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Mediating role of poverty in the association between environmental factors and cognitive performance in preschoolers

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Artículo Original

Abstract

The association between environmental factors and cognitive performance during childhood could be mediated by poverty (i.e., households with Unsatisfied or Satisfied Basic Needs). This study explored such mediating roles in preschoolers from different socioeconomic backgrounds. Tasks to assess executive attention, working memory, inhibitory control, planning, and fluid reasoning were administered to 250 children aged 4 and 5 years. The results suggested that poverty mediated the effects of family composition, child health, health risk factors, children and adults at home, maternal age, and literacy activities on the performance of executive attention, fluid reasoning, and inhibitory control. These results contribute to our understanding of the relationship between environmental factors and cognitive development through the identification of the mediating role of poverty.

Keywords: poverty, environmental factors, mediation, cognitive development, preschoolers.

Resumen

El rol mediador de la pobreza en la asociación entre factores ambientales y el desempeño cognitivo de preescolares.
La asociación entre los factores ambientales y el desempeño cognitivo durante la infancia podría estar mediada por la pertenencia a hogares pobres (i.e., hogares con necesidades básicas insatisfechas o satisfechas). Este estudio exploró tal mediación en preescolares de diferentes contextos socioeconómicos. Para tal fin, se administraron tareas que demandaron atención ejecutiva, memoria de trabajo, control inhibitorio, planificación y razonamiento fluido a 250 niños/as de 4 y 5 años. Los resultados sugirieron que la pobreza medió los efectos de la composición familiar, la salud infantil, los factores de riesgo para la salud, cantidad de niños/as y adultos en el hogar, la edad materna y las actividades de alfabetización sobre la atención ejecutiva, el razonamiento fluido y el control inhibitorio. Estos resultados contribuyen a la comprensión de la relación entre los factores ambientales y el desarrollo cognitivo a través de la identificación de la pobreza como variable mediadora.

Palabras clave: pobreza, factores ambientales, mediación, desempeño cognitivo, preescolares.

Tabla de Contenido

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Introduction

Cognitive development and poverty during childhood are complex phenomena that involve biological and psychosocial components (Bradley & Corwyn, 2002; Hackman, Farah, & Meany, 2010; Segretin et al., 2016). Although several environmental factors (e.g., maternal age, literacy activities) could influence basic cognitive functions (Sameroff, 1998; Zauche, Thul, Mahoney, & Stapel-Wax, 2016), the effects of some of them could vary according to whether the person lives in a poor home or not (Bradley & Corwyn, 2002; Sarsour et al., 2011). The literature has explored

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two main proposals: (a) one that analyzes how poverty impacts child cognitive development (Johnson, Riis, & Noble, 2016; Kishiyama, Boyce, Jimenez, Perry, & Knight, 2009; Segretin et al., 2016; Stevens, Lauinger, & Neville, 2009; Yoshikawa, Aber, & Beardslee, 2012); and (b) another that shows how environmental variables (e.g., health variables) affect cognition (Hackman et al., 2010; Rao et al., 2010; Ursache & Noble, 2016).

In general, these studies are based on associations between two variables. For example, a vast amount of literature indicates that growing in a poor home can modulate children's academic outcomes and the emergence and development of different aspects of cognition and emotional behavior (Blair & Raver, 2016; Brooks-Gunn & Duncan, 1997; Dickerson & Popli, 2016; Luby et al., 2013). In addition, other studies documented the association between environmental factors (e.g., maternal stress, literacy activities) and cognition. Most of them have shown only direct associations between those variables (Finegood, Raver, DeJoseph, & Blair, 2017; Rhoades, Greenberg, Lanza, & Blair, 2011; Sharkins, Leger, & Ernest, 2016). However, these studies contrast with reality, where these relationships (poverty, environment, and cognition) are the result of the interaction of a large number of variables (Bradley & Corwyn, 2002; Bronfenbrenner, 1992; Lipina & Colombo, 2009).

On the other hand, vast literature about mediation analysis attempts to explain in a more comprehensive way the complex interactions among poverty, environmental factors (other than poverty factors), and cognitive development. In general, these studies are focused on how poverty affects cognition and analyzes how this effect is mediated by other factors (Lipina et al., 2013; Rubio-Codina, Attanasio, & Grantham-McGregor, 2016). The most frequently analyzed mediating mechanisms are (a) physical health and nutrition of children, (b) type and quality of interactions between parents and children, (c) parental mental health, (d) possibilities/opportunities for affective and cognitive stimulation at home, and (e) material, health, educational, and institutional resources of the neighborhoods (Guo & Mullan Harris, 2000; Hackman et al., 2010; Sarsour et al., 2011; Sulik et al., 2015). In short, although various studies have introduced environmental factors as mediators of poverty effects on cognition (Blair et al., 2011; Noble, McCandliss, & Farah, 2007), less is known about the opposite relationship: how poverty mediates the effects of environmental factors on cognition (Ronfani et al., 2015).

In such a context of analysis, we focused on self-regulation processes. Self-regulation is a multidimensional and complex construct that involves a set of cognitive and emotional processes occurring at different levels of organization implicated in the regulation of thoughts, emotions, and actions, and aimed at adaptation to several circumstances in everyday life (Bell & Deater-Deckard, 2007; Hofmann, Schmeichel, & Baddeley, 2012; McClelland, Ponitz, Messersmith, & Tominey, 2010; Montroy, Bowles, Skibbe, McClelland, & Morrison, 2016; Nigg, 2017).

Specifically, we analyzed executive attention, inhibitory control, working memory, and planning processes, which are fundamental to cognitive activity and social behavior throughout life (Moffitt et al., 2011; Posner, Rothbart, & Tang, 2013). Particularly, executive attention is strongly activated in situations that entail attentional control, such as when there is conflict between responses suggested by stimulus dimensions (Posner & Raichle, 1998; Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005). Inhibitory control involves the ability to control attention, behavior, thoughts, emotions, and/or external stimuli to suppress strong predispositions to act and allow more appropriate responses (Diamond, 2013). Working memory is the ability to maintain and manipulate online relevant information to perform a task (Diamond, 2013; Schelble, Therriault, & Miller, 2012; Sdoia, Di Nocera, & Ferlazzo, 2019). It makes it possible to retain a limited amount of information to generate possible solutions, while it is no longer perceptually present (Baddeley & Hitch, 1994; Bergman Nutley et al., 2011; D'Esposito & Postle, 2015; Smith & Jonides, 1999). Finally, planning can be defined as the ability to solve a problem by creating a strategy and an action plan that consist in executing and evaluating different steps (Debelak, Egle, Köstering, & Kaller, 2016; Shallice, 1982). Particularly, the importance of such competencies is that they are part of everyday behavior, and they are essential in the regulation of complex behaviors and the acquisition of early school learning (Bull & Lee, 2014; Diamond, 2013; Garon, Bryson, & Smith, 2008; Rothbart, Sheese,

& Posner, 2008). We focused on preschool children because the early development of these cognitive processes could be susceptible to environmental influences, such as home and school experiences (Lipina et al., 2013; Rao et al., 2010; Ursache, Blair, & Raver, 2012; Vernon-Feagans, Willoughby, & Garrett-Peters, 2016).

Fluid reasoning is a complex human ability related to solving new problems independently of the knowledge previously acquired (Jaeggi, Buschkuehl, Jonides, & Perrig, 2008). It is critical for solving different cognitive tasks and for adapting thinking to new situations. In addition, this skill is also involved in daily activities during child development and, specifically, in educational success (Green, Bunge, Chiongbian, Barrow, & Ferrer, 2017).

In this context, the research questions that guided this study were (1) does poverty mediate the association among environmental factors and the performance of cognitive processes? and, (2) does this mediation vary with each process?

It is important to highlight that one way to characterize poverty is the Unsatisfied/Satisfied Basic Needs (UBN/SBN) approach introduced in the 1980s by Economic Commission for Latin America and the Caribbean (CEPAL). It allows the identification of the structural causes of poverty (Minujin, 1992). Although this method determines whether a list of basic needs for a dignified life are satisfied in the households, it is not clear how this factor is related to other environmental variables (Martínez & Nicolini, 2017). Therefore, to answer these questions, the present study proposed to analyze poor homes (in terms of UBN or SBN) as a mediator in the associations between environmental factors and cognitive performance in a sample of preschoolers in the city of Buenos Aires.

Out hypotheses were as follows: (1) poverty will mediate the associations between attention, inhibitory control, working memory, planning, and fluid reasoning and specific environmental factors (i.e., family composition, reception of social benefits, child health, health risk factors, children and adults at home, maternal age, years of preschool attendance, literacy activities, and access to computer resources) (e.g., Ronfani et al., 2015); (2) different patterns of mediation will be identified based on cognitive processes and environmental factors (Hackman, Gallop, Evans, & Farah, 2015; Lawson et al., 2014; Lipina et al., 2013); and (3) cognitive differences will be based on socioeconomic disparities (Fracchia et al., 2016; Segretin et al., 2014, 2016).

Methods

Participants

Two-hundred and fifty healthy Argentinean children (134 girls; 116 boys) aged 4-5 years (M = 4.87, SD = 0.59) were recruited from three schools in the City of Buenos Aires in 2009. Informed consent was obtained from parents/caregivers, and ethical approval was obtained from the CEMIC ethical review committee (Protocol N° 320). The study was conducted in accordance with APA's ethical standards and international and national children's rights laws.

Study design and procedures

A cross-sectional study was implemented to evaluate the associations among poverty, environmental factors, and cognitive performance. No atypical cases were identified, and therefore the entire sample was considered. In addition, missing cases were charged when they were less than 20% in each task.

Cognitive measures

Children were assessed with a set of tasks administered by examiners (psychologists, or psychology or psychopedagogy students), in two sessions of about 40 min each, in a quiet school room conditioned for this purpose. The order of the sessions was the same for all participating children. Examiners were blind to the objectives of the study and the composition of the groups. We had no psychometric information about the tasks used to assess the children's cognitive performance. These tasks were as follows:

Attention Network Test (ANT). The computerized version for children was used to assess different aspects of attention processing (Rueda et al., 2004). In each trial, children pressed a right or left button depending on the direction an animal was facing on the computer screen. Total efficiency (i.e., the proportion of correct responses to the total administered) was the dependent variable of interest.

Stroop-like Heart-Flower. This computerized task was designed to evaluate inhibitory control and cognitive flexibility processes (Davidson, Amso, Cruess Anderson, & Diamond, 2006). It consisted in presenting three contingencies of stimuli: (a) *congruent:* children were asked to

press the button on the same side in which a heart appeared; (B) *incongruent:* children were asked to press the button on the opposite side of a flower; (C) *mixed:* congruent and incongruent stimuli were combined randomly. The efficiency of the mixed condition (i.e., the proportion of correct responses to the mixed condition administered) was the dependent variable of interest.

Self-ordered searching. This is a computerized test used to evaluate the spatial working memory of objects (Luciana & Nelson, 2002). The purpose was to select all the pictures of objects, one at a time; each time an object was selected, the others disappeared from the screen and reappeared, but in a different order. Four blocks were administered, two of six and two of eight items. The dependent variable considered was a composite variable generated from the sum of scores that corresponded to blocks 1 and 4.

Corsi Block task. This was used to assess visuo-spatial working memory (Berch, Krikorian, & Huha, 1998; Huang, Klein, & Leung, 2016). During administration, the child was asked to reproduce a sequence of lights (from one to eight, lighting time 1000 ms), which were turned on inside a series of boxes arranged randomly in the device. Difficulty levels increased with the number of lights. The dependent variable of interest was the total score, which was computed as the sum of correct responses multiplied by the level of difficulty.

Tower of London (TOL). This was used to assess planning (Berg & Byrd, 2002; Shallice, 1982). In each trial, the children were required to reach a goal configuration of three colored balls from an initial configuration, following a set of rules, and they were asked to generate the appropriate action sequence to reach the configuration model. Difficulty levels included exercises with 1 to 9 movements. The dependent variable was the total score, computed as the sum of correct responses multiplied by the level of difficulty.

Kaufman Brief Intelligence Test (K-BITM). The matrices subscale was administered to obtain an overall measure of fluid reasoning performance (Kaufman & Kaufman, 1990). The dependent variable analyzed was the total score, computed as the sum of correct answers.

Environmental factors

Individual interviews were conducted during the school year in a private room with parents or legal caregivers to obtain information from the home environments. In this context, we administered a socioeconomic background scale (NES) (Lipina, Martelli, Vuelta, & Colombo, 2005; Segretin et al., 2014) to identify indicators of UBN (Boltvinik, 1995) and other individual and environmental factors associated with children's daily life experiences. In addition, all the information was validated with the school records about the family´s environmental characteristics, which were available in the kindergartens.

Based on the literature in this area (Bradley & Corwyn, 2002; Hackman et al., 2010; Lipina et al., 2013), we selected a set of variables from the scale to evaluate each household: family composition (in relation with the presence of both parents, single parent or other caregivers at home), reception of social benefits (number of benefits), child health (number of child health records, including low weight at birth, preterm birth, neurological disorders, perinatal disorders), health risk factors (number of peri-, pre-, and postnatal risk factors for child heath), children at home (number of children under 14 years of age living at home), adults at home (number of adults living at home), maternal age, years of preschool attendance (number of years that the child was previously enrolled at school or in a childcare institution), literacy activities (a composite variable was created based on the number of books available at home and the frequency of book reading to the children), and computer resources (a composite variable was created based on whether a computer and internet connection were available in the household). UBN criteria are based on the identification of at least one of the following conditions: (a) inappropriate dwelling conditions (precarious houses that were not intended for housing purposes), (b) absence of waste discharge systems in the household, or (c) overcrowding conditions (three or more people sleeping in one bedroom). Based on this information, two groups of children were generated: UBN homes and SBN homes.

Data analysis

Standard descriptive analysis and correlation analysis for each independent variable were performed to identify associations, from the set of 10 environmental variables. Before running mediation analysis, two composites were generated based on a previous approach: (1)

literacy activities, generated by averaging the z scores of the variables *amount of books* at *home*, and *frequency of book reading to children*; and (2) *computer resources*, generated by averaging the z scores of the variables *computer use and internet use*. To compare differences between socioeconomic groups in the independent variables, univariate analysis and Mann-Whitney U test (if appropriate) were used.

Univariate analysis of variance was implemented to compare performance among children from UBN and SBN homes. The fulfillment of assumptions of normality, homoscedasticity, and independence were previously verified. In cases where non-compliance with one or more of these assumptions was detected, quadratic or trigonometric transformations were applied, as appropriate. In the univariate variance models, poverty (UBN/SBN) was included as an independent variable, performance in cognitive tasks and environmental factors were dependent variables, and age was a covariable.

First, a correlation analysis was implemented to identify associations between dependent variables. Then, each dependent variable was analyzed separately to identify significant mediators. Before the inclusion of each dependent variable in the mediation analysis, their scores were transformed into z-scores, to obtain a common metric for comparisons across tasks. For each task, only one dependent variable was included in the analyses (see Cognitive measures).

Finally, Sobel-Goodman mediation tests were implemented, which included poverty as a mediator variable, each environmental factor as an independent variable, and cognitive performance as the dependent variable (Figure 1). In this paper, we considered a full mediation when there was an indirect effect, but no direct effect. When there were both indirect and direct effects, we considered it a partial mediation (Baron & Kenny, 1986; Zhao, Lynch, & Chen, 2010).

All analyses were adjusted for age. For the number of comparisons (n = 10), the Bonferroni correction was used for a significance level of .05 (the final value of p was .005).

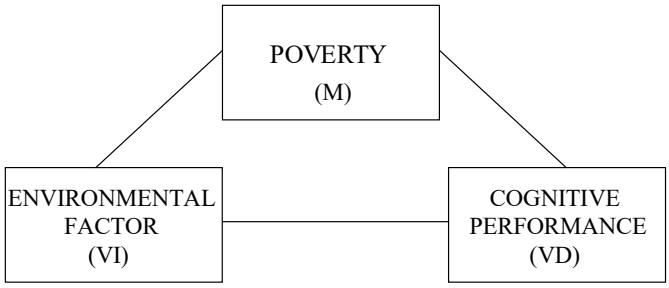

Figure 1. Diagram of mediation analysis model that tests the mediating effect of poverty on the relationship between environmental factors and cognitive processes.

Results

Independent variables

The correlation analysis between the independent variables and poverty resulted in low and non-significant associations between them, except for the association between literacy activities and poverty, where the association was moderate (Table 1).

Dependent variables

Results from the correlation analysis between the dependent variables showed non-significant associations, except for the relation among executive attention and inhibitory control, where the association was moderate (Table 2).

Socioeconomic condition

The results of the univariate analysis regarding the environmental conditions indicated some significant differences between children from UBN and SBN homes. In particular, families from

UBN homes had more *adults at home* (*z = -2.25; p = .025*). Children from SBN conditions were more likely to be in the *care of a single person* (*z = -2.17; p = .030*). Children from UBN homes had more *child health* (*z = -4.85; p = .000*) and *health risk factors* (*z = -5.95; p = .000*). In addition, in comparison to children from the SBN group, the children from the UBN group yielded the following findings: (a) almost one more year of *preschool attendance* (z = -1.91; p = .056); (b) fewer *books at home* and *lower frequency of book reading* to children (z = -7.87; p = .000); (d) lower frequency of *computer* and *internet use* (z = -7.13; p = .000); and (e) *younger mothers* (f = 5.28; p = .023). There were no significant differences in the other variables analyzed (Table 3).

As expected, comparisons between BN groups showed that the UBN group obtained significantly lower efficacy levels and scores in

most variables analyzed: executive attention, visuo-spatial working memory, inhibitory control, planning, and fluid reasoning. The SBN group obtained significantly lower efficacy in object spatial working memory (Table 4).

Table 1.
Spearman correlation analysis between the independent variables (environmental factors) and the mediator (poverty) of children coming from different socioeconomic contexts in Buenos Aires, Argentina.

	Poverty	FC	NB	CH	HRF	NC	NA	MA	YPA	LA
Family composition (FC)	.15*									
Number of benefits (NB)	.09	-.08								
Child health (CH)	.34***	-.06	.48***							
Health risks factors (HRF)	.41***	.02	.52***	.59***						
Number of children under 14 (NC)	.12	-.20**	.61***	.48***	.49***					
Number of adults (NA)	.16*	-.21**	.40***	.41***	.46***	.59***				
Maternal age (MA)	-.15*	.23***	-.27***	-.27***	-.30***	-.35***	-.37***			
Years of preschool attendance (YPA)	-.14	-.03	.34***	.23***	.19**	.31***	.24***	-.03		
Literacy activities (LA)	-.56***	-.02	-.33***	-.47***	-.44***	-.32***	-.27***	.32***	-.07	
Computer resources (CR)	-.51***	.07	-.16*	-.33***	-.30***	-.20**	-.26***	.22***	.15*	.51***

Note. *p < .05; **p < .01; ***p < .001

Table 2.
Pearson correlation analysis between the dependent variables (cognitive performance) of children coming from different socioeconomic contexts in Buenos Aires, Argentina.

	Inhibitory control	Planning	Working memory	Fluid reasoning
Planning	.38***			
Working memory	.33***	.13*		
Fluid reasoning	.39***	.29***	.23***	
Executive attention	.56***	.44***	.33***	.38***

Note. *p < .05; ***p < .001

Table 3.
Differences between socioeconomic groups (SBN/UBN) in the independent variables (environmental factors) of preschoolers from Buenos Aires, Argentina.

Variables	*n*	SBN	UBN	*Z*	Sig
		Mdn	*Mdn*		
Number of adults at home	200	5	6	-2.25	**.025**
Family composition	206	1	1	-2.17	**.030**
Child health records	201	3	3	-4.85	**.000**
Health risk factors	207	2	3	-5.95	**.000**
Years of preschool attendance	198	3	3	-1.91	**.056**
Literacy activities	199	2	1	-7.87	**.000**
Computer resources	197	3	1	-7.13	**.000**
Number of children under 14 at home	200	5	5	-1.69	.091
Number of public benefits	205	1	1	-1.33	.181
		M (SD)	*M (SD)*	*F*	Sig
Maternal age	204	35.15 (6.44)	33.16 (5.83)	5.284	**.023**

Note. The significant scores are highlighted in bold.

Table 4.
Comparison of dependent variables (cognitive performance) in preschoolers from two different socioeconomic groups in Buenos Aires, Argentina.

Task	Dependent Variable	SBN		UBN		*df*	*F*	Sig
		n	*M(SD)*	*n*	*M(SD)*			
ANT	Total efficiency	147	0.22 (0.88)	98	-0.33 (1.07)	1.245	23.80	**.000**
Stroop	Efficiency mixed condition	144	0.17 (0.99)	98	-0.26 (0.96)	1.242	13.31	**.000**
Self-ordered	Proportion of corrects answers	147	-0.14 (0.81)	98	0.20 (0.82)	1.245	10.01	**.002**
Corsi	Total score	147	0.21 (1.08)	98	-0.31 (0.76)	1.245	18.58	**.000**
TOL	Total score	147	0.14 (0.99)	98	-0.20 (0.98)	1.245	8.38	**.004**
K-BITM	Total score	147	0.24 (0.96)	98	-0.37 (0.95)	1.245	26.32	**.000**

Note. SBN: Satisfied Basic Needs; UBN: Unsatisfied Basic Needs. All analyses were adjusted for age. The significant scores are highlighted in bold.

Mediation analysis

According to the criteria to determine a total or partial mediation, results from the Sobel-Goodman test showed the following results.

Total mediation.

(a) *The effects of maternal age on executive attention and fluid reasoning were totally mediated by poverty*; (b) *the effects of children at home and adults at home on executive attention were largely mediated by poverty* (Table 5).

Partial mediation.

(a) The effects of *family composition on executive attention, fluid reasoning, and inhibitory control* were partially mediated by poverty; (b) the effects of *health risk factors on executive attention and fluid reasoning* were partially mediated by poverty; (c) the effects of *literacy activities on executive attention* and *fluid reasoning* were partially mediated by poverty; (d) the effects of *child health, children at home*, and *adults at home*

on *fluid reasoning* were partially mediated by poverty (Table 6).

Table 5.
Mediation model with dependent variables (cognitive performances) regressed on mediator (poverty) and independent variables (environmental factors) for total mediation for preschoolers from two different socioeconomic groups in Argentina.

Environmental variable (IV)	Cognitive domain (DV)	Path a			Path b			Path c			Effect		%M
		Coef.	SE	Sig.	Coef.	SE	Sig.	Coef.	SE	Sig.	Indirect	Direct	
Maternal age	Executive attention	-.013	.006	.019	-.443	.122	.000	.021	.010	.037	.047	.124	0.280
Maternal age	Fluid intelligence	-.013	.006	.019	-.525	.133	.000	.024	.011	.027	.043	.102	0.284
Number of children under 14	Executive attention	.055	.018	.003	-.454	.130	.001	-.062	.034	.068	.021	.270	0.402
Number of adults	Executive attention	.054	.020	.008	-.452	.130	.001	-.073	.038	.051	.033	.185	0.331

Note. DV: Dependent variable; IV: Independent variable; MV: Mediator variable; %M: Proportion of total effect that is mediated. Analysis was adjusted for age and gender.

Table 6.
Mediation model with dependent variables (cognitive performances) regressed on mediator (poverty) and independent variables (environmental factors) for partial mediation for preschoolers from two different socioeconomic groups in Argentina.

Environmental variable (IV)	Cognitive domain (DV)	Path a			Path b			Path c			Effect		%M
		Coef.	SE	Sig.	Coef.	SE	Sig.	Coef.	SE	Sig.	Indirect	Direct	
Family composition	Executive attention	-.150	.037	.000	-.429	.128	.001	.237	.070	.001	.010	.014	0.272
Family composition	Fluid reasoning	-.150	.037	.000	-.455	.134	.001	.267	.073	.000	.009	.007	0.256
Family composition	Inhibitory control	-.149	.038	.000	-.266	.128	.039	.213	.070	.002	.066	.014	0.185
Health risk factors	Executive attention	.194	.028	.000	-.361	.136	.009	-.204	.056	.000	.013	.027	0.343
Health risk factors	Fluid reasoning	.194	.028	.000	-.375	.144	.010	-.259	.059	.000	.014	.003	0.281
Literacy activities	Executive attention	-.314	.033	.000	-.310	.154	.045	.271	.0272	.000	.048	.043	0.360
Literacy activities	Fluid reasoning	-.314	.033	.000	-.295	.159	.064	.362	.073	.000	.067	.002	0.256
Child health	Fluid reasoning	.163	.030	.000	-.330	.136	.016	-.299	.059	.000	.027	.000	0.180
Number of children under 14	Fluid reasoning	.055	.178	.002	-.483	.133	.000	-.134	.035	.000	.019	.001	0.193
Number of adults	Fluid reasoning	.054	.020	.008	-.479	.131	.000	-.172	.038	.000	.030	.000	0.150

Note. DV: Dependent variable; IV: Independent variable; %M: Proportion of total effect that is mediated. Analysis was adjusted for age and gender.

Discusión

The literature has traditionally analyzed the relation between poverty, environmental factors, and cognitive development, and the studies tend to focus on the direct associations between them (Blair, Ursache, Greenberg, Vernon-Feagans, & The Family Life Project Investigators, 2015; Raghubar, Barnes, & Hecht, 2010; Ursache, Noble, & Blair, 2015; Weiland & Yoshikawa, 2013). More recently, other studies have explored how these associations are mediated by environmental factors (Hackman et al., 2015; Liberzon et al., 2015; Luby et al., 2013). Using such an approach, we analyzed the contribution of poverty to the association between specific environmental factors and cognitive skills. We identified the specific mediating role of poor and non-poor homes in the association between environmental factors – family composition, maternal age, health risk factors, child health, literacy activities, children and adults at home – and executive attention, inhibitory control, and fluid reasoning.

First, the results of this study show that children from poor homes had lower performance in tasks that demanded the identification of stimuli from the environment, flexibility to look for different sources of information to solve tasks where contingencies changed, interference control, and generation of sequences of actions to solve the tasks. These results add evidence to the literature on childhood poverty and cognition studies about the differences in the performance of children from different socioeconomic backgrounds (Bradley & Corwyn, 2002; Farah et al., 2006, 2008; Hackman & Farah, 2009; Lipina & Colombo, 2009; Yoshikawa et al., 2012).

Second, in agreement with previous results (Fracchia et al., 2016; Lipina et al., 2005, 2013; Lipina & Colombo, 2009; Segretin et al., 2014, 2016), we identified significant differences in several environmental factors between socioeconomic groups. Specifically, families from the poverty group were exposed to more adults at home, younger mothers, a higher number of child health and health risk factors, a tendency to have more than one caregiver, almost one more year of preschool attendance, fewer books at home, lower frequency of book reading to children, and lower frequency of computer and internet use.

The results of our mediation analysis suggested that depending on the environmental factor analyzed, the proportion of poverty mediation varied from .15 to .40. For total mediation, the relation of the *maternal age* variable on the *executive attention* and *fluid reasoning* competencies was mediated largely by poverty. Several studies have indicated the association between maternal age and childhood cognitive and behavioral outcomes (Fall et al., 2015; Fergusson & Lynskey, 1993). However, our results suggested that whether a child lived in a poor home or not determined the correlation of this environmental factor on the child's performance.

Also, poverty mediated the effects of *children* and *adults at home on executive attention* processes. This means that these relationships were fully explained by poverty or non-poverty backgrounds. Some evidence suggests that the number of people at home (whether children or adults) resulted in a lack of personal space or privacy and enforced intimate proximity to household members with communicable diseases and that the potentially excessive social or external demands could have harmful effects on cognition (Goux & Maurin, 2005; Leventhal & Newman, 2010).

The results of partial mediation analyses showed that the associations between *family composition* and performance in *executive attention, fluid reasoning, and inhibitory control* varied according to the socioeconomic backgrounds. Previous studies have indicated that children who lived with both parents had higher cognitive performance (e.g., Sarsour et al., 2011). However, the fact that this relationship varied according to poverty implied that beyond the direct effect of having one or both parents at home on *executive attention, fluid reasoning,* and *inhibitory control*, a large proportion of the association of this environmental factor depended on the socioeconomic conditions of the households. Hence, the effect of such a factor in the case of children living in poverty was different from those who lived in non-poor homes.

Likewise, the variable *health risk factors* affected children's performance in *executive attention* and *fluid reasoning* tasks, and this relation was mediated by poverty. In accordance with our results, the literature showed that the presence of health risk factors in childhood was associated with impacts on cognitive development (Lengua et al., 2015; Weitzman, 2007). Nevertheless, the fact that poverty was a mediator

implies that beyond the direct effect that health risk factors have on cognitive competences, their presence or absence influences children from poor homes and children from non-poor homes in different ways.

Literacy activities were associated with *executive attention* and *fluid reasoning*, and this association was mediated by poverty. Kegel and Bus (2014) suggested that children who had more literacy stimuli in their homes had higher cognitive performance. However, our results suggested that literacy activities do not have an identical effect on poor and non-poor contexts, beyond the direct relation that literacy activities have *on executive attention* and *fluid reasoning*.

Finally, the variables *child health* and *children* and *adults at home* were associated with *fluid reasoning,* and this relationship varied according to poverty.

These results showed that the environmental factors that we analyzed had different types of relationships when they were present in both UBN and SBN contexts. Because the frequency of *single-parent households* and *children and adults at home* were higher in poverty contexts, and the frequency of *literacy activities* was lower in those children, it is important to consider these variables as potential targets for future interventions aimed at optimizing cognitive processes skills in preschoolers from those contexts. Therefore, poverty did not mediate the relationship between environmental factors and cognitive performance in a uniform way, but its influence differed depending on the type of environmental factor. Additionally, results of the mediating effects of poverty were verified for three of the five cognitive processes analyzed. Thus, results indicated a differential sensitivity of each process to different environmental factors and the mediating role of poverty. This variation is consistent with other studies that indicated that not all aspects of the socioeconomic backgrounds affected the associations between environmental factors and cognitive development (Duncan & Magnuson, 2012; Duncan, Magnuson, & Votruba-Drzal, 2017; Lipina, 2016). In addition, this variation suggested different patterns of cognitive integration through development (Garon et al., 2008). These findings should not be generalized since this study has certain limitations that should be covered in future studies with different cognitive tasks for the same processes, a wider age range, different environmental factors, and different levels of organization (e.g., molecular, neural, and behavioral). Another limitation of the present work was the lack of psychometric information about the cognitive tasks, an issue that should be solved in future studies. Therefore, this generates the need to continue exploring (a) the application of this model of analysis with a more diverse set of self-regulatory tasks (e.g., flexibility); (b) more diverse samples in terms of individual and environmental factors; and (c) the influences of interventions, to better understand the development and integration of different cognitive processes during learning processes. Understanding these cognitive processes is necessary not only for improving cognitive performance but also for improving the general well-being of these populations (Campbell et al., 2002; Evans, 2016; Hoelscher, Moag-Stahlberg, Ellis, Vandewater, & Malkani, 2016). Specifically, social policy aimed at promoting human development in general, and child development in particular, should be designed together with scientific policies that provide information on what issues should be investigated based on the needs of each society. Although the information in this work must be taken cautiously due to the limitations mentioned above, it is useful since it contributes to optimizing the design of interventions aimed at fostering child cognitive development in populations exposed to poverty.

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