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Teachers' Perceptions about the Etiology of Intelligence and Learning Difficulties

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Abstract

The etiology of intelligence and learning difficulties is interpreted and perceived in different ways within society. The present study aims to explore the perceptions of a sample of *n*=501 Brazilian teachers regarding genetic and environmental influences on intelligence and learning difficulties. Using numerical scales, it was observed that importance was ascribed by teachers to genetic and environmental influences across both the intelligence and learning difficulties domains. For intelligence, however, the evidence points to a greater belief in genetic influence. A multiple-choice items test revealed some differences on the perceptions of teachers according to gender, age, schooling, area of knowledge, income, years of experience, knowledge of genetics, and having studied genetics. Responses favouring genetic explanations were associated with certain demographic factors while the perception that only environment affects the various domains was not associated with any specific demographics.

Keywords: cognition; teachers' beliefs; biological determinism; genetics; behavioral genetics.

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Percepciones del Profesorado acerca de la Etiología de la Inteligencia y las Dificultades de Aprendizaje

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Resumen

La etiología de la inteligencia y las dificultades de aprendizaje se interpretan y perciben de diferentes maneras dentro de la sociedad. El presente estudio tiene como objetivo explorar las percepciones de una muestra de n=501 docentes brasileños con respecto a las influencias genéticas y ambientales sobre la inteligencia y las dificultades de aprendizaje. Utilizando escalas numéricas, se observó que los profesores asignan importancia a las influencias genéticas y ambientales en los dominios de inteligencia y dificultades de aprendizaje. Para la inteligencia, sin embargo, la evidencia apunta a una mayor creencia en la influencia genética. Una prueba de ítems de opción múltiple reveló diferencias en las percepciones de los docentes según el sexo, la edad, la escolaridad, el área de conocimiento, los ingresos, los años de experiencia, el conocimiento de la genética y el estudio de la genética. Las respuestas que favorecen las explicaciones genéticas se asociaron con ciertos factores demográficos, mientras que la percepción de que solo el medio ambiente afecta los diversos dominios no se asoció con ninguna demografía específica.

Palabras clave: cognición; creencias del profesorado; determinismo biológico; genética; genética conductual.

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The human cognitive system is involved in a range of neurological processes that characterize forms of acquisition, organization, use and expression of knowledge. The terms intelligence and learning, in their various cognitive mechanisms, are evidently related (Almeida, 1992), even parents and teachers of twins perceive the genetic and environmental influence on intelligence and learning difficulties in a very similar way (Walker & Plomin, 2005).

Although recent discourses have been considering the processes of learning and school outcomes as something beyond cognitive abilities (Abed, 2016), the educational system remains to privilege such abilities through standardized assessment. Human cognitive abilities have historically been attributed more to genetic factors than to environmental factors (Gould, 1996; Snyderman & Rothman, 1988), and these, in turn, were considered immutable by various social groups (Castera & Clement, 2014; Gould, 1996; Keller, 2005; Rattan, Savani, Naidu & Dweck, 2012; Thomas & Sarnecka, 2015; Willoughby et al., 2019)

The Brazilian teachers' conceptions about origin and evolution of life are more creationist than the teachers' conceptions in other Latin American countries, like Argentina and Uruguay, for example (Silva, Clément, Leão, Garros, & Carvalho, 2017). Such conception may be related to deterministic beliefs. Therefore, although we have some idea about teachers' perceptions of nature-nurture on educationally relevant traits in the United Kingdom and Europe (Walker & Plomin, 2005; Castera & Clement, 2014; Crosswaite & Asbury, 2018), it is likely that the perceptions of teacher in Brazil may differ to those found in Europe. Studies exploring the perceptions of teachers about genetic determinism have been conducted in many countries although primarily within the same study (Castera & Clement, 2014). In Brazil, studies have focused only on university students' perceptions about genetics (Carver, Castéra, Gericke, Evangelista, & El-Hani, 2017; Gericke; et al., 2017).

The first results about teachers' perceptions of behavioral genetics in Brazil were reported in a larger, multi-dimensional study perceptions about all behaviors were analyzed together (Antonelli-Ponti, Versuti, & Silva, 2018). The way teachers perceive their students may constitute beliefs, and these have the potential to influence teaching practice (Buehl & Beck, 2015). Furthermore, due to the complex historical and social debates and discussions around the etiology of cognitive ability, particularly in relation to education, it is necessary the investigation the perceptions of Brazilian teachers about the genetic and environmental influence in relation to the cognition of their students.

Intelligence

Intelligence, measured by IQ tests, is considered the best predictive factor of school performance, overcoming other variables involved (Poropat, 2009) and demonstrating high relation with all school disciplines (Deary, Strand, Smith, & Fernandes, 2007).

The expression general cognitive ability (g) has been adopted in behavioral genetics studies, using a hierarchical model where 'g' is at the top, followed by specific cognitive abilities, which have 'g' in common, and the tests that can measure them, it's a latent concept (Plomin, DeFries, McClearn, & McGuffin, 2011). Studies evaluating the genetic and environmental influence on lifelong intelligence show that in childhood, intelligence has a greater environmental influence and is quite malleable during this period, and over the years, the genetic influence becomes larger and intelligence becomes more stable (Haworth, et al., 2011). About intelligence at the national level, experts agree that environment factors, like better health, better nutrition, include better education and school-systems, contribute to improve intelligence (Rindermann, et.al., 2016b). However, it is worth remembering that when discussing the genetic aspect of a trait, such as intelligence (or IQ) the role of the environment must still be considered, primarily through gene-environment correlation, in which the genetic characteristics influence, shape and choose the environment in three ways: passive, reactive and active (Plomin, DeFries, Knopik, & Neiderhiser, 2016)

This increase in heritability in intelligence can be understood through innovation and genetic amplification: "innovation refers to the possibility that increasing heritability results from novel genetic influences that were not present at previous time points" (Briley & Tucker-Drob, 2013, p.1705) and that can be triggered by changes outside the genes, such as physiological changes such as hormones at puberty, or environmental changes as a new school environment that lead to the activation of new genes. It is easy to understand this concept applied to childhood since in this phase the individual deals with constant novelties, thus recruiting or activating genes that are appropriate for each situation (Briley & Tucker-Drob, 2013); "amplification refers to the possibility that early genetic influences on cognition become increasingly important with age" (Briley & Tucker-Drob, 2013, p.1705). An example would be the selection of environments according to the genetic predispositions, that is, the individual genetic preference for a given environment, which will keep active the genes that were initially activated for that task or activity, being these more expressed than those that are not stimulated. This is known as gene x environment interaction.

In early childhood, it is the predominant innovation, but it rapidly decreases, and amplification becomes responsible for increased heritability after eight years of age. It is important to note that genetic influence may become more or less important according to the relevance of the trait to the environmental context (Briley & Tucker-Drob, 2013). The relevant genes to environment in which the individual is inserted are activated in childhood and can remain active throughout life, increasing or decreasing its performance depending on the need to use these genes (Asbury & Plomin, 2013). Overall this means that although intelligence and IQ are highly heritable, we cannot ignore the complex interactions between genetics and the environment in which the child is living.

Learning difficulties

Difficulties, disturbances or learning disorders are difficulties in learning and using academic skills. Learning difficulties is an umbrella term for very wide range of disabilities, ranging from mild to severe and encompassing a whole range of different characteristics and expressions (American Psychiatric Association, 2013).

Behavioral genetics has found that both genetic and environmental factors influence learning difficulties (Erbeli, Hart, & Taylor, 2018; Swagerman et al., 2015) and it is suggested that these difficulties are within a spectrum of abilities. This bell curve of ability is present across all psychological traits. Individuals who present such difficulties are in the left end of the normal curve distribution (Plomin, et al., 2016), that is, they are not abnormal, only that they have low ability. Talent skills expressions, such as reading specialists, are influenced by the same genes that are responsible for normal reading expression and also reading difficulties, it means that the same genes associated with difficulty reading tend to be associated with all reading comprehension, including normal readers and excellent readers (Plomin, Shakeshaft, McMillan, & Trzaskowski, 2014). This phenomenon has been termed "the abnormal is normal" (Asbury & Plomin, 2013; Plomin et al., 2016). The diagnoses go from qualitative dichotomous features like "is or is not" a good reader, "has or does not have" dyslexia, for quantitative distributions within the same normal curve (Plomin et al., 2016). "What we call common diseases such as learning disabilities are the quantitative extremes of continuous distributions of genetic risk" (Haworth & Plomin, 2010, p.786).

Genetic influence is certainly not the only determinant, but it plays an essential role (Swagerman et al., 2015). The environment, in turn, influences on several levels, from socioeconomic status (Erbeli et al., 2018) to emotional problems, which are related to learning difficulties (Santos & Graminha, 2006; Almeida, 1992) and beliefs related to the potential of achievement, which can be developed as tools to promote learning (Medeiros, Loureiro, Linhares, & Marturano, 2003). This comprehension must be transmitted to teachers, in teacher training courses on genetics of human behavior, as a way of collaborating in their understanding of their students and in their teaching practice (Crosswaite & Asbury, 2018).

Public perceptions about human cognition

Over time, research has been conducted to evaluate the perceptions of various groups of people on issues related to genetic influence and various aspects of human cognition (Castera & Clement, 2014; Crosswaite & Asbury, 2016; 2018; Gericke et al., 2017; Human Genetics Comission, 2001; Rindermann et al., 2016a; 2016b; Snyderman & Rothman, 1988; Thomas & Sarnecka, 2015; Walker & Plomin, 2005).

When exploring the perceptions of professionals from psychology and education – which is most relevant to this study - studies shows substantial acceptance of the importance of genetics, not discarding the environment, about the intelligence of the people (Rindermann et al., 2016a; 2016b; Snyderman & Rothman, 1988). Looking more broadly at the general public, studies have found the general public's perception about aspects of human genetics demonstrated a greater perception of the role of genes than of the environment influencing intelligence. However, studies have also demonstrated opposition towards suggestions that genes play an important role in educational outcomes (Crosswaite & Asbury, 2016). On average, parents and teachers of UK twins reported that genes were at least as important as the environment to intelligence and learning difficulties, with some emphasis on genetics (Walker & Plomin, 2005). These findings were replicated in a later study, also in the UK context, that explored just teacher perceptions of the etiology of cognitive ability. In this sample of both primary and secondary teachers, it was found that most teachers placed equal emphasis on the role or genes and the environment (Crosswaite & Asbury, 2018).

A large study on intelligence aspects involving experts in the field, including teachers, revealed that most participants believe in the role of genes and the environment in the differences between individuals and estimate the heritability of intelligence between 57% and 60% (Snyderman & Rothman, 1988). The same research was recently conducted and generally demonstrated the maintenance of such perceptions (Rindermann, et al., 2016a; 2016b). A specific sample for teachers of twin 7-year-olds, considering a Likert scale, where number one represents genetic influence and number five, environmental influence, generated an average of 2.35 (Walker & Plomin, 2005); the teacher sample of the present study, with different analysis, in a previously reported result, generated an average of 2.57. In an inverted scale, participants at least 18 years old and located in the United States had averages from 3.32 to 3.37 (Willoughby et al., 2019). The exception to the pattern found so far is given in a sample of Brazilian university students, which generated an average of 2.61, also with an inverted scale, in which lower averages represent greater environmental influence for intelligence (Gericke et al., 2017).

In Brazil, a study exploring teacher beliefs about the about causes of learning difficulties, found that teachers attribute the root of these problems to hereditary, social and educational conditions, but considered the family environment as a predominant factor (Oliveira, Santos, Aspilicueta, & Cruz, 2012). Research on beliefs in genetic determinism in a sample of Brazilian university students (Gericke et al., 2017) found that the construct was divided into beliefs about biological traits and beliefs about social traits. Findings were similar to the study of Brazilian teachers' perceptions about the influence of genes and environment on human behaviors in the educational environment (Antonelli-Ponti et al., 2018). Perceptions were divided into patterns related to social traits (personality and behavioral problems) and cognitive traits (intelligence and learning difficulties), furthermore, it was found that some teachers attribute equal weights to both factors, demonstrating an interactive perception (100% innate and 100% acquired) and not an additive perception (for example, 50% innate and 50% acquired) in relation to influences (Briley et al., 2018; Jacquard & Kahn, 2001).

The present study focuses specifically on teachers' perceptions about how genetics and the environment influence the cognitive traits of their students, represented here by the domains intelligence and learning difficulties. We were guided to answer these three research questions:

When comparing intelligence and learning difficulties, do teachers place a greater emphasis on nature or nurture for one over the other?

Is the perception of teachers more additive or interactive?

Is any group of teachers more (or less) deterministic?

Method

A descriptive, cross-sectional study was conducted from a convenience sample from October 2014 to October 2015. Participants included n=501 teachers from the public system (65%) and the private system (35%) from the state of São Paulo. The sample consisted predominantly of women (72.1%), which is in line with the Brazilian teaching population, with an average of 40 years (from 22 to 67 years). Teachers involved taught across a range of academic subjects and were classified into three main categories. The first referred to as ‘human sciences’ encompassed the subjects related to languages, history, social sciences; the second involved the 'biological' specializations; and the third category encompassed the 'exact' areas (physics, chemistry, mathematics).

The data collection took place after the researcher's contact with educational institutions of the state of São Paulo, mainly of municipalities in the northwest region. In all sessions, the teachers received the questionnaires on paper, and were asked to consent. The project was approved by the Committee of Ethics in Research in Human Beings of *Faculdade de*

Filosofia, Ciências e Letras de Ribeirão Preto - University of São Paulo, Brazil, under protocol nº 771.808.

The research instrument, which consists of Likert scales, was originally applied to parents and teachers in the United Kingdom (Walker & Plomin, 2005). Numerical scales from 0 (zero) to 10 (ten) for genes and for environment were added to the original questionnaire, in order to obtain another measure of perception beyond the 1 (one) to 5 (five) Likert scale. While the Likert scale measures which portion is assigned by teachers, for genes and the environment, the numerical scales have brought measures about what importance of genetics and the environment, separately, are assigned by the teacher for each behavior.

Considering the differences of language and culture, the process of adaptation of the questionnaire was carried out and its structure previously reported in Antonelli-Ponti et al (2018). In that previous paper the analyses were about a Likert scale averages and the group analysis was conducted considering all behaviours together. For the purpose of this paper only the items related to the teachers' perception about intelligence and learning difficulties will be analyzed focusing in numerical scales and group analysis for each domain.

Data analysis

Numerical scales (from 0 to 10) were presented on a scale of genetic influence and scale of environmental influence, which represents the weight that the teacher attributes to each of the factors in intelligence and learning difficulties. Descriptive statistics and t-test of paired samples were conducted with these scales' data by International Business Machines Statistical Package for the Social Sciences (IBM SPSS).

The Likert scale (from 1 to 5) was formed by items in the multiple choice format: 1 = Only genes; 2 = More genes than environment; 3 = Genes and environment in equal parts; 4 = More environment than genes; 5 = Only environment. This scale was used for comparison between different demographic groups of teachers (Gender, Age, Schooling, Area of Knowledge, Income, Years of experience, Knowledge in Genetics, Studying Genetics) on an exploratory and descriptive analysis of the categorical data, whcih was conducted by Statistical Analysis System (SAS), as used in (Antonelli-Ponti et al., 2018) for all behaviours together, and generated one map of correspondence for intelligence and one map of correspondence for learning difficulties. The closer the variables are presented, the more frequent their joint occurrence.

Results

Teachers attribute the origin and development of their students' cognition more to genetic rather than environmental factors. There is a tendency to consider genetic and environmental factors in cognition. For intelligence, however, the evidence points to a greater belief in genetic influence.

Notably, none of the groups sampled expressed a belief in the role of environment being the exclusive explanatory factor explaining student differences in intelligence or learning difficulties. Also, no strong associations were found to characterize differences between sample groups in the correspondence maps. However, some proximity between groups and items are taken into account

Numerical scales

Most participants placed high importance to the role of genetics as well as the role of the environment across the two domains (Table 3). The highest mean was the one referring to the scale of genetic influence on intelligence (7.23) (Table 1).

A statistically significant difference was observed between the responses of the scale to genetics and the responses to environmental scale in the domain of intelligence ($t_{(498)} = 7.06$; $p<0{,}05$) but not in learning difficulties.

The distance of perception between the weight of the genetic influence and the weight of the environmental influence (effect size) is very small for Learning Difficulties (0.05), and larger, approaching moderate, for Intelligence (0.39) (Table 1). Acceptance of the interaction of factors is greater the lower the observed distance.

Table 1
Mean, standard deviation and size effect of numerical scales from 0 to 10 on the weight of genetic and environmental influence on intelligence and learning difficulties (n=501)

Scale	Genetics		Environment		Size effect*
	Mean	SD	Mean	SD	
Intelligence	7.23	2.18	6.12	2.5	0.39
Learning difficulties	6.6	2.23	6.47	2.19	0.05

* Cohen's D= mean (genetics) - mean (environment) / √mean of standard deviations^2

Results regarding teachers who expressed a belief about the etiology of intelligence and/or learning difficulties are shown in table 2. Results showed that only a small percentage of teachers expressed the belief that the two domains were down to either all environment or all genes.

Table 2
Percentages of simultaneous responses to extreme values on numerical scales from 0 to 10 on the influence of genetic and environmental influence on intelligence and learning difficulties.

Intelligence			Learning difficulties		
Genetics	Environment		Genetics	Environment	
10	10	4.2%	10	10	2.8%
10	0 (zero)	2.4%	10	0 (zero)	1%
0(zero)	10	0.6%	0 (zero)	10	0.4%

Table 3
Percentage of responses of the numerical scales from 0 to 10 on the influence of genetic and environmental influence on intelligence and learning difficulties (n=501).

	Intelligence		Learning difficulties	
Scale	Genetics	Environment	Genetics	Environment
0	0.6%	3.0%	0.4%	1.2%
1	0.6%	1.2%	0.8%	1.0%
2	1.2%	5.2%	2,4%	2.4%
3	2.4%	6.2%	4.8%	3.6%
4	4.6%	4.4%	6.6%	4.8%
5	18.0%	24.4%	22.8%	25.3%
6	7,0%	8.4%	8.8%	10.8%
7	11.6%	12.4%	13.6%	14.0%
8	20.8%	17.0%	16.4%	16.2%
9	16.2%	8.4%	11.6%	12.8%
10	16.8%	9.2%	11.2%	7.2%

Multiple choice items

The items which demonstrate perception of exclusive genetic influence (IGA1) or to some extent (IGA2, IGA3, IGA4) on Intelligence appear scattered on the map along with the sample groups. The item that demonstrates exclusive perception of the environment (IGA5) appears distant and unrelated to any of the teacher groups.

It is important to note that group who declare to have studied genetics during teacher training (EG1) as well as teachers who studied human sciences (AC1) have strong association with the item that represents the balance between influences (IGA3). The male group (G2) has an association with the item 'more environment than genes' (IGA4), together with the exact sciences group (AC3), the older group (I4) and higher schooling group (E4). The teachers who declare that do not have knowledge in genetics (CG2) are associated with the item 'more genes than environment' (IGA2).

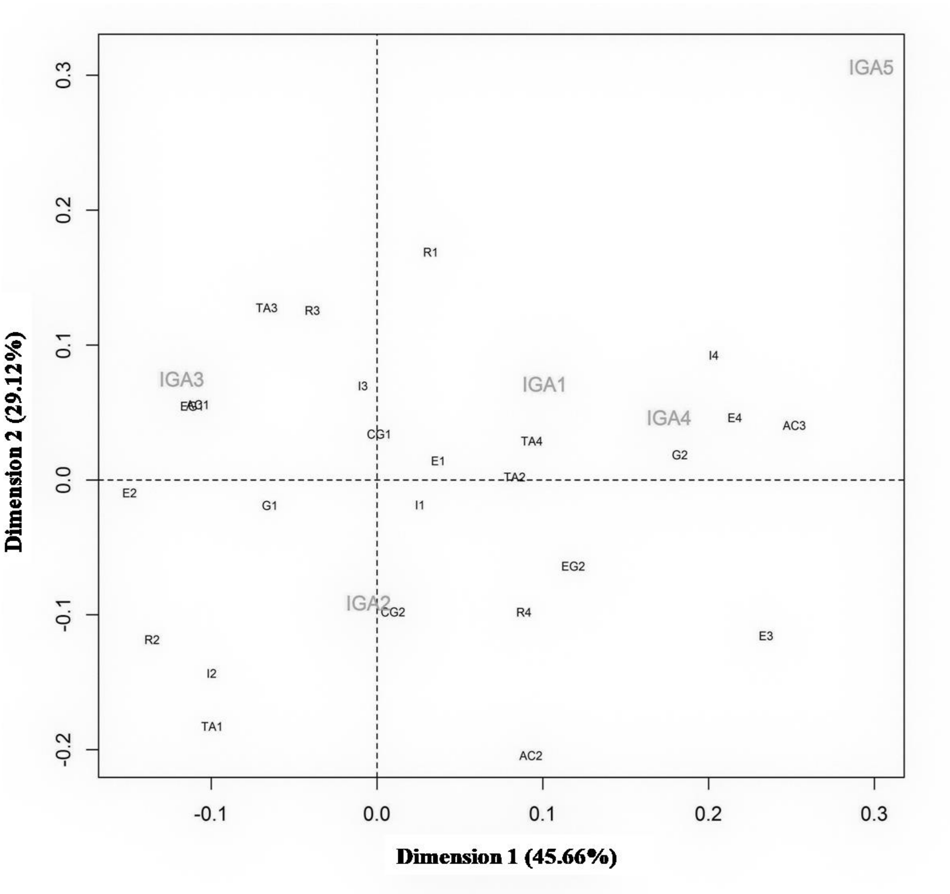

Figure 1. Correspondence Map of the multiple choice items on teachers' perception about genetic and environmental influence in Intelligence and the sample groups.

IGA1=only genes; IGA2=more genes than environment; IGA3=genes and environment in equal parts; IGA4=more environment than genes; IGA5=only environment. G1=Female; G2=Male; AC1=human sciences; AC2=biological sciences; AC3=exact sciences; EG1=studied genetics; EG2=did not study genetics; CG1=knows genetics; CG2=does not know genetics; E1=complete higher education; E2= complete higher education with specialization; E3=master's degree; E4=doctorate and postdoctoral training; R1, R2, R3 and R4=income ranges in increasing order; I1, I2, I3 and 14=age ranges in increasing order; TA1, TA2, TA3 and TA4=times of activity in increasing order.

On teachers' perception about Learning Difficulties, the items that demonstrate perception of exclusive genetic influence (IGA1) or to some extent (IGA2, IGA3, IGA4) appear on the map together with the sample groups. The item that demonstrates exclusive perception of the environment (IGA5) appears distant and unrelated to any of the teacher groups.

The other important cluster here is of the 'only genes' (IGA1), 'more genes than environment' (IGA2) and 'genes and environment in equal parts' (IGA3). This cluster is separated from 'more environment than genes' (IGA4). This cluster is associated most notably the lower schooling groups (E1, E2), the female group (G1) and the human sciences group (AC1). The complementary groups to these: greater education (E3, E4), male (G2) and of the biological sciences (AC2) and exact sciences (AC3), has no association with any item.

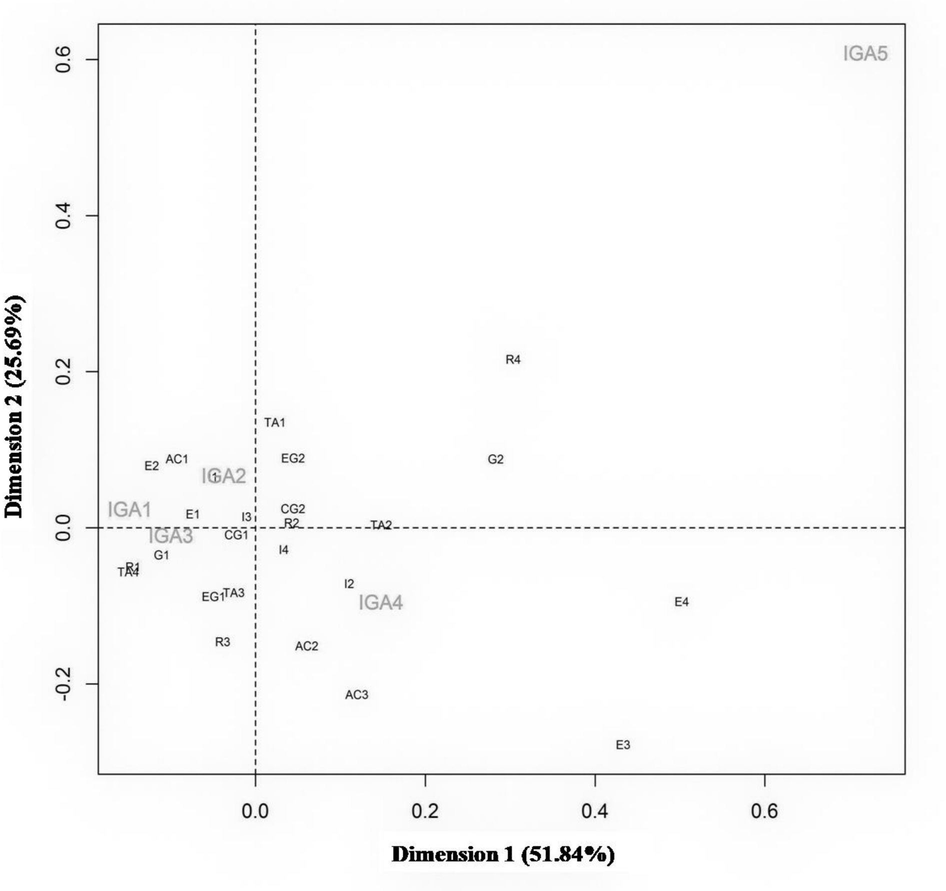

Figure 2. Correspondence map of the multiple choice item son teachers' perception about genetic and environmental influence in Learning Difficulties and the sample groups. IGA1=only genes; IGA2=more genes than environment; IGA3=genes and environment in equal parts; IGA4=more environment than genes; IGA5=only environment. G1=Female; G2=Male; AC1=human sciences; AC2=biological sciences; AC3=exact sciences; EG1=studied genetics; EG2=did not study genetics; CG1=knows genetics; CG2=does not know genetics; E1=complete higher education; E2= complete higher education with specialization; E3=master's degree; E4=doctorate and postdoctoral training; R1, R2, R3 and R4=income ranges in

increasing order; I1, I2, I3 and 14=age ranges in increasing order; TA1, TA2, TA3 and TA4=times of activity in increasing order.

Discussion

This study analyzed the perception of Brazilian teachers regarding the genetic and environmental influence on the cognitive ability of their students. The novelties are the analysis of the perception of the sample groups regarding intelligence and learning difficulties, which had not been done previously (Antonelli-Ponti, et al, 2018), and the analysis of the scales from 0 (zero) to 10 that evaluate the perception regarding the weight that the teachers attribute to the each factor (genetics and environment). The latter brings important results on genetic determinism and additive or interactive perception in this sample.

Most of the participants attributed high values both to the weight of the genetic influence and to the influence of the environmental influence in the two domains (Table 3). The extreme perceptions (zero for genetics and 10 for environment or 10 for genetics and zero for environment) were higher in intelligence than in learning difficulties (Table 2). However, the percentage was higher for responses 10 for genetics and zero for environment, demonstrating evidences about belief in genetic determinism, especially for intelligence. The interactive answers (10 for genetics and 10 environment, simultaneously) was also higher in intelligence than in learning difficulties (Table 2). At the same time as there are beliefs in genetic determinism, radically considering only genes, there is also an interactive perception that attributes maximum value to both factors. Interactive perception does not impose a degree of importance between the factors, considering that the traits are "100% innate and 100% acquired" (Jacquard & Kahn, 2001, p. 167).

Perceptions that only environment influences the cognitive abilities did not associated with no one sample group. The next sections will discuss the results separately, beginning the perception about intelligence, followed by the perception about the learning difficulties.

Teachers' perception about Intelligence

The numerical scales' results show greater acceptance of the genetic influence on intelligence. The concentration of responses above five is higher on genetic scale than on environment scale, and the difference between scales is statistically significant.

About the multiple choice questions, the item "environment only" (IGA5) is far from the sample groups; the items that contain genetic influence and all the groups of teachers appear sparse, with no concentration between them (Figure 1). This scenario shows that the population evaluated has a rather diversify perception. People who consider intelligence a fixed attribute had a greater tendency to believe that intelligence is innate and that the brain has little plasticity, while people who consider malleable intelligence have tended to believe that intelligence can suffer interference from the environment and that the brain can change throughout life (Thomas & Sarnecka, 2015). In the cited study, as in the current result, the perceptions were distributed in a *continuum*, not only in two extreme points, demonstrating that the interaction between organism and environment is considered in various degrees.

Age groups are scattered without a clear pattern of visualization or important association, however, the younger range (I1) appears without an association, but the older age group (I4) is associated with "more environment than genes" (IGA4) (Figure 1). Perceptions by age strata were inverted if we compare with an earlier study (Human Genetics Commission, 2001), which younger people considered the role of the environment and older people emphasized the role of genes in intelligence.

The highest level of schooling (E4) is associated with item IGA4 (more environment than genes). The E1 group is not strongly associated with any of the items but appears between IGA2 (more genes than environment) and IGA1 (genes only). Considering the more inactive items IGA1 and IGA2 when compared to items IGA3 (genes and environment in equal parts) and IGA4 (Figure 1), we found similarity with the study of Cástera and Clément (2014) which found that the higher the number of years in the graduation, the smaller was the level of genetic determinism of the evaluated teachers. Another group that understood the interaction between genes and environment is educated mothers with schooling and with more than one child (Willoughby et al., 2019). Still comparing the present study with the aforementioned study, knowledge in biology did not influence beliefs in innatism (Castéra & Clément, 2014). Here, we note that the three major areas of knowledge are associated with items that consider the two factors, the human area (AC1) is associated with IGA3 - and quite associated with having studied genetics in its formation (EG1), which we suppose be related to the genetic epistemology of Jean Piaget; the biological area (AC2) is closer, but not associated, to IGA2; and the exact area (AC3) shows an association with IGA4. Regardless of the area, we agree that investment in years of study and continuing teacher training and education may reduce the belief in genetic determinism among teachers.

Mother with more children may be able to observe the difference between them, the similarities with parents and the influences of shared and non-shared environments (Willoughby et al., 2019). It could be expected that teachers of students at different ages would perceive influences on intelligence differently, according to the stage of cognitive development. It can be argued, however, that the probability of teachers with lower levels of education (E1) acting at initial levels of education with children and adolescents is higher, and teachers with higher levels of education (E4) are more likely to act at advanced levels of education, with adult learners. In this case, the E4 group (as well as the older group I4) associated in AC with IGA4 reveals the perception of common sense, which suggests that the environment exerts more influence as experiences accumulate throughout life (Asbury & Plomin, 2013). However, studies show that genetic influence, which is lower in childhood, increases in adolescence and young adulthood (Haworth et al., 2011) and continues over time until cognitive capacity is considered "is almost as heritable as height" (Asbury & Plomin, 2013, p. 6). On the other hand, the most important environmental influence is the non-shared, which remains important and relatively stable during life and that shared environmental influence is greater in childhood and decreases throughout development (Haworth et al., 2011).

The result of this research, a lot of perception of influence of the two factors including a portion of interactive perception, is optimistic. Non-deterministic teachers can value personalized contact and personal experiences in childhood through the promotion of diversified environmental stimuli of great importance, since the susceptibility to such interventions may activate genes for intelligence in the phenomenon of genetic innovation (Briley & Tucker-Drob, 2013). The varied possibility of choices in childhood will provide the selection of the environment appropriate to the genetic predisposition of each individual, since the genetic influence prevails or equals to the environmental one during a time (Asbury & Plomin, 2013). In subsequent stages of individual development and school maturation, insertion into the chosen environment will lead to the phenomenon of genetic amplification, and consequent genetic decline regarding unselected environments (Briley & Tucker-Drob, 2013). Considering the relationship between intelligence and academic performance (Deary et al., 2007) as well as gene-environment correlations (Plomin et al., 2016), directed strategies are necessary for students to perform to the fullest of their abilities and the breadth of their predispositions.

Teachers' perception about Learning Difficulties

The majority of the participants attributed values equal to or greater than five to the weight of genetic influence as well as the environmental influence (Table 3). The dispersion between the two scales is very small (Table 1), and there are not statistically significant differences between them. This, plus an amount of interactive responses (10 for genes and 10 for environment), shows acceptance about the interaction of the two factors, and an interactive perception (Briley et al., 2018; Jacquard & Kahn, 2001), contrary to the additive perception, similar to studies with twins which need to quantify heritability and environment (Erbeli et al., 2018).

In this domain, dichotomous responses to scales appear less than intelligence responses, but maintain the pattern: more teachers assigned maximum value (10) for genetics and none (zero) for environment in a deterministic perception that the diagnosis is irreversible; and fewer teachers assigned the maximum value (10) for environment and none (zero) for genetics attributing that the family, neighborhood or/and school environment are determinants of such difficulties.

In a Brazilian teacher sample, was ascribed the family environment as a predominant factor for learning difficulties (Oliveira, Santos, Aspilicueta, & Cruz, 2012). Although it is reported as a family environment, if we consider the passive and reactive gene-environment correlation (Plomin et al., 2016) such perceptions seem to implicitly accept the genetic influence in this domain. The Figure 2 show (IGA1), "more genes than environment" (IGA2), "genes and environment in equal parts" (IGA3) and "more environment than genes" (IGA4). The item "environment only" (IGA5) appears quite far away, revealing the acceptance of genetic influence by the teachers.

Castéra and Clément (2014) found that the fewer years of schooling of the teachers, resulted in a more innate viewpoint. It can be seen that E1 and E2 (full superior and specialization) are associated with items that may be considered more innatists (IGA1 and IGA2), while E3 and E4 (masters and doctoral / postdoctoral, respectively) appear on the less innate side of the map less (Figure 2). Gericke et al (2017) did not find differences between the participants with greater and less knowledge in genetics in relation to the beliefs in genetic determinism. The approximations observed in the groups that declared that they had not studied aspects of genetics (EG2) and did not have knowledge in genetics (CG2) were among themselves and with the perception of greater genetic influence (IGA2). The group who declares that would have studied genetics during teacher training (EG1) is not associated with any category of response but is closer to IGA3 (genes and environment in equal parts). The group who declares to have knowledge in genetics (CG1) is positioned between IGA2 and IGA3 (Figure 2).

The genetic influence referred by behavioral genetics does not label extreme positions of the curve as abnormal (Asbury & Plomin, 2013; Plomin et al., 2016). This hypothesis, allied with the balanced and interactive perception of teachers founded here, is encouraging because it excludes the possibility of categorized diagnosis, which may lead parents and teachers not to offer incentives for children to overcome their limitations (Asbury & Plomin, 2013). Genetic formation on teachers' courses may assist in the extinction of deterministic beliefs and consequently diagnoses that label individuals based on the perception about the etiology of their learning difficulty.

Limitations and future research

Although we have a significant sample, it is not representative, which is a weakness of the study. In addition, the division by demographic characteristics generates smaller groups. By getting larger sample other comparative analyzes among groups could be performed.

The research instrument in present study assesses the explicit teachers' perceptions; an instrument that measures the same perceptions in an implicit way may bring new results. Furthermore, would be useful include an instrument for assess teachers' practices in order to understand if the perceptions and beliefs affect the way how teachers deal with and invest in their students.

There is evidence that beliefs related to people's potential for intelligence can be shaped by culture (Rattan et al., 2012) and by political views (Willoughby et al., 2019). Personal or family experiences of diseases or genetic tests can collaborate in the formation of perceptions, characterizing belief in genetic determinism (Senior et al., 1999). Beliefs in genetics determinism can be the origin of determinist beliefs in families with a child diagnosed with learning difficulties, leading to accommodate behaviors both in family and school. The experiences and observations can be used in a positive way. In the lack of particular experiences, it is known that learning can occur through observation (Mendes & Seidl-de-Moura, 2016), which should be considered in future studies using, for example, overcoming stories (Bernard, Dercon, Orkin & Taffesse, 2014). The promotion of knowledge about the interaction between genes and the environment, going beyond of examples of Mendelian genetics, may be relevant in the ongoing training of teachers (Crosswaite & Asbury, 2018), and may also serve as an incentive to the creation of new ways of acting.

Conclusion

This study found that overall teachers placed emphasis on the role of both genetics and environment in explaining differences for both intelligence and learning difficulties. It was found that emphasis on the role of genetics was particularly pronounced for intelligence. Perceptions changed little based on various demographic factors suggesting that across the teaching population views were homogenous.

These findings mean although there are deterministic perceptions about cognition as well as additive perceptions, separating the influence of factors and placing a greater weight on some of them, a new form of perception is emerging: the interactive perception about cognition, considering the interdependence between genes and the environment.

We believe that the characteristics of the groups are not highly evident because we are experiencing a time of change perception on this issue and, in this sense, promoting more information about behavioral genetics has the potential to generate greater understanding about influences and to decrease deterministic beliefs.

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