

Science stories for children: an analysis of children's books from the perspective of invisible narratives

Histórias de ciências para crianças: uma análise de livros infantis em uma perspectiva de narrativas invisibilizadas

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Abstract: This article examines children's literature with scientific themes and its role in shaping children's scientific identity. The objective is to investigate whether the discourse and representations present in these books contribute to critical and inclusive science communication. To this end, seven children's books were analyzed through content analysis, considering aspects such as scientific content and social representations, with a focus on gender, race, and class stereotypes. The research highlights the importance of language in communication and literature as a tool to shape social representations and evoke emotions. The results indicate that most stories portray science in line with contemporary references of science communication. However, although there has been progress in the representation of diverse characters, stereotypes still persist and must be addressed to create inclusive and empowering narratives.

Keywords: public communication of science, literature, ethnic-racial relations, gender equity, representations.

Resumo: Este artigo examina a literatura infantil com temas científicos e seu papel na formação da identidade científica das crianças. O objetivo é investigar se os discursos e representações presentes nesses livros contribuem para uma divulgação científica crítica e inclusiva. Para isso, foram analisados sete livros infantis brasileiros por meio da análise de conteúdo, considerando aspectos como conteúdo científico e representações sociais, com foco em gênero, raça e estereótipos de classe. A pesquisa destaca a importância da linguagem na comunicação e da literatura como ferramenta para moldar representações sociais e evocar emoções. Os resultados indicam uma representação da ciência na maioria das histórias alinhada às referências contemporâneas de divulgação científica. Porém, embora haja progresso na representação de personagens diversos, estereótipos ainda persistem e devem ser combatidos para criar narrativas inclusivas e empoderadoras.

Palavras-chave: divulgação científica, literatura, estudos étnico-raciais, gênero, representações.

Introduction

Science is an integral part of culture. When we tear it out of the realm of culture or treat it as a second type of culture, we ignore the fact that scientists and science are also influenced by ideas found in literature, philosophy and the arts in general. Vogt (2012) attributed the bases for the disconnection between science and other cultural practices to the institutionalization of science, and to the distancing that results, which separates those who take part in scientific activity from those who do not share its practices, codes and values. From this perspective, the meeting point between science and society acquires a central position in the debate, given that:

Although it is an integral part of science itself, communication, when directed toward a public that does not participate in the scientific process from a technical standpoint — that is, communication with society in general — acts as a transformative element of science, embedding it within culture and thus shaping the third element of this relationship: scientific culture. (Vogt & Morales, 2016, p. 23)

In a reflexive way, scientific culture acts directly and indirectly on the broader formation of culture, increasingly and more quickly, so that social dynamics themselves are permeated by elements of science, in symbolic, imagistic and often structural ways (Castelfranchi & Fernandes, 2015). This being so, today it is “not only a ‘right’ of the public, nor even only a moral duty of scientists, technologies or politicians. It is, above all, a necessity, a societal and physiological techno-scientific process, inevitable.” (Castelfranchi & Fernandes, 2015, p.191).

Technoscientific citizenship (Castelfranchi & Fernandes, 2015) is indispensable for each citizen to have the right to make common choices that affect their life on a large scale. If science has become something that in practice permeates everyday life, it collides with many of the choices that directly influence our quality of life. Therefore, science communication that seeks simply to provide people with scientific content is not enough. After all, it is not knowledge alone that offers an individual the status of citizen, but rather the possibility of being able to decide.

In a scenario in which the right to communication is a privilege of certain social groups, narrations are reduced to points of view, corroborating the perpetuation of a single story (Adichie, 2018). Given that “Speaking is not restricted to the act of

emitting words, but of being able to exist” (Ribeiro, 2017, p.37), the construction of a single story is intrinsically associated with the notion of power. According to Adichie (2018, p.11), this power “[...] is the ability not only to tell the story of another person, but to make it be their definitive story”.

When we talk about culture, we are referring to the exchange of meanings among members of a group or society. According to the cultural theoretician, Stuart Hall (1997, p.38), “The relation between ‘things’, concepts and signs lies at the heart of the production of meaning and language. The process which links these three elements together is what we call ‘representation’”. Indeed, but if representation is essential to the processes by which meanings are produced, does this imply that meanings are not inherent to things or words? It is true that, once they have been constructed, meanings are fixed with so much strength that we begin to believe that these meanings have always been present in objects, people, experiences and languages. However, because representations are historically and socially situated, meanings can never be truly fixed.

It is by means of stereotyping that the representation of difference is configured. It is no accident that stereotypes have become a type of shared knowledge: they are perpetuated in different representational spaces, such as in the means of communication and in cultural productions. Thus, stereotyping is a set of representational practices that “[...] reduces people to a few, simple, essential characteristics, which are represented as fixed by Nature. (Hall, 1997, p. 257). By fixing difference, stereotyping also determines limits, excluding everything that is outside them and establishing “[...] a symbolic frontier between the ‘normal’ and the ‘deviant’, the ‘normal’ and the ‘pathological’, the ‘acceptable’ and the ‘unacceptable’, what ‘belongs’ and what does not or is the ‘Other’ [...]” (Hall, 1997, p. 258).

By functioning as a means of legitimizing social arrangements that exclude, stereotypes help to maintain the social and symbolic order. This political dimension of stereotyping tends to show up as a result of asymmetric power relationships that exist in society. Then:

Power [...] has to be understood here, not only in terms of economic exploitation and physical coercion, but also in broader cultural or symbolic terms, including the power to represent someone or something in a certain way – within a certain ‘regime of representation’. It includes the exercise of *symbolic power* through representational practices. Stereotyping is a key element in this exercise of symbolic violence. (Hall, 1997, p. 259, author’s emphasis)

Scientific culture is mostly and traditionally studied using analyses that take into consideration, especially, the public’s lack of knowledge of science. However, it

can – and should – be understood by means of deeper cultural aspects, such as stereotypes of scientists that recur in cultural communications and productions.

A systematization of these classic stereotypes, originally done by Haynes (2003) from an analysis of Western literature, pinpoints seven recurrent representations: the evil alchemist — arrogant, thirsting for power, involved in illegal and secret activities, who only communicates with his peers; the noble scientist — the hero or savior of society, altruistic, intelligent and humble, always trying to provide explanations for everything; the foolish scientist — eccentric, dazzled by absurd types of research, uninterested in humanity; the inhuman scientist — obsessed by science to the point of sacrificing his emotions and personal relationships; the adventurous scientist — courageous, resilient, optimistic and able to defend science as a tool for overcoming difficulties; the mad scientist, evil and dangerous — paranoid, megalomaniac, threatening to destroy the planet if he does not receive what he desires; and the helpless scientist — victim of his own findings, incapable of predicting the consequences of his research.

The representation of the standard image of a contemporary scientist is also usually associated with a series of elements that characterize the figure. In trying to decipher them, Mead and Metraux (1957) mapped indicators that reinforce that classic stereotype: lab coat or uniform; glasses; abnormally large beard, mustache or sideburns; symbols of research activity (scientific instruments and laboratory equipment); symbols that represent knowledge (books, shelves and cupboards); technological products; appropriate captions (formulas, taxonomical classifications, the interjection ‘Eureka’, etc.). For each of these elements, a symbolic value is always attributed:

“Eyeglasses, for example, are associated with eye strain (and thus intense observation). Lab coats are associated with dirty work (and thus experimentation and empirical knowledge), but also with purity (functioning symbolically as priestly white robes). Beards may be seen as meaning “unshaven” (working long and unusual hours) or may represent, as suggested by Mead and Metraux, “deviation from the accepted way of life” [...]; or, finally, beards may represent wisdom and possession of knowledge.” (Chambers, 1983, p. 258)

Once we have assimilated the relevance of social representations in the determination of culture, the question remains: what are the possible means by which we circumvent and deconstruct these stereotypes? Fortunately, the answer lies in the representational field itself. Because signification can never be fixed, it can also be reversed, generating new representations of the difference. To this end, some strategies can be adopted in a transcodification process, such as: (1) inverting

stereotypes; (2) attempting to replace negative images with positive ones; and (3) contesting the representation using a new view that aims to defamiliarize it (Hall, 1997).

For each of the approaches mentioned, there are negative implications. For example, simply inverting stereotypes does not evade the contradictions of the binary structure and, although the inclusion of positive images increases diversity, the negative aspect is not necessarily displaced. According to Stuart Hall (1997), we often grant the status of cultural change to what is, in fact, merely a multicultural deviation. After all, changes in representations resulting from political struggles are generally accompanied by the persistence of oppressive old patterns. Finally, it is important to emphasize that mere imagistic representativeness does not in itself construct a political project of emancipation, especially when such images are emptied of meaning.

Since systems of representation are incorporated early on by children in their formative processes, the same “becoming” is associated with the different identities that make up historically oppressed social groups. For this reason, strategies of contestation that include child audiences are both necessary and urgent.

Children’s literature has been considered an important ally in science education. It makes it easier to understand specific scientific concepts by means of metaphors, examples and other strategies, as well as promoting curiosity and intrinsic motivation to understand scientific phenomena in the world (Cruz & Breda, 2024). Mora (2015) emphasizes the closeness between science and esthetic language, highlighting that literature should not just be seen as a didactic support tool, but as a means toward humanization and cultural dialogue. Zanetic (2006) advocates that reading literary texts can underpin the construction of a critical spirit in relation to the world and contribute epistemologically to a scientific understanding of nature. Almeida and Sedano (2020) affirm that the planned use of literary works allows for “discussions about phenomena and concepts in the sciences in a creative, imaginative and esthetic way” (p. 19). Furthermore, literature is a powerful ally in contextualizing the role of science in society and its historical processes (Piassi, 2012; Almeida & Sedano, 2020). Piassi (2012) proposes that these texts may contribute within three spheres: conceptual-phenomenological, historical-methodological and sociopolitical.

With this in mind — believing in the power of children’s literature as an “especially appropriate instrument for exploring the integration between cognitive and affective aspects [of children]” (Schall, 2005, p.16) — we advocate the importance of

books related to science in the set of activities regarding science communication that are capable of consolidating scientific culture in society. This importance is mainly in the context of non-formal education, outside school, where these books help to construct this culture within family environments. However, if this strategy is to transcend the limits of hegemonic groups, it is vital to understand that the social representations present in these narratives are just as important as the scientific content that they convey.

Methodology

Building on the discussion presented in the previous section, we formulated the main question of our study: do the discourse and representations currently conveyed in children's books with scientific themes contribute to critical and inclusive science communication? Bearing in mind the current situation, in which participation and interest in science are associated with socially privileged individuals, we hypothesize that the existing books, rather than helping to construct more plural scientific identities, instead help to maintain the current reality.

Considering that our analysis lies within the realm of non-quantifiable meanings, we implemented a qualitative research approach, centered on the development of plausible interpretations of the selected works, using content analysis (Laurence Bardin, 2011). Since the objective of our research is to evaluate the discourse circulating in children's literature with scientific themes, analyzing representations of science, scientists, and the roles involving gender, race, and class occupied by the characters, the documents selected for content analysis needed to provide this kind of information.

The pre-analysis stage of the research systematized the initial ideas by selecting documents, formulating hypotheses, and preparing indicators (Laurence Bardin, 2011). In our case, the *a priori* formulation of the objective and hypothesis based on the bibliographic framework led us to select documents and construct indices that were capable of confirming or refuting our original intuition.

The selected works had to feature human or anthropomorphic characters and be aimed at children. Given the absence of a catalog of contemporary scientific children's books, the corpus was built up from recommendations published by the magazine *Ciência Hoje das Crianças* [Science Today for Children] (CHC), recognized for its tradition in science communication and distribution in public schools. Its literary sections, such as #Superdicas [Supertips], provided titles with the

potential to influence children's reading habits and scientific identity. The books included in the research corpus were those featured in its literary sections between 2012 and 2020. The selection of books followed the criteria of pertinence, homogeneity, and exhaustiveness (Laurence Bardin, 2011). The very inclusion of the books in these lists, based on recommendations from the magazine's scientific editorial staff, already characterized the pertinence of the scientific theme in the works. Each book was defined as one registered unit in order to allow for a comprehensive analysis of the works. Finally, to complete the selection, works found in the personal collections of the authors of this article were also added.

We categorized the recommended books according to the extent to which they valued diversity in gender, race, and class in the construction of the narrative. The criterion aimed to identify children's works of literature with scientific themes that already addressed the issue of diversity. However, it is important to emphasize that merely fulfilling this criterion was not sufficient for a mapped book to be subsequently selected.

We identified the works that contained most material for the analysis of representations of science, scientists and roles involving gender, race and class, as occupied by the characters. This led us to select the books "Albert (volume 2)", "Albert (volume 3)", "Ada Batista, cientista [Ada Twist, Scientist]", "A curiosidade premiada [Curiosity Rewarded]", "A menina que contava [The Girl who Counted]", "Canta sabia [Sing, Songthrush]", and "Serradacapivara.com: os incríveis desenhos desses homens misteriosos [Serradacapivara.com: The incredible rock paintings by those mysterious men]". We thus limited the scope of our analysis to seven examples.

Finally, to proceed with the analysis of the targeted content, it was necessary to define the comparable units of categorization, preparing the ground for the data. These units often include words, sentences, phrases or paragraphs. In our case, we opted to define the entire book as a unit to be registered, as we were seeking a complete view of each work and, moreover, the selected books are quite short, in terms of number of pages.

Table 1*Codification of the books selected*

Name of the book	Authors and illustrators	Publisher	Year of first publication	Codification
Albert (volume 2)	Lani Yamamoto	Farol Literário	2004	Book A
Albert (volume 3)	Lani Yamamoto	Farol Literário	2004	Book B
Ada Batista, cientista	Andrea Beaty and David Roberts	Intrínseca	2016	Book C
A curiosidade premiada	Fernanda Lopes de Almeida and Alcy Linares	Ática	1978	Book D
A menina que contava	Fábio Monteiro and André Neves	Paulinas	2013	Book E
Canta sabiá	Giselda Laporta Nicolelis and Nilton Bueno	Formato	2012	Book F
Serradacapivara.com: os incríveis desenhos desses homens misteriosos	Denise Crispun and Mariana Massarani	Global Editora	2012	Book G

Once the books had been selected, a protocol for content analysis was needed, in order to construct a codification system that “[...] by cutting, aggregating and enumerating, allows a representation of the content or of its expression to be reached [...]” (Bardin, 2011, p.133). In this case, we adopted *a priori* categories for the content analysis and based this on a protocol that was originally dedicated to the analysis of news about science and technology transmitted by TV news channels — developed by the Ibero-American Network of Monitoring and Capacity-Building in Scientific Journalism (Ramalho et al., 2012). This protocol has the objective of studying the frameworks used – in other words, “a central organizing idea that provides a context and suggests what the problem to be dealt with is, by means of criteria of use, selection, exclusion and elaboration” (Ramalho et al., 2012, p. 15). It has already been successfully adapted to analyses of the representation of scientists in works designed to entertain, such as cartoons (Reznik, Massarani, & Moreira, 2019) and podcasts (Lopes, 2022).

Naturally, this protocol had to undergo a series of adaptations in order to be applied to a sample of children’s literature books with scientific themes featuring human or anthropomorphic characters. To this end, thematic categories of analysis were developed in an attempt to classify the “[...] constitutive elements [...] by differentiation and, subsequently, by regrouping according to genre (analogy), using

previously defined criteria” (Bardin, 2011, p. 147). With this in mind, we defined four main dimensions through which the following aspects are evaluated: the main characteristics of the book, its characters, the role of science, and the structure of the narrative. Table 2 presents a schematic version of the protocol used in the present study.

Table 2

Protocol for the codification of elements of science communication, gender, race and class present in the selected books. Adapted from Ramalho et al. (2012)

Dimensions	Categories of analysis
General characteristics	Publication date Team responsible: author, illustrator, translator, publisher Elements on the cover: title, illustration, relevant data
Characters	Representation of children Representation of non-scientist adults Representation of scientists
Scientific elements	Centrality of science Scientific subject dealt with Image of science and of scientists Perspective of science communication
Narrative	Narrative arc Role of science Questions of gender, race and class

The first dimension of the protocol concerns the general characteristics of the selected book. The purpose of this dimension is to situate the unit of analysis within the sample by recording certain data that allow it to be identified — this is a dimension that is not used in the content analysis itself.

The second dimension focuses on the physical and psychological characteristics of the characters, as presented both in the texts and in the illustrations. With the intention of helping to detect possible social stereotypes, the categories created systematize information regarding children, adults, and scientists, if they are present. To this end, the characters’ involvement with the scientific universe is evaluated, as are the gender performances and the race and class roles assigned to them. Through these lenses, the following aspects are analyzed: how do different characters react to the same situation? What are their habits? Which objects are associated with them?

In an attempt to exhaust all the aspects that allow a work to be considered a book with a scientific theme, the third dimension of the protocol examines scientific elements from different angles. The first concerns their centrality to the plot: although the books were selected because of their connection to the scientific universe, this does not mean that science is explicitly mentioned in the text. In any case, all the books are permeated by scientific content, even if indirectly; therefore, the second

category of this dimension features this content. The third category addresses the images of science and scientists that are constructed. What vision of scientific practices, processes, and agents does the book feed into the popular imagination? It is worth emphasizing that, in this case, it does not matter whether the narrative lacks scientist characters, since the protagonists' main characteristics are usually built upon this profile. Finally, the fourth category seeks to establish a bridge between these images conveyed and some messages that are commonly encouraged in initiatives that value more effective science communication.

The final dimension of the protocol examines the narrative presented, seeking to consolidate a broader view of the story as a whole. For this, we describe the narrative arc; we evaluate the role of science in the development of this arc, focusing on how the presence of scientific elements contributes to the flow of the story. We also highlight the issues of gender, race, and class that permeate the work, evaluating both the representations of the characters described in previous categories and any other indicators that may stand out.

Results

As described in the methodology, the selection and then reading of the books allowed us to create a protocol for codification (Table 2) of the elements of science communication, gender, race and class present in the chosen books. This protocol was applied individually to each of the seven works selected. The complete codification of the application of the protocol, with the elements that were significant for the framework, can be consulted in Machado (2021).

General Characteristics

Book A and Book B correspond, respectively, to volumes 2 and 3 of the same literary collection. Both books, which were originally published in Iceland, were first launched abroad in 2004 and in Brazil in 2012. Written and illustrated by the same author (North American, but having lived for decades in Iceland), the works were translated by a science professional who has a high profile in the media: the physicist and scientific communicator Marcelo Gleiser. On the book covers, some subtle elements show the relationship between the work and the universe of science. The first of these is the title of the collection, which refers to the main character, named after the prominent physicist Albert Einstein, one of the greatest references among

scientists, in the popular imagination. The second is the way in which the volume in the series is indicated, always by alluding to an exponential (mathematical element), and the third is the representation of the main character, who is wearing pajamas printed with planets in Book A, and in Book B is adjusting the symbol that refers to the volume in the series. Besides these elements, in both Book A and Book B, the name of the translator is shown on the front cover, instead of appearing only inside the book, as is usual. This allows people who know of the scientist to associate these books immediately with children's books that have a scientific theme.

Book C was first published outside of Brazil in 2016 and is part of a literary series created by an American author and illustrator, in which each book tells the story of a child beginning to discover their professional aptitudes. Written in verse form, the books were translated by a Brazilian poet and released in Brazil in 2019 as part of the *Young Thinkers Collection*. The volume analyzed refers to the profession of scientist and, in addition to bearing the word “scientist” in the title, it also carries the name of the main character who, as in Book A and Book B, is named in honor of a historical figure in science, in this case, Ada Lovelace, a mathematician and writer recognized for her pioneering efforts in computing. To reinforce the association with the scientific universe, the background of the cover image simulates graph paper. On the front cover, the protagonist (wearing gloves and safety goggles) writes formulas on the wall while her older brother points at her in alarm; on the back cover, she shares drawings of planets with her family members, surrounded by experimental contraptions (Chambers, 1983).

Book D is the oldest work in the selection. Produced by a Brazilian team — in which the author also scripted the illustrations — the book was first published in 1978. The success of the work led to multiple reprints; in the present study, we analyzed the twenty-second edition. Unlike the aforementioned works, the elements on the cover do not suggest as strong an association with the scientific universe, featuring only the noun “curiosity” in the title, alongside an illustration of the protagonist attentively observing a bee pollinating a flower.

Book E, also originally Brazilian, was published for the first time in 2013. The author and illustrator mix elements from the world of mathematics with some figures that symbolize the practice of cutting and sewing. A good example is the title, which includes the verb “counted”, in which the letter “o” is replaced with a button. The illustration, with its graph paper background, like Book C, presents an image that simulates a sequence of upright books, showing their spines (Chambers, 1983), in which one is about chemistry and another about music.

Written by a Brazilian author responsible for more than one hundred works of children's and young adult literature, Book F was published in Brazil in 2012. On the cover, the title of the work refers to a well-known bird species, the Sabiá-Laranjeiras [Rufous-bellied Thrush]; and the illustration, created by a Brazilian illustrator, depicts the orchard where the story takes place, showing two thrushes caring for three eggs in a nest, while other birds appear in the background. From the cover, we already know that it is a story about animals, which generally denotes a strong association between the work and the scientific universe.

Finally, Book G, also a Brazilian production and published in 2012, was co-written, with the illustrator contributing to the construction of the narrative. On the cover, we see an explicit reference to Serra da Capivara National Park in the title, accompanied by the suffix ".com," simulating a website address. The relevance of this archaeological site to Brazilian archaeology — combined with the reference to technology — allows the book to be identified by someone who: (1) is looking for a book with an educational approach; and (2) has prior knowledge of the subject. In this case, the illustration of the protagonist superimposed on a photographic image of a local rock painting may help in the process of recognizing the work.

Characters

Although Book A and Book B do not present characters who are scientists, the protagonist in the series, a white boy, is named in honor of a famous scientist (Albert Einstein). In both volumes, the boy is frequently surrounded by objects or toys that allude to the scientific universe (Chambers, 1983). Bearing in mind that Book B works with the idea that the protagonist has gotten older since Book A, some of Albert's characteristics change from one volume to the other, as do his games, which include building things and playing outside or exploring nature. The other characters in the plot are his parents (both white), whose faces are never drawn. In Figure 1, from Book A, we can see that his father is wearing blue and appears in environments containing objects that allude to the scientific universe (Chambers, 1983), and his mother wears pink, appearing in environments full of domestic utensils, and in most scenes carrying a dishcloth or towel. In Book B, only his mother is present, represented caring for Albert's baby sister.

Figure 1

Representation of Albert's parents in Book A



Note. [Description of the image] We can see the marked difference in the representation of Albert's mother (on the left) and father (on the right). Although both are carrying out caregiver functions, the father always appears in environments with books or other symbols connected to science. [End of description].

Like these books, Book C does not show characters who are scientists, but there is a protagonist with a profile associated with science. Analogously, the main character in the book, Ada Marie, is also named after two famous scientists (Ada Lovelace and Marie Curie — but the story usually uses only her first name, including in the title). Ada Marie (a Black girl) is driven by challenges. She is always tidy, wearing a dress and clips in her Black Power hair. When she carries out scientific activities, she wears safety goggles and gloves (Chambers, 1983). Curious, observant and imaginative, Ada always notes down her tests and reflections, tests which usually create an enormous mess. As well as the protagonist, other children appear as characters in the narrative. The most significant is Ada's brother, a Black boy who plays tennis, wears sports clothes and has smelly feet. Shocked by his sister's behavior, he usually tells tales to his parents. To complete the cast of children, Ada's school friends appear in some scenes, always enthusiastic about the protagonist's experiments. Although the great majority of these friends are white, the number of girls and boys is balanced, and the clothing does not follow traditional gender demarcations (Butler, 2019). The adult cast is composed of Ada's parents and her teacher. The teacher, who is white, very heavily made-up and wearing tight clothes, is horrified by the girl's experiments. Although her parents, who always appear together, initially feel puzzled, frustrated and exhausted by their daughter's behavior, they come to admire her and study ways to stimulate her more. In Figure 2, we can see how the parents are represented. Her mother (Black) uses high heels, accessories and elegant dresses with African patterns, while her father (Black) wears a suit and tie and uses formal shoes. Both the clothes they wear and the objects in

the house show that this is a family from the upper classes, which, to some extent, points to representativeness coopted by capital (Fraser, 2009).

Figure 2

Representation of Ada's family in Book C



Note. [Description of the image] In the image above, we can see Ada and all her family at home. As well as the sumptuous clock and various objects on the floor, Ada's parents' clothes make it clear to which social class the family belongs. [End of description].

Unlike the previous works, Book D has a scientist character who answers questions happily and without hesitation. In Figure 3, we can see the astronomer, an elderly white man, appearing in only one scene. He fits perfectly into the traditional stereotype of the foolish scientist (Haynes, 2003): he has messy white hair, beard and mustache. He wears glasses and a lab coat. The protagonist in this story, Glorinha (a white girl), is extremely curious and is always asking questions and raising doubts. In a parallel with Ada Twist in Book C, she also frightens her parents with her "atypical" curiosity. Like the other girls who appear in this book, Glorinha uses a ribbon in her hair and wears a dress. Her youngest brother — a white boy, who wears a shirt and shorts like all the other boys present in the book — is not as curious as his sister, but his attitude is more investigative than hers. The differences between the two of them are shown in their games: Glorinha plays with a doll, and her brother likes to build things, drive a car and operate a machine. These gender roles are intensified in the adult characters. In general, the women appear as carers and the men as workers. In particular, the mother (white) serves coffee, talks on the phone, sews, puts the little brother to bed, takes the initiative to seek help for her daughter and is always present. The father (white) reads the paper, takes the initiative to seek out the scientist, drives the car and explores nature with a

magnifying glass. Most of the adults are female, apart from the father and a businessman, and white, apart from the housemaid (Black), the man from the countryside (Black) and the gardener (mixed race). It is worth pointing out that only one child in the story is Black: one of Gloria's classmates, with no speaking role.

Figure 3

Representation of the scientist in Book D



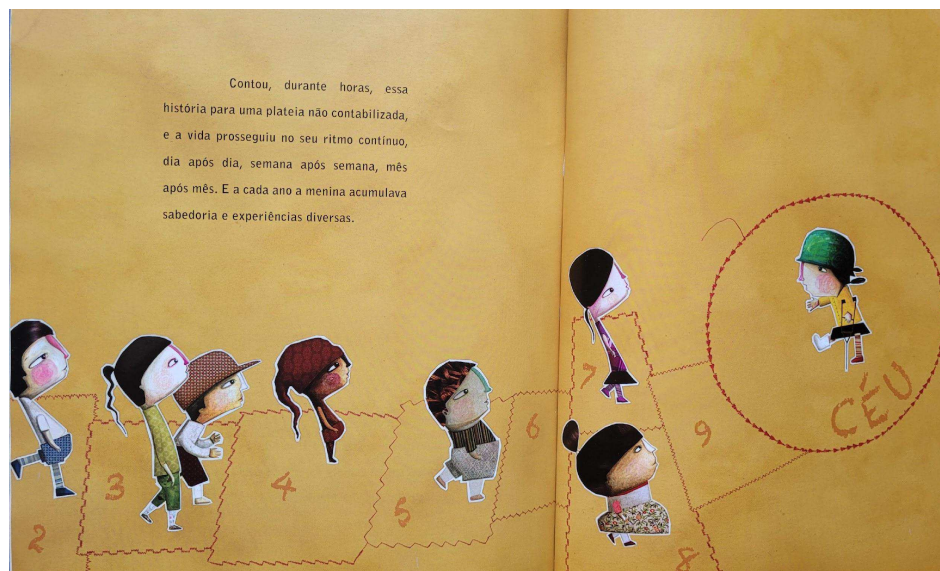
Note. [Description of the image] Glorinha and her family visit a scientist to answer some doubts. In the illustration of the character, we can see a series of features typical of the stereotype of the foolish scientist. [End of description].

The specific features of the illustrations in Book E, shown in Figure 4, make it difficult to analyze the characters' race in the same way. On the other hand, with respect to gender issues, the number of female and male children is the same, and their clothing is diverse. Alga, the protagonist, is a girl who sees numbers in everything and has fun with them; she is creative, poetic, and romantic in her mathematized interpretations of the world. Like Book A, Book B, and Book C, this story does not contain scientist characters. However, unlike the aforementioned works, the scientist profile is somewhat less developed in the main character, who simply has a strong aptitude for numbers. Alga, the best math student in her class, does not care about competition; what she truly values are relationships. Among them, the most significant emotional bond is between Alga and her mother, a seamstress. Alga's mother wears an apron, makes clothes with buttons for her daughter, and has sewing tools covered in numbers, reinforcing their presence in her daughter's universe. Finally, the story ends with the protagonist already an adult. At

this point, she occupies the roles of fiancée, wife, and mother, no longer having any explicit connection to numbers — only to her husband, a storyteller.

Figure 4

Representation of the children in Book E

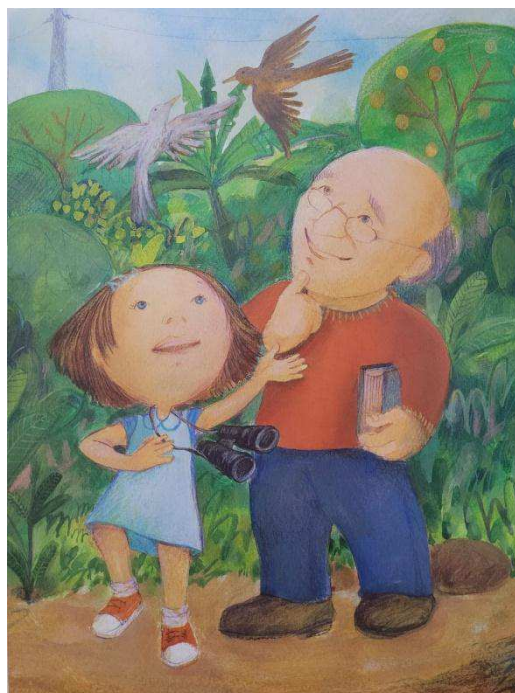


Note. [Description of the image] The child characters are always shown playing in the illustrations. In the image, one can see diversity in the representation of the characters. [End of description].

Book F has the active presence of only two characters: the protagonist, who is interested in scientific subjects, and the scientist, her grandfather, represented in Figure 5. Clara, the main character, is a (white) girl who likes to watch birds. She usually plays the role of a carer for these animals, and she is very affectionate and friendly. The girl, who always wears a dress and uses clips in her hair, sometimes carries her binoculars, which were a present from her grandfather, around her neck (Chambers, 1983). Highly curious, alert and perceptive, she looks for help from her grandfather and from books, to gain a deeper understanding of her subject of interest: bird behavior. Clara's grandfather, an elderly white ornithologist, wears glasses and always has a book with him. Dedicated to his profession, he spends his time deep in the woods, patiently observing birds. His years of work have given him much experience, leaving him with various answers on the tip of his tongue; as a result, he can answer all the questions raised by his grand-daughter, who likes to merge what she learns with some ideas present in classic Western fairytale narratives (Mora, 2015): "So she is going to be happy ever after, like a real princess in a fairy tale!" (Nicolelis, 2012, p. 23), concludes the main character, when she discovers that the bird that she has been watching has found a mate, resolving the great dilemma of the narrative.

Figure 5

Presence of elements associated with science in Book F



Nota. [Description of the image] Clara and her grandfather appear carrying symbols of scientific research (binoculars) or of knowledge (a book) in all the images in the book. [End of description].

In Book G, our only direct contact is with Maria, the story's main character, while everyone else is merely mentioned by her. Maria is a white girl with thick curly hair who usually wears loose-fitting clothes. Very technologically inclined, she generally carries a camera or a tablet and likes to document her travel experiences through reports and photographs. All these reports are sent to her father, who receives daily messages from his daughter after being informed that she is going to be traveling with her mother for work. Maria's mother occupies the role of scientist in the narrative. Like the other archaeologists who work with her in the field, according to Maria, her mother spends hours picking up little fragments, is meticulous, and studies a great deal: "Archaeologists spend hours 'picking up little fragments', bones, and pieces of objects. Everything is of value to them. [...] Maybe that's why Mom hates seeing me carelessly throwing things around my room." (Crispun & Massarani, 2012, p. 12). Besides taking care of her daughter, Maria's mother studies late into the night and enjoys detective novels. Film references are also present in the description of the father, who usually watches science fiction movies with his daughter. Imaginative, curious, and observant, Maria reflects deeply on what she learns in Serra da Capivara and still toys with the idea of making a discovery.

Elements of science

Before continuing, to avoid confusion it is important to state that, although the selected books have been classified as works in which science is “explicit” in the story, this does not mean that science is mentioned explicitly in the text. The centrality of science in the plot varies in the different publications chosen for the case studies, as evaluated in one of the categories of analysis found in this dimension.

The concept of science according to how a person perceives it is a social construct, influenced partly by the way in which that person interacts with science, their formal education, their exposure to science communication products, their social relationships and by the way in which the theme is represented in highly varied types of communication and entertainment. In general, science is presented to the public as an objective activity, characterized by the use of a strict method (Durant, 2005). To this end, issues such as the nature of the scientific method itself (Chalmers, 1993), and the idea of science as a collective undertaking, fruit of a scientific field with constant disputes going on (Bourdieu, 2003), are placed in the background in social representations of science.

In Book A and Book B, for example, science is never explicitly mentioned; however, it underlies the reflections made by the protagonist. In Book A, science appears primarily as a process. Thus, while addressing certain scientific themes (time, observation of natural phenomena, and the visibility of celestial bodies), the book also shows that science requires time to be produced, which is in line with recent discussions in science communication. From this perspective, the work may be classified within the contextual model (Brossard & Lewenstein, 2010), since it contextualizes the discussion about scientific time through play time. The images constructed around the main character portray scientists as creative and ingenious people who undergo long processes of observation and reflection.

In Book B, science appears not only as process, but also as content. Similarly to Book A, part of the process of scientific investigation is illustrated through everyday childhood play, for example when Albert reflects on his size while playing on the swing: “Sometimes, I am so big that I can jump over houses...” (Yamamoto, 2012, pp. 11–12). From that point onward, the work dives into a discussion of dimension, scale, and perspective, showing that scientific questions cannot be analyzed from a single point of view. Science, therefore, is constructed through successive observations and experiences, and the scientist is an explorer (Haynes, 2003) who investigates the same phenomenon from different angles.

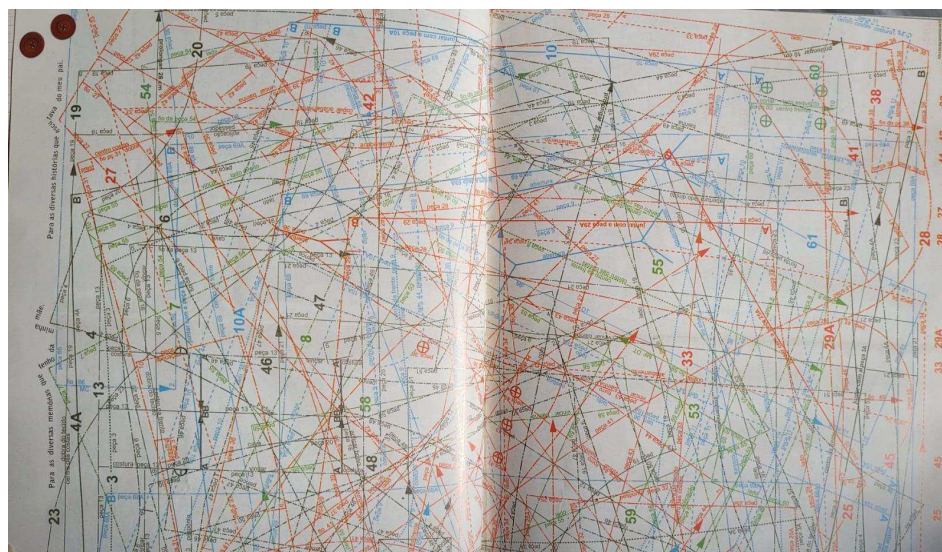
On the other hand, in Book C the explicit presence of science is not there as content but rather as method, and it is used to solve the mystery presented and characterize the protagonist. Starting with the profile of the main character, the book makes scientists appear curious, creative and tireless: “She asks lots of questions. How could she resist? It’s all in the heart of a young scientist” (Beaty, 2019, p. 32); but they are also chaotic and misunderstood: “Young Ada’s chaos wreaked havoc at school. But this much was clear about Miss Ada Twist: She had all the traits of a great scientist” (Beaty, 2019, p. 17). Failure is presented as part of this scientific process; after all, experiments need to be analyzed and reformulated, and not every investigation is conclusive.

In Book D, science is present in some of the questions asked by the protagonist, and it is explained, above all, in the visits to the astronomy observatory, to the botanical garden, and to the zoo. Besides the scientist, other people (the gardener, the zookeeper, the wise old woman in the neighborhood, etc.) are shown to be good sources of answers to the many questions asked throughout the story: “People who do things have a lot to tell you” (Almeida, 1995, p. 20), says the narrator. Thus, the book tells us that it is not only the scientist who does science: knowledge is also produced by other members of society, as the lay expertise model proclaims (Brossard & Lewenstein, 2010). In this scenario, in which science is motivated by curiosity and its issues permeate everyday life, knowledge is built up from observing nature and asking questions.

In Book E, science touches upon the protagonist’s observations and reflections and permeates the illustrations by means of numbers and other symbols (a telescope, a machine, etc.). Throughout the narrative, the dialogical nature of science is emphasized: the hard sciences (astronomy and, especially, mathematics) dialogue with other areas of knowledge (for example, literature) without any kind of hierarchy; in fact, knowledge is enhanced when constructed in an integrated and creative manner. The relationship established between mathematics and sewing, represented in Figure 6, also helps to illustrate how science can be perceived in different contexts, even in activities that are often labeled as completely unrelated to the scientific universe.

Figure 6

Relationship between mathematics and sewing in Book E.



Note. [Description of the image] The image that opens the story is a page of sewing patterns, typical of dressmaking. Full of numbers, this page emphasizes the parallel between the universes of sewing and of mathematics. [End of description].

Book F, of all those selected, is the one that deals with science in the most explicit way, as it is present in the description of observations that the protagonist and the scientist make, and in the explanations provided solely by the scientist. Despite indicating that science demands study if certain problems are to be solved, the work shows that scientists, even though they master their special area, are not the only ones capable of making scientific discoveries (Castelfranchi, 2010) and can be surprised by unexpected results. The story is constructed around some ornithological concepts (such as the characteristics and markings of gender in rufous-bellied thrushes, especially the ones that are semi-albino), and it also reinforces – as does Book A – the importance of respecting scientific time.

Book G resembles Book F in giving science the central position in the plot. Indeed, science is present in the various messages sent by the protagonist to her father, which are the result of observations she makes and questions she asks, as well as what she learns during her trip to Serra da Capivara. By presenting scientific concepts (archeological sites, rock paintings, prehistoric societies and animals) from the narration and references of a child, the book makes the dialogue with its young readers much stronger (Mora, 2015). In this adventure full of lessons to be learned about archeology, the main character learns that science is constantly being constructed, because scientific discoveries are made all the time, both by scientists (studious explorers who love mysteries) and by non-scientists.

Narrative

In Book A, after arguing with his parents — who never let him finish having fun with his games — Albert refuses to go to sleep and begins to contemplate the silent night. While observing the stars, the boy reflects on the time at which things happen, and he realizes that everything is always changing. In Book B, Albert, now a little older and with a newborn sister, starts hearing that he is a “big boy.” From that point on, he starts questioning the meaning of being big or small, embarking on a journey filled with dimensions and comparisons. In both works, the development of the narrative is supported by peripheral and symbolic elements (illustrations and reflections) that convey some images of science. The characters in the stories all belong to the same white, middle-class family, in which gender roles are maintained (hooks, 2018). The association between the protagonist and a scientist depends on the reproduction of certain social representations (Hall, 1997), both of science and of male children.

Book C in turn introduces us to Ada Twist, a girl who, the book tells us, has all the traits of a great scientist. Ada is always asking questions and discovering the world around her. One day, when she encounters a stinky smell, the girl decides to investigate it. For this she needs to face up to her greatest challenge: the difficulty her parents have in dealing with such a curious daughter. Given that the book proposes to describe the profile and adventures of a child who has the aptitude for a scientific profession, science directs the development of the narrative. Although the story revolves around an upper-middle class Black family, in which the parents share the caring functions and the daughter reproduces some of the images that are traditionally associated with the scientific universe, the elements of racial representativeness are present only in the illustrations, and non-white people are still in the minority at the school Ada attends.

Figure 7

Representation of the housemaid in Book D



Note. [Description of the image] The maid who works in Glorinha's house appears in two scenes, both in the kitchen, beside the cooker. At first, she is uncomfortable with the girl's questions about how to cook beans. Later, when Glorinha has learned to cook, the maid can be idle and is seen eating a banana. The racist representation of the character fits into the 'mammy' image of control. [End of description].

Book D, in turn, tells the story of Glorinha, a very curious little girl. As in Book C, the parents do not know how to deal with their daughter's personality. In this case, Glorinha's endless questions lead her parents to seek advice from the wise old woman of the neighborhood on how to handle the situation. After the woman diagnoses her with "accumulated curiosity," the family come together to help the girl find answers to her questions, and they begin to see the world and its mysteries through new eyes. Because of this, science serves both as the motivation for the construction of the narrative arc and as the resolution to one of the story's obstacles, which emerges when Glorinha starts asking more elaborate questions. Unfortunately, the book is permeated by a series of sexist, racist, and classist stereotypes. The reproduction of these stereotypes occurs both in the illustrations, as shown in Figure 7, and in the roles represented by the characters in the narrative structure. These representations are caricatured, reinforcing the most deeply rooted ideas of the popular imagination (Hall, 1997).

Book E introduces us to Alga, a girl who loves mathematics. Alga is always counting, calculating, creating formulas, inventing and solving problems. Time passes and the girl grows up, still involved with mathematics. Once she is an adult, she falls in love with someone who likes recounting just as she likes counting: he is a

storyteller. Reflections that are full of science help build up the identity of the character, differentiating her from other children, especially other girls, as the narrator insists: “Always different from most of her friends, Alga saw numbers in everything, and in things the numbers that she knew.” (Monteiro, 2013, p.1). Despite this, the story connects mathematics with elements usually considered to be feminine, such as sewing. However, its happy ending still lies in marriage and motherhood (hooks, 2018). Due to the nature of the illustrations in this book, it is difficult to identify the color or race of the characters, but few have dark skin tones.

In Book F we meet Clara, another curious girl. She lives in a house surrounded by an orchard full of birds. One day, during her observations, Clara discovers a rufous-bellied thrush that is different from the others; fortunately, her grandfather is a bird specialist and can help her to understand this bird better. The plot unfolds with the scientific concepts that the author wishes to introduce. So that they are clearly presented, the narrative is built up to contextualize the information (Brossard & Lewenstein, 2010). In this process, a parallel is also created between the behavior of the thrushes and the human beings, with hetero-normative and patriarchal romantic analogies: “They reject her because she is different [...]. None of the males want to mate with her, and so she’ll never have a companion. What a pity!” (Nicolelis, 2012, p.13), says Clara’s grandfather after discovering the gender of the semi-albino bird. And so, although this bird stimulates reflections about diversity, her happiness depends exclusively on being accepted by a mate.

Last of all, Book G is the report of Maria’s journey, when she accompanies her mother, an archeologist, on a field expedition to Serra da Capivara. During the trip, the girl writes a series of messages to her father, telling him everything that she sees and raising various points that are full of imaginative ideas about prehistoric times. Inspired by the archeological records at Serra da Capivara, this narrative works as a structure for the introduction of various scientific concepts in a more lighthearted manner (Brossard & Lewenstein, 2010). It is worth noting that, throughout the text, the expression “man” is repeatedly used instead of “human being.” Moreover, traditional gender roles are present in the protagonist’s interpretations of primitive life: “I can just imagine it: the men in front, with their pointy clubs, and the women beside them, carrying children in their arms and preparing a raw meat sandwich to eat whenever hunger struck” (Crispun & Massarani, 2012). And even though she appears wearing conventionally feminine clothing in only one illustration, as shown in Figure 8, it is precisely in that image that she is flirting with a boy.

Figure 8

Exemplification of gender performance in Book G



Note. [Description of the image] On the left we see Maria, with her usual loose-fitting clothes, looking at a rock painting. On the right, we see Maria in closer-fitting and more conventionally feminine clothes, performing her gender role (Butler, 2019) when she comes across a boy. [End of description].

Final Considerations

From the false idea of neutrality to linguistic preconceptions, language is a powerful tool for framing different bodies and separating distinct social realities, even within the school environment. Because we understand the power of language to access subjectivities, evoke emotions, and produce affective responses, we argue here for its central role in any communicative experience, and it is in literature that we see a field filled with new possibilities.

Literature studies both what was and what could have been, as well as what people used to believe to be true. In the case of literature with scientific themes, we are faced with a fundamental point in the debate on trans-disciplinarity: the meeting between science and art. By helping to break down the artificial barriers constructed between multiple fields of knowledge, the union of literature and science is much more than a utilitarian tool for facilitating the public's understanding of certain scientific concepts. However, for this encounter to function as a strategy for bringing science and society closer together — rather than science and a few privileged social groups — it is essential that the zeal applied to the social representations present in these books should be in step with the care taken with the accuracy of the scientific concepts being shared. Especially in the case of children's literature, we argue that such works can be extremely important in helping (or hindering) the shaping of

children's scientific identity, which will, in turn, influence the relationship future generations develop with science.

Therefore, in our research, with the intention of evaluating elements of science communication, gender, race and class present in children's books with a scientific theme, we carried out an analysis of the content of seven books published in Brazil. From a perspective that looks exclusively at the scientific elements, the selected works presented discourse that is well in line with some of the good practices of science communication. Besides contextualizing the scientific content presented, the set of books that we studied advocated that: the processes of science have their own timeframes, and they need to be respected; the issues of science cannot be analyzed from just one perspective; science is driven by questions and reflections, the result of successive observations, tests and analyses; science has its own methodology; failure is part of the scientific process, as not every investigation is conclusive, and some conclusions can be surprising; science is always being constructed, and scientific discoveries are made all the time; issues of science permeate people's daily lives; science is motivated by curiosity; it is not only the scientist who does science, as knowledge is also produced by other members of society; hard sciences are in dialogue with other areas of knowledge, and there is no hierarchy among them; and knowledge is boosted when it is built up in an integrated and creative way.

From the viewpoint of social representations, however, the final considerations regarding the set of works were not so positive. Although most of the main characters were girls, the reproduction of gender, race, and class roles could still be seen, to varying degrees, in all the books. Book D, the oldest in the selection, was also the one most laden with sexist and classist stereotypes, to the point of becoming caricatured and explicitly racist. Although the main character is a curious and observant girl, her behavior is treated by her parents as abnormal, to the extent that they feel the need to seek help in dealing with their daughter. The same thing happens in Book C (published almost forty years later): the protagonist, who according to the work itself possesses all the characteristics of a great scientist, makes her parents completely bewildered about the way she is — a conflict that dominates much of the narrative arc. Meanwhile, the exploratory behavior of the main character in Books A and B, albeit very similar to that of the girls in the previously mentioned works, is never challenged by his parents.

On the other hand, in Book F, other issues come to the surface, such as scientific explanations permeated by heteronormative and patriarchal romantic

analogies — as also occurs in Book G — and the repeated references to fairy-tale narratives, complete with a “living happily ever after.” This parallels Book E, in which the protagonist finds a happy ending far from numbers, but close to her husband and children. It is worth noting that, unlike all the other books, Book C features Black protagonists, but this representation comes at a cost, since among all the families portrayed in the analyzed works, theirs is the one with the greatest purchasing power.

With these observations in mind, it is notable that the task of reversing social representations is more difficult than fulfilling some demands made by best practices in science communication. Even with clear evolution in social representations in regard to the oldest book in our set, it is undeniable that the apparent multicultural shift seen in contemporary books still does not cover anti-oppression issues in any profound way. It turns out that presenting a female protagonist is not enough to deal with the depth of structural chauvinism, and nor does a Black protagonist manage to raise a book to the category of anti-racist. Unfortunately, social stereotypes are so entrenched in the popular imagination that an active effort is needed, involving the study of works by anti-racist feminist thinkers and a good old-fashioned awareness of class, in order to produce books that challenge the practice of stereotyping. It should be recalled that care must be taken, because the opportunist use of anti-oppression platforms weakens real policies, lending even more strength to the dominant groups.

However, the objective of this study is not to make any type of comparison that puts science on one side and, on the other, anti-oppression agendas. Our aim here is integration. After all, the intersectional and anti-capitalist feminist viewpoint offers tools for overcoming the habit of carrying out male, white and Western science, as it is responsible for bringing in a whole spectrum of individuals for debates that enter our technocratic society. Given that it is not possible to carry out a social transformation by combating only one type of oppression and ignoring others, it is by integrating struggles, appreciating similarities and valuing differences that we will manage to create a society in which exercising our technoscientific citizenship loses its status of privilege. And it is for this reason that we insist on writing for children, because while we must have a clear awareness of the dangers involved, it is even more urgent to convert these immediately into action.

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