Temperament Predicts Processing Speed in Low Socioeconomic Status Rural Preschoolers

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ABSTRACT— Extreme poverty all over the world is concentrated in rural settings. However, studies about cognition in low socioeconomic status (SES) children are for the most part conducted in urban populations. This paper investigates, in a poor rural sample, what are the individual and socioenvironmental variables that make the difference in performance in a processing speed task. Forty four 5-year-old children were evaluated with a processing speed task; individual and socioenvironmental information was obtained from parents' interviews. Higher scores in the effortful control dimension of temperament were associated with higher performance in the processing speed task. No other individual or socioenvironmental variable predicted the performance. These results showed that effortful control is important in processing speed and suggest that in low SES rural contexts, low effortful control children would require stronger interventions.

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Over the last decades, public policies and interventions have been designed to attenuate the negative effect of poverty in cognitive development (Richter et al., 2017). However, most of them are targeted for urban populations (Schreuder, 2010; Tine, 2017). This bias may be a consequence of practical considerations (e.g., ease of access) but it fails to address the striking fact that worldwide, most of the inhabitants living in extreme poverty are children in rural populations (Olinto, Beegle, Sobrado, Uematsu, et al., 2013). In Argentina, where this study was conducted, the incidence of rural poverty is 18.2%, more than twice the incidence in urban areas (8.3%) (Instituto Nacional de Estadísticas y Censos [INDEC], 2010). Thus, the study of child cognitive development in rural settings has obvious practical consequences.

There are also theoretical reasons to pursue this goal. Previous research suggested that some features of scarceness which are prevalent in rural contexts present special risk factors for cognitive development. For example, rural settings have a largely reduced access to preschool education (Castro & Rolleston, 2015; Gouin et al., 2015) and fewer years of parental education (Foulkes & Mori, 2009; Mykerezi, Kostandini, Jordan, & Melo, 2014; Tine, 2017). Rural contexts have been also characterized by low-quality dwellings and low parental occupation (Chambers, 2014), factors that has been shown to affect normal cognitive development (Ngure et al., 2014). As a consequence, poor rural environments provide a more taxing scenario for typical cognitive development, than urban contexts with comparable overall levels of poverty (Hermida et al., 2018). Although this evidence presents rural contexts as ones with particular risk, there is a wide range of variability in their effects on cognition, because cognitive development depends not only on environmental factors but also on individual variables (Bronfenbrenner, 1979). In particular, temperament has been proposed as an important factor to explain these individual differences in cognition and underlying neural function (Rothbart, Sheese, & Posner, 2007). Child temperament can be analyzed in three dimensions (Rothbart, 2004): surgency (includes positive anticipation, impulsivity, increased levels of activity, and a desire for sensation seeking), negative affect (includes fear, frustration, sadness, discomfort, and anger), and effortful control (the ability to act purposefully in modulating thoughts, emotions, and behavior). Importantly, effortful control is a key factor for children's adjustment (Lengua, 2009) and a good predictor of academic readiness and success (Blair & Razza, 2007; Blair, Ursache, Greenberg, & Vernon-Feagans, 2015; McClelland et al., 2007; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008), empathy, compliance and social competence (Eisenberg et al., 2003; Kochanska, 1997; Lengua, 2003). Thus, temperament (within other individual variables) and socioenvironmental variables, affect cognitive development resulting in individual differences.

In this paper, we sought to find how individual and socioenvironmental variables affect cognitive development in a context of particular relevance due to its risk and prevalence: rural poverty.

How exactly socioenvironmental variables may affect cognitive development, in the specific context of extreme rural poverty remains as an open question. Our work builds in two hypotheses: the first possibility is that the effects observed should be the same—in spite of different magnitude—than those observed in other studies of poverty and cognition (Brooks-Gunn & Duncan, 1997; Hackman & Farah, 2009) (which underlies on the assumption of a linear relation between these variables). This predicts a positive linear association between socioenvironmental variables and cognitive development (e.g., the higher the level of parental education, parental occupation and dwelling, the higher score in the cognitive test). An alternative hypothesis is that given the differences between rural and urban contexts (Vernon-Feagans et al., 2013) the linear relationships found in previous studies (carried out in urban areas) could not be verified in rural areas. For example, if the levels of socioenvironmental variables are very low, there could be a "floor effect," whereby, at high levels of poverty, socioenvironmental variables will not produce noticeable effects in cognition. Based on this hypothesis, some demographic and social factors which may be of great pertinence to determine cognitive development in urban areas may turn out to be not so significant in the more ubiquitous contexts of rural poverty.

Regarding individual variables, we expected to replicate the results of previous studies. Past preschool attendance has been linked with cognition in rural contexts (Hermida et al., 2018), so we expected to replicate this finding. However, because the quality of rural education is generally low (Vernon-Feagans et al., 2013), the effects of preschool education on cognition could be lower. In the case of temperament, we expect to find the same associations than in previous studies (Blair et al., 2015; Rothbart et al., 2007): the effortful control dimension of temperament predicting cognition.

As an indicator of cognitive achievement we measured processing speed. Processing speed is the pace at which someone takes information, analyzes it, and responds to it. Also it can be defined as the speed of responding to simple content in which, without time limits, perfect performance occurs (Salthouse, 2000). Measures of processing speed include components of central processing or cognitive speed, as well as motor speed (Sternberg, 1969), and may also have working memory components (Kennedy, Clement, & Curtiss, 2003). Processing speed has been associated with general fluid intelligence (Deary, 2000; Jensen, 2006; Sheppard & Vernon, 2008; Troche, Thomas, Tadin, & Rammsayer, 2018) and executive functioning (Clark et al., 2014), which is also a strong predictor of academic success (Berg, 2008; Caemmerer, Maddocks, Keith, & Reynolds, 2018; Luo, Thompson, & Detterman, 2006). There is evidence that processing speed accounts for between 70% and 90% of the age-related variance in fluid intelligence quotients in children and adults (Grudnik & Kranzler, 2001; Kail & Salthouse, 1994). Global theories of cognitive development have conceptualized processing speed as a central mental capacity that drives changes in higher-order cognition (Hale, 1990; Kail & Salthouse, 1994). Those models suggest that children's processing speed is a driving mechanism in cognitive development that supports gains in working memory, inhibitory control, and associated cognitive abilities (Clark et al., 2014; Fry & Hale, 1996). Recently, it has been argued that individual differences in processing speed explained the relationship between executive functions and academic achievement in primary school children; and processing speed within executive functions tasks can be used to predict academic attainment and aid in the development of intervention programs (Gordon, Smith-Spark, Henry, & Newton, 2018). Considering this, processing speed is a well-established candidate to explain higher-order differences in cognitive ability as a function of socioenvironmental and/or individual variables (e.g., Colom, Abad, Quiroga, Shih, & Flores-Mendoza, 2008; Conway, Cowan, Bunting, Therriault, & Minkoff, 2002; Fry & Hale, 1996; Jensen, 1998; Kail & Salthouse, 1994).

Also, processing speed measures appear as a good way for addressing cognition in low SES rural children for some reasons. In the first place, processing speed measures have proved sensibility to socioenvironmental influences, from early developmental stages. For example, differences among children from different SES are evident since 18 months (Fernald, Marchman, & Weisleder, 2013). In the second place, speed of processing has been shown to develop rapidly from 3 to 5 years of age (Kail, 1991), the ages we are interested in. Finally, processing speed measures have been applied in recent large-scale studies on nonurban low socioeconomic status children (Blair et al., 2015; Ribner et al., 2018). It has also been used in studies linking individual variables as personality with cognition (Rindermann & Neubauer, 2001). In particular, we used the Coding WPPSI III Subtest that has been standardized in Argentina, which let us to compare rural children's scores with typical developing urban children scores of the same age (Barbenza & Velasco, 1998). Also, this task implies materials and activities Argentinean rural children are familiarized with (i.e., draw, with paper and pencil).

MATERIAL AND METHODS

Design and Participants

We applied a cross-sectional design: children were evaluated with a processing speed task, and parents answered a child temperament questionnaire and a socioenvironmental scale. We calculated the minimum sample size required for an anticipated effect size of .20, a statistical power level of .8, one predictor per regression and a probability level of .05 (Cohen, Cohen, West, & Aiken, 2013). The minimum sample size required is 41.

Forty-six 5-year-old children and their families were recruited in two public kindergartens to participate in the study. Data from two children with diagnosed neurological disorders were excluded from the study. Finally, forty-four 5-year-old (23 females; mean age = 5.39 years, *SD* = .26) participated in the study.

Both schools were located in Santiago del Estero, the province with the highest percentage of rural population in Argentina (31.3%). Schools were in Añatuya's outskirts, a city with a population of 23,286 and an average density population of 6.3 inhabitants/km^2. Based on Miller and Votruba-Drzal (2013) "rural" criteria [an area with less than 50,000 inhabitants which is independent of a metropolis (less than 30% of the population work in a metropolis), both schools were considered rural.

Both schools provided children a meal and a snack every day. Primary caregivers gave written informed consent to participate in the study, which was authorized by an institutional Ethical Committee (Centro de Educación Médica e Investigaciones Clínicas, Consejo Nacional de Investigaciones Científicas y Técnicas, Protocol N° 967). The study was conducted in accordance with APA's ethical standards, and international and national children rights norms.

Dependent Variable: Processing Speed Assessment

The Subtest Coding of WPPSI III battery (Intelligence Scale Wechsler Preschool and Primary III) was implemented to assess processing speed ability (Wechsler, 2004). The child must copy a series of symbols within geometric shapes, during 2 min. Each symbol is paired with a geometric shape and the child has a model that reminds correspondences. The internal content validity consistency and test–retest reliability of this subtest has been widely confirmed (Gordon, 2004), with high correlation with other processing speed tests. It has also been standardized in Argentina (Barbenza & Velasco, 1998).

Each item was punctuated depending on accuracy: 1 point was given when the symbol was copied adequately; 0 point when there was no copied symbol or when it was incorrectly copied.

All tests were scored by an expert. The resulting scores were then verified by a second expert. There was 93% of agreement among experts. There were only three cases (out of 46) in which the second expert disagreed with the score assigned by the first expert. In those three cases the score was defined by a third different expert. All of them were blind to the study hypothesis. Seven examiners (psychologists), blind to the study hypothesis, conducted the processing speed assessment. The task was administered in the schools, in quiet spaces provided by the institution. Each child was tested by an examiner and each evaluation lasted about half an hour. The task was administered in Spanish, the mother tongue of the children.

Independent Variables

We performed interviews with parents or caregivers. Because most parents were illiterate or had difficulties to read, experimenters read the items and marked their responses. Scales were administered in Spanish, the native language of parents. The interviews were used to obtain data on the following variables.

Individual Variables

As a first individual variable we considered the number of months children attended school before the year of the study (*Past preschool attendance*).

As other individual aspect, we considered the child temperament. We used the very short form of the Child Behavioral Questionnaire (CBQ) in the 3-to-5-years version (Putnam & Rothbart, 2006). It consists of 36 items that compose the dimensions of *surgency*, *negative affect*, and *effortful control*. The behavior of children is evaluated by their mothers following a 7-point scale according to how true is each behavior in the case of their son or daughter. Higher scores are indicative of higher values in each dimension. Three dependent variables (*surgency*, *negative affect*, and *effortful control)* are obtained by averaging the scores of each dimension's items. This questionnaire demonstrated both satisfactory internal consistency and criterion validity (Putnam & Rothbart, 2006). The scores on the very short version had adequate internal consistency (Cronbach's alpha) estimates of 0.75 for surgency, 0.72 for negative affect, and 0.74 for the effortful control dimension (Putnam & Rothbart, 2006). Parental agreement for the full version of CBQ scale (which includes the 36-items of the very short form) was reported to be satisfactory (Majdandžić, Van den Boom, & Heesbeen, 2008; Rothbart, Ahadi, Hershey, & Fisher, 2001), with correlations ranging from .49 to .76. Correlations between laboratory observations of children's temperamental behavior and caregiver responses to the full version of CBQ were generally moderate (e.g., Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Majdandžić et al., 2008).

Socioenvironmental Variables

A socioeconomic scale (Colombo & Lipina, 2005) was administered to identify indicators associated with the specific experience of poverty for children (e.g., parental completed level of education, father's occupation level, and number of people per room at home [overcrowding]). This scale was used in previous local studies (Hermida et al., 2015; Lipina, Martelli, Vuelta, Injoque-Ricle, & Colombo, 2004; Segretin, Lipina, & Petetta, 2009) and is based on criteria used by the National Institute of Statistics and Census (INDEC, 2010). Scores were assigned directly to father's and mother's level of education, following the Argentinean poverty criteria (INDEC, 2010), according to the maximum level of education completed by each caregiver.

Mother's and father's occupation scores were also assigned following codes used by the INDEC (2010), where occupation is measured in function of type of activity, level of autonomy, and salary. For *dwelling*, scores were assigned based on type, floor, water, bathroom, ceiling, external walls, and home property.

Statistical Analyses

First, we conducted descriptive statistics of individual and socioenvironmental and variables, as well as processing speed score, to check for variability in data (variables with more than 75% of the cases concentrated in the same value were excluded for being homogenous in this sample). To avoid collinearity, we conducted Pearson's correlation analyses among variables (in cases of variables showing $r < .70$, only one variable was selected for the following analyses).

Second, to analyze the contribution of individual variables to performance in the processing speed task, we visualized data and performed single linear regressions. *Processing speed score* was the dependent variable and each individual variable was included as an independent variable. Single regressions were conducted because multiple linear regressions (including interactions) would have required to triplicate our sample (Cohen et al., 2013), which was beyond our capacity considering the practical difficulties for obtaining data in rural contexts.

Third, we repeated the same scheme for socioenvironmental variables, but in this case we created a composite by averaging the Z scores for socioenvironmental variables that were theoretically related, assuming they belong to the same environmental condition (Lipina et al., 2013). After that, we performed single linear regressions. *Processing speed score* was the dependent variable and each socioenvironmental variable (or the composite) was included as an independent variable.

Because this results in several independent comparisons, we applied a strict Bonferroni correction to discard effects of multiple comparisons. The assumptions for linear regressions were verified for all regressions (we conducted residual analyses to check normality, independence, homoscedasticity and no collinearity).

RESULTS

Descriptive Statistics

After descriptive statistics analyses, the variables *dwelling score* and *mother occupation* were excluded from the following analyses because they have no variability. Ninety-seven percent of the cases have *dwelling score* = 2, which means they live in ranch made of wood and mud with no services. Regarding the variable mother occupation, 79.1% of the cases were unemployed.

Descriptive statistics for selected individual and socioenvironmental variables are presented in Table 1. Means and *SD*s (Table 1) confirm that this sample is extremely low SES. Regarding socioenvironmental variables, most mothers were unemployed and had completed primary school level; most fathers had incomplete primary school level and low hierarchy employments; most homes had no services and were overcrowded. Regarding individual variables, children had (on average) less than 1 year of children previous school attendance.

Descriptive statistics showed that *Processing speed score* averages ($X = 5.44$; $SD = 3.23$) are below norm-references scores for this age ($X = 10$; $SD = 7$). This confirms that, as expected, these rural low SES children had on average a processing speed achievement in this task that was below the mean score for their age.

Table 2 shows correlations among individual and socioenvironmental and variables. Moderate-to-low negative correlations were found between *Past preschool attendance* and *surgency*, as well as between *Past preschool attendance* and negative affect. *Surgency* and *effortful control* also were moderated and negatively correlated.

Table 1
Descriptive Statistic (Individual, Socioenvironmental and Dependent Variables)

	n	*Mean*	SD	*Skewness (SE)*	*Kurtosis (SE)*
Individual variables					
Past preschool attendance[a]	44	8.45	5.54	−.93 (.38)	−1.19 (.70)
Surgency score	44	4.29	.89	.01 (.36)	−0.10 (.70)
Negative affect score	44	4.36	.86	.19 (.36)	−.63 (.70)
Effortful control score	44	5.43	.74	−.49 (.36)	.28 (.70)
Socioenvironmental variables					
Father's completed level of education[b]	38	2.53	1.74	.66 (.38)	−.05 (.75)
Mother's completed level of education	40	3.08	2.34	1.19 (.37)	1.17(.73)
Parental education composite	35	.04	.81	.85 (.40)	.51 (.78)
Father's occupation score[c]	42	1.55	1.04	1.44 (.37)	1.46 (.72)
People per room at home	41	3.48	1.33	1.09 (.37)	2.35 (.72)
Processing speed score					
Coding score	41	14.17	9.73	.58 (.37)	−.27 (.72)
Standardized coding score[d]	41	5.44	3.23	.54 (.37)	−.30 (.72)

[a]Amount of months that the child had attended to school before the year of the study.
[b]Code used by the INDEC (2010) to measure educational level where 0 = no studied, 1 = primary school uncompleted; 3 = primary school completed; 6 = high school uncompleted; 9 = high school completed/college uncompleted; 10 = college completed/graduate school uncompleted; 12 = graduate school completed.
[c]Code used by the INDEC (2010) to measure occupation in function of type of activity, autonomy and salary where 0 is unemployed; 1 is, for example, peddler; 2 is. for example, a street sweeper; 4 is, for example, taxi driver; etc.
[d]The standardized Coding score has mean = 10 and *SD* = 7.

Table 2
Pearson Correlations Among Independent Variables

Pearson correlations among individual variables	1	2	3	4
1. Past preschool attendance	—			
2. Surgency score	−0.359[a]	—		
3. Negative affect score	−0.386[b]	0.187	—	
4. Effortful control score	0.131	−0.352[a]	0.165	—
Pearson correlations among socioenvironmental variables	5	6	7	
5. Parental educacton composite	—			
6. Father's occupation score	−0.083	—		
7. People per room at home	−0.223	0.042	—	

[a]Correlation is significant at .05 level (two-tailed).
[b]Correlation is significant at .01 level (two-tailed).

Table 3
Processing Speed as Function of Individual Variables

	Processing speed			
*Individual variables (*n *= 41)*	t	R^2	*Standarized* β	p
Past preschool attendance	.39	.00	.11	.70
Surgency	−.65	.01	−.10	.52
Negative affect	.88	.02	.14	.39
Effortful control	3.35	.22	.47	.00*,**

**p* < .002.
***p* < .01.

Associations between Individual Variables and Processing Speed

To analyze the contribution of individual variables in processing speed performance, we visualized relationships between *surgency*, *negative affect*, *effortful control* or *past preschool attendance*, and *processing speed*. Effortful control was the only predictor of processing speed (Figure 1). We then calculated four single linear regressions. In all of them, processing speed score was included as the dependent variable, and one of the individual variables was included in each single regression as the independent variable. Results of those regressions are shown in Table 3. Only the effortful control dimension of temperament explained *processing speed score* ($\beta = .47$; $F(41) = 11.23$; $p < .01$, with an R^2 of .22). This association remains significant after a Bonferroni correction for multiple comparisons. Specifically, one more point in the effortful control scale is associated with .47 more points in *processing speed score* (Figure 1) and 22% of the variability in processing speed score is explained by effortful control. The same results are obtained when performing a multiple linear regression including the four individual variables (Table S1, Supporting Information): only the effect of effortful control is significantly related to *processing speed score*.

Associations between Socioenvironmental Variables and Processing Speed

To analyze the contribution of socioenvironmental variables to performance in processing speed, we created a composite by averaging the socioenvironmental variables *Z* scores for *mother education* and *father education*. We

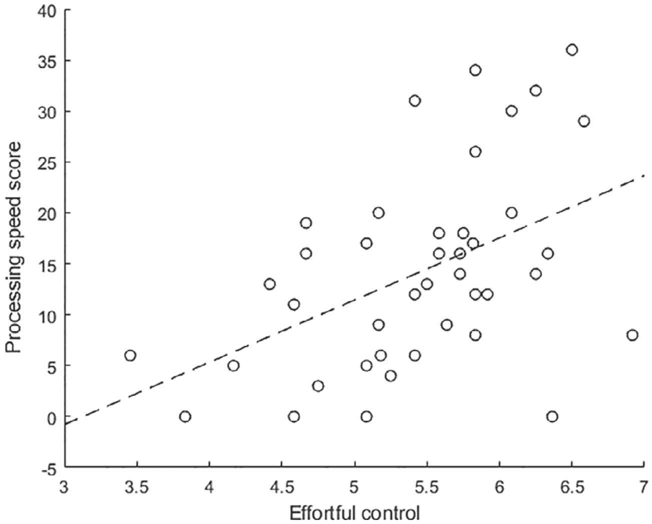

Fig. 1. Processing speed score as a function of effortful control. Line represents linear fit (nonstandardized β = 6.108).

Table 4
Processing Speed Score as Function of Socioenvironmental Variables

		Processing speed			
Socioenvironmental variable	n	t	R^2	*Standardized* β	p
Parental education composite	33	.86	.02	.15	.40
Father's occupation score	39	.76	.02	.12	.46
People per room at home	38	.186	.00	.03	.85

named this composite *parental education* and it reflected the educational level of primary caregivers. *Parental education* was included as a predictor of processing speed in one single linear regression. Other single linear regressions were conducted including *father occupation* and *people per room at home* as predictors.

Results of those regressions (Table 4) were nonsignificant, indicating that the socioenvironmental variables considered were not associated to individual differences in processing speed performance. This pattern of nonsignificant associations is maintained if we perform a multiple linear regression including all three socioenvironmental independent variables (Table S2). In this particular sample, with extremely low SES and cognitive achievements below the mean score for this age, socioenvironmental variables does not seem to affect processing speed.

DISCUSSION

Although urbanization is increasing year by year, almost half of all people (45% of the worldwide population) live in rural areas (UNICEF, 2012). Also, most low-income population (68%) is rural (World Bank, 2018). In particular, extreme poverty is concentrated in rural areas, across all world regions. In South Asia the percentage of extremely poor people living in rural areas is 83%; in Sub-Saharan Africa 82%; in East Asia and the Pacific 74%; in Europe and Central Asia 66%; and in Latin America and the Caribbean 53% (Castaneda et al., 2016). Moreover, in rural areas, families tend to have more children (Organización de las Naciones Unidas para la Alimentación y la Agricultura [FAO] and Rossel, 2012). According with recent reports (UNICEF, 2016), at least four out of every five children living in extreme poverty are in rural areas worldwide.

Rural poverty is generally different from urban poverty, not only in the magnitude (Olinto et al., 2013), but also in the type of risks that present for cognitive development. For example, preschool children living in rural poverty scored significantly lower than their poor urban counterparts in different executive function tasks (Castro & Rolleston, 2015; Hermida et al., 2018).

However, most of the studies on the effects of poverty in cognitive development have been carried out in urban populations (Schreuder, 2010). The intention of our work is to contribute to the understanding of how socioenvironmental and individual variables affect cognition in rural low SES contexts.

Specifically, this study show a linear relationship between effortful control and children scores in a processing speed task: higher scores in effortful control were associated with higher processing speed scores. The association between effortful control and cognition has been shown by several studies (Rothbart & Bates, 2006), most of them based on urban samples (e.g. Bush, Lengua, & Colder, 2010; Eisenberg et al., 2003; Lengua, 2003; Lengua, Bush, Long, Trancik, & Kovacs, 2007; Li-Grining, 2007). Although there are some studies including rural samples (e.g. Blair et al., 2015; Blair & Razza, 2007; McClelland et al., 2007), the relations between effortful control and cognition are still poorly studied in this background. Our study contributes to fill this gap showing that the association effortful control-cognition is also valid in a rural extremely low SES context. Importantly, our results suggest child's temperament is relevant to processing speed performance in settings of high scarcity of developmental opportunities. These results are in line with the previous literature showing links between effortful control and different outcomes that are relevant to cognitive (e.g. self-monitoring, executive functioning) and emotional (social competence) development and adjustment (Blair et al., 2015; Blair & Razza, 2007; Eisenberg et al., 2003; Kochanska, 1997; Lengua, 2003; McClelland et al., 2007; Rothbart et al., 2007; Valiente et al., 2008), and therefore, are in consonance with our hypothesis (regarding temperament and cognition, we expected to find the same associations than in previous studies: effortful control predicts processing speed).

Interestingly, we neither find a relation between processing speed and the other individual nor socioenvironmental variables. This result disagree with previous studies that showed a relation between these factors and cognitive performance: parental education (Foulkes & Mori, 2009; Mykerezi et al., 2014; Tine, 2017), father's occupation and overcrowding (Ngure et al., 2014) as well as past preschool attendance (Castro & Rolleston, 2015; Gouin et al., 2015) have been associated with rural child cognitive achievement. In fact, our results suggested an effect of SES (linked with socioenvironmental variables) since these children obtained a mean processing speed performance lower than expected for their age. But within this group, there was no association between socioenvironmental variables and performance, which is in line with one of the two alternative hypotheses we had proposed (linear relationships among socioenvironmental variables and processing speed could not show a linear relationship) Why did these socioenvironmental variables do not impact cognition performance in our sample?

Different explanations are possible. In the first place, since the children in this sample have very low performance, it might be possible that in this performance range the socioenvironmental effect has saturated. If we had included children with a higher SES, we would probably find an effect of the environmental variables on the processing speed score. But this extremely low SES context could not produce enough variability to show the association SES-processing speed.

In the second place, finding effects on general cognition do not exactly mean finding effects on processing speed. Rural child cognitive general outcomes might not be reflected in a specific processing speed task. Different studies with rural samples have used different cognitive outcomes. Some studies used general cognitive development test (e.g. Gouin et al., 2015; Mykerezi et al., 2014; Ngure et al., 2014); others used specific skills tests—different from processing speed (Tine, 2017) and a final group of studies created a measure by combining other measures of cognitive achievement (Castro & Rolleston, 2015; Foulkes & Mori, 2009). Thus, our results could not find significant differences, unlike other studies which did find them, probably due to the cognitive measure used.

In the third place, associations may differ in distinct rural contexts. Each rural area characteristics may vary the relation between risk and outcome, leading to other associations among the same factors or different effect sizes (Blair et al., 2008). The absence of impact that we found might be replicable only in similar extreme low SES context.

Finally, there can be interactions among those individual and socioenvironmental variables that we cannot analyze due to our sample size. Our model could be hiding interaction effects on cognition.

Because of the significance of effortful control as a predictor of processing speed together with the absence of effect of the other variables observed emerged a hypothesis to be explored: effortful control modulates the effects of poverty on cognition (Lengua, 2009). Specifically, effortful control has been described as an alleviator of the effects of socioeconomic and contextual risk (Bush et al., 2010; Kim-Cohen, Moffitt, Caspi, & Taylor, 2004; Lynam et al., 2000). For example, impulsivity (an indicator of poor effortful control) increases the likelihood of developing problems in the context of a high-risk neighborhood (Bush et al., 2010; Lynam et al., 2000). Although we did not conduct mediation analyses (due to our small sample size), our results are in consonance with this reasoning: while living in a rural low SES context, children with more effortful control have higher processing speed scores. Future studies should address this hypothesis deeper in order to make clear the role of effortful control in the poverty–cognition relationship. Also, because there are different possible pathways through which effortful control could modulate this relationship. Considering the development of effortful control as a complex phenomenon with socioeconomic, family, parenting, and physiological factors contributing to its development (Blair et al., 2015; Lengua, 2009), children with high effortful control could tend to generate better developmental environments (because of their better adjustment in home and school), which in turn could contribute to facilitate adequate parenting practices. Importantly, children from low-SES families tend to demonstrate lower effortful control compared with children from higher-SES families (e.g., Evans & English, 2002; Hughes, Ensor, Wilson, & Graham, 2010; Mezzacappa, 2004; Mistry, Benner, Biesanz, Clark, & Howes, 2010), with differences apparent from preschool age (Lengua, Honorado, & Bush, 2007). Little research clarifies the factors that might account for the effects of low SES on effortful control (Blair & Raver, 2012), although parenting and cumulative risks have been shown to be mediators of that association (Lengua et al., 2014). Current efforts, with higher sample sizes, are trying to analyze the pattern of multiple associations among effortful control, cognition, and SES (Putnam et al., 2019).

As a final point, these results contribute with evidence for further design of interventions in these populations. First, educational, familiar and/or economical interventions should contribute to equalize rural children developmental opportunities, independently of their temperament. Nonetheless, in low SES rural contexts, low effortful control children might require stronger interventions. Second, identifying effortful control predictors could lead to good intervention targets. For example, parenting appears to be a key predictor of the development of effortful control and a mediator of the effects of other contextual risk factors (e.g., Lengua, Bush, et al., 2007). In consequence, parenting interventions could be a way to promote children effortful control, and in turn, to promote child cognitive development. Future intervention studies should explore further these proposals.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Results of multiple linear regressions including individual variables and processing speed score.

Table S2. Results of multiple linear regressions including socio-environmental variables and processing speed score.

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