analysis of the data was carried out in order to



observe the characteristics and distribution of the data, perform transformations and examine other aspects such as extreme data, inconsistencies and deviations. Subsequently, with the data derived from the information gathered in the surveys and development evaluations, the Stata Program (licensed by the University of La Sabana) processed uni and bivariate descriptive analyzes and indexes were constructed by gathering different variables using the technique of Analysis of Joint Correspondence (Joint), YMCA: socio-economic condition, human capital, risks around housing, nutritional and socio-cognitive development index (IDSC). The latter, the IDSC, was taken as a dependent variable in the analyzes and is a continuous quantitative variable, which can take any value between 1 to 100 and which for the sample had an average score of 49.7 (DS = 18.0; Min. = 4.2; Max. = 96.3).

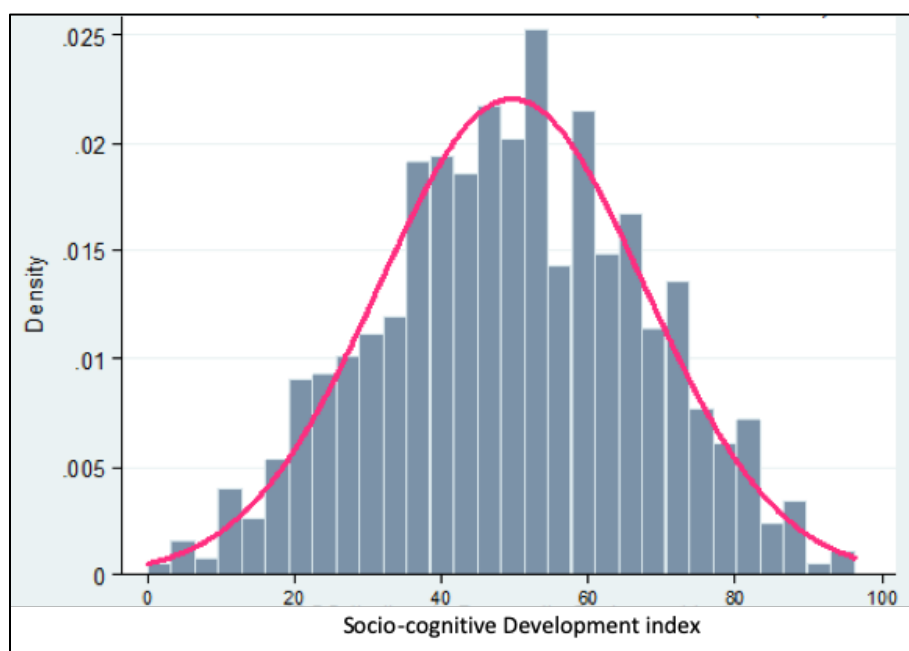
## **Results**

The results focus specifically on the general distribution of the socio-cognitive development index in IPV program, associated with other 14 variables and obtained model by multiple regression ( $F(37, 229) = 26.27, p < .0001, R^2 = .15$ ) mentioned before, that indicates a difference between those who perform or not those activities of up to 7.5 points of difference in the IDSC.

### *General distribution of the IDSC.*

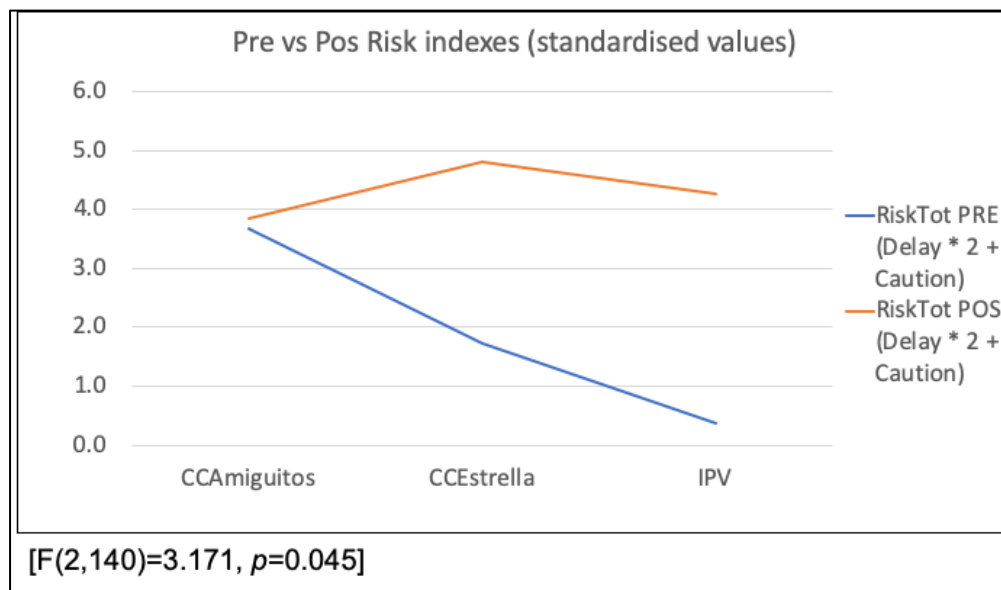
The analysis of the general results shows that on average 49.6% of the skills and behaviors expected in relation to socio-cognitive development are observed. However, this same general analysis indicates that 80% of the participating children do not reach

more than 65% of the abilities and behaviors expected in relation to the socio-cognitive development corresponding to the age of the participants (Figure 2). The technical reports presented in various studies that use the instruments from which the information collection tools are derived for the results obtained (Iceta & Yoldi, 2002; Fuentes-Biggi, Fernandez & Alvarez, 1992), indicate that 80%, more than 900 children and girls in the sample, could be at risk to take advantage of their full potential for development.



**Figure 2. General distribution of the socio-cognitive development index in the IPV participants (n = 1177).**

After the regional study, the second component is related to results obtained in a specific CC, where developmental screening indicates the effect of intra-facility activities as a positive factor that avoids the loss of development potential that can be expected in uncontrolled environments or institutions (Figure 3), such as those in the first sample ( $t(207)=-2.026, p=0.044$ ). This particular finding demonstrates a relationship between the cognitive and social development of preschool children with the quality of care and the interventions that are carried out in high quality institutions when these are measured with suitable instruments (Brunsek et al., 2017).



**Figure 3. The effects of using CARE® for Delayed, Caution and Risk (#Delayed items\*2 + #Caution items) indexes of H-LI in two CC (n=27) and IPV sample (n=117).**

Finally, at the point of care, the use of a tool administrated by parents, a compilation of activities to report enhanced development (CARE®). CARE® is a Developmental Screening (DS) tool. DS is a method frequently used by parents, caregivers or professionals to identify and detect risk indicators of delay in typical development (Ringwalt, 2008). DS allows professionals in health and social disciplines to follow positive aspects of children, as developmental milestones, but is more frequently used to find developmental delay associated with pathologies such as autism spectrum disorders (ASD), Rett syndrome, fragile X syndrome, Williams syndrome, among others clinical issues (Halla, Pruckner & Schober, 2016).

A problem derived from that preferential use for DS is for children qualified as not-at-risk in typical development observations, but living in contexts where still persist social and psychological conditions that affect their individual development, like poverty, negligence or maltreatment, which can affect high school qualifications, or other cognitive and social goals (Grantham-McGregor et al., 2007). These children, even with specific medical and biological factors maintaining that risk, like low birth weight or neonatal central nervous system infections, does not receive early intervention in health systems nor government or community programs (Doyle et al., 2014). Also, parents could underestimate just how

early children can be affected by interaction and experiences, lacking the first year of life as a fundamental moment for enhancing their children development.

Walker et al. (2011) model includes two dimensions in Nurturing Care that might be used and transformed for a better effect in enhancing development: Responsive Caregiving and Early Learning. Responsive Caregiving is related to caregiver nurturance, routines with emotional and cognitive support and Early Learning is related to home opportunities for explore and learn through play and different materials like books or toys. However, insufficient scientific rationale for early intervention (Daelmans et al., 2015) and a clear distortion of children in needs conditions (Morgan, Farkas, Hillemeier & Maczuga, 2012) demand more information and analysis into caregiving routines and home opportunities for exploring and learning. Developmental screening using parents' reports could be a valid option to get than information.

CARE® denotes optimal psychometric properties for child development screening (Sensitivity = .80, Specificity = .76, LR + = 3.8, LR- = .26) and significant changes in the risk indexes for a control group of children (Delayed items: Avr.= 4.5 , SD = 3.8) compared with those who used the booklet with their parents or caregivers (Avr.= 1.2, SD = 1.1);  $t(17) = - 2.82, p = 0.012$ ).

### **A promise for the future in commons knowledge and a solution to stop extinction process: sustainable cognitive development**

The data we offer indicate two possible ways into one framework of evolutionary extinction process: One for a new structure of care and another as an alternative, within Scarcity's studies or Psychology of scarcity reported in other topics related to poverty and their effects on behavior (Camerer et al., 2018; Shah, Mullainathan & Shafir, 2012; Shah, Mullainathan & Shafir, 2018; Shah, Shafir & Mullainathan, 2015).

Within the framework of the evolutionary structure of care, is necessary to transcend any survival and collective agreements 'care for the enhanced individual development. A definitive way is monitoring the domestic educational activities and the interactions

between caregivers and children in the everyday, recognized as an indispensable source of information and socio-cognitive transformation, which is as important as the sociodemographic factors that can characterize parents and caregivers in this region and in other previous international results (Allen, 2011).

The evidence gathered in the IPV Program allows us to affirm that daily reading, play, painting and sports activities among others, which constitute contingencies that allow, within an integral framework of care, to obtain the greatest potential of individual development in the children, we do not appreciate enough to expect changes in the general situation of socio-cognitive development that compromises more than 65% of the expected abilities in the ages of the study participants in question. That would be the basis for the definitive exile of inequalities unfair and protected by social negligence, which can be more lethal and persistent than any individual or collective condition. Paraphrasing Darwin, great would be our sin if we maintain structural care and we ignore functional and contingent care, especially, by not recognizing it and by not transforming it into something more social than natural and therefore modifiable.

In addition to the above, an alternative hypothesis related to the effects of a psychology of scarcity is possible (Camerer et al., 2018; Shah, Mullainathan & Shafir, 2012; Shah, Mullainathan & Shafir, 2018; Shah, Shafir & Mullainathan, 2015). The psychological effect of scarcity can be manifested as a kind of negligence individual and collective, when for our case, the frequency of interactions between a caregiver and their child are limited and reduced because they might be not considered relevant for child development. For example, do not read stories with a one-year-old child because he does not read. Although the approach is logical, any parent or caregiver who does not have the

mechanism of active scarcity on early interactions, will spend time with a child who does not read (by age or any other condition) regardless of the limitations that this reasoning imposes. In this sense, once the cognitive mechanism of scarcity is activated or imposed, for the caregiver the broad spectrum of importance decreases for many events and interactions that can affect development in a positive way and what for our case, is attributed to basic processes of daily life with children under six years of age. These basic daily processes include social interactions, spontaneous exploration of the environment, play and self-directed mobility, among many others, as essential situations for children's lives and fundamental for their neurological and communicative development (Adolfsson, 2011). Therefore, it is urgent, within the framework of daily life, to explore all the skills and activities that may be leaving aside mothers, fathers and caregivers in general of boys and girls at an early age. The environments and activities in which they can manipulate objects, to explore their social, emotional and cognitive world daily, is done in a general way through the parental interactions and with their primary caregivers (Fay-Stammbach, Hawes and Meredith, 2014), but many of them are restricted according to environmental and cognitive characteristics, such as the scarcity mechanism.

Early interventions in childhood and before six years of age can transform the disadvantages of children who develop in unfavorable environments (Gardner, Walker, Powell & Grantham-McGregor, 2003, Gertler et al., 2014; Grantham-McGregor et al., 2007), even in conditions of extreme limitation and with the help of precise strategies on skills that favor parental sensitivity for development (Hackworth et al, 2017, Murray et al., 2016).

In conclusion, each home is the key to positively or negatively affect the development of children under 6 years of age. Hospitals, gardens and nursery schools can do a good

job, but their effect is almost marginal when compared to what could happen daily, in the daily lives of children. However, these desirable interactions do not occur in the homes of more than half of the boys and girls in certain age groups at LMIC. Our model intends to explore and indicates an alternative to keep searching, understanding and applying all our commons resources for sustainable cognitive development for all.

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