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TRANSLATION AND MULTIMODALITY IN SCIENCE POPULARIZATION FOR CHILDREN[1]

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Abstract

Literature and science popularization share the possibility of adapting their texts according to their intended recipient. If we think of children as the target audience, these texts must meet a series of characteristics that are related to their recipients. In this context, translation becomes a functional tool to bring science closer to children through literature, an excellent instrument for its popularization and education. In the present work, based on the methodology presented in the OncoTRAD project, we intend to translate and adapt a scientific text in a multimodal format: a comic aimed at a child audience. This fulfils the purpose of bringing science closer to children and educating and informing the child and youth population.

Keywords: Multimodality. Science popularization. Translation and adaptation. Children's literature. Community translation.

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Resumen

La literatura y la divulgación científica comparten la posibilidad de adaptar sus textos en función del receptor al que se dirigen. Si pensamos en un público infantil, además, han de cumplir una serie de características en base a ciertas necesidades y capacidades que presenta el destinatario de estos textos. En este contexto, la traducción se convierte en una herramienta funcional para acercar la ciencia a los niños a través de la literatura, un excelente instrumento para la divulgación y educación de la población. En el presente trabajo, basándonos en la metodología presentada en el proyecto Onco-TRAD, pretendemos traducir y adaptar un texto científico en formato multimodal, en este caso un cómic, dirigido a un público infantil, cumpliendo así con el propósito de acercar la ciencia a los niños y de educar e informar a la población infantil y juvenil.

Palabras clave: Multimodalidad. Divulgación científica. Traducción y adaptación. Literatura infantil. Traducción social.

1. Introduction

Literature for children and young people (López Tamés 1990; Cervera 1991; García Padrino 1992), as well as literature for children, adolescents, and young people (Mendoza García 2018), focus on the recipient and their linguistic demands or skills, which may vary depending on age (Cámara 2003). Therefore, this kind of literature presents several specific features (plainness, simple, straightforward language, repetitions, use of everyday language or images, etc.) that have been reviewed, among others, by McDowell (1973), Hunt (1999), Kress & van Leeuwen (2006), Rudvin & Orlati (2006) or Stojanovic (2012).

The coexistence of text and image in works addressed to children or young people plays an essential role in highlighting the particular aspects that need to be transmitted to children (Oittinen 2000). Some authors have studied this distinctive feature of children's literature from a multimodal perspective (Kress 2009; Mayer 2009; Bateman 2014), a discipline that comes from semiotics (Halliday 1985) and explores the connections and importance of the terminological and visual components of a text. In a specific context, such as the scientific one, the interaction of text and image is of paramount importance (Lemke 1998). If we want a child to access science, we must consider their very own characteristics, as specified in Literature for Children,

Adolescents and Young People (in Spanish, LIAJ), and use suitable tools for textual adaptation (Van Coillie 2005; Nikolajeva 2006).

There are currently scientific institutions in Spain, such as CSIC, that create and publish different resources to popularize science through audiobooks, children's songs, cards, videos, comics, and graphic novels. The latter are part of what we know today as Graphic Medicine, the focus of OncoTRAD[2], a project from the University of Cordoba.

If we focus on a child recipient within the frame of this project, whose primary purpose is to translate and adapt scientific papers for patients and their relatives, we may wonder if it is possible to translate and adapt a scientific paper for a girl or a boy. Thus, to answer this question, we have set out the following goals:

- Defining the concept of Literature for children and young people (in Spanish, LIJ) and Literature for children, adolescents, and young people (in Spanish, LIAJ).
- Analysing the features of LIAJ and examining the concept of multimodality, exploring how science is popularised among children in Spain.
- Studying the adaptation techniques for children and using them in the process of translating and adapting a scientific paper from an educational point of view.

2. Literature for Children and Multimodality

2.1. Literature for Children, Adolescents and Young People (LIAJ)

There is a general consensus that *Literature for children and young people* (LIJ) comprises the texts aimed at a non-adult audience (Mendoza García 2018). Authors such as López Tamés (1990), Cervera (1991), or García Padrino (1992), who consider that there is indeed specific literature created and written for children and young people, support this hypothesis.

2. Project I+D+i FEDER Andalucía 2014-2020 Ref. Nr. UCO-1381162 and title: OncoTRAD: Medicina Gráfica y Traducción al Servicio del Paciente Oncológico y Su Entorno en la Sociedad Andaluza.

However, Moreno Verdulla (2006: 11) argues that the concept may be too broad. Depending on their age, he divides it into two types of receivers: "children and young people, understanding the latter as 'adolescence and youth', since it is with the arrival of puberty when an individual is no longer a child but who is still far from being an adult." This division is also supported by the fact that children and adolescents have different demands and linguistic abilities.

In addition, and based on the age of the recipient, Mendoza García (2018) assumes that we should subdivide this type of literature into three stages: childhood, adolescence, and youth, and he creates the term *Literature for Children, Adolescence, and Young People* (LIAJ), a term that we will use in the present paper.

After defining the receiver of this type of literature, we must define their needs and, therefore, the functions of this type of literature. As Abascal Ruíz (1997: 146) states:

> Children's narrative is the most vivid source, the most suggestive illustration, and the favourite for children from all latitudes. This is not, of course, a simple historical coincidence, but it is closely related to the specific interests of children in accordance with their degree of psychical and emotional development, their desire to know everything, and their continual desire to be entertained and to enjoy themselves, aspects that lead to aesthetic enjoyment.

In most cases, LIAJ has two primary purposes, namely didactic and ludic. Likewise, considering the social and cultural context of the recipient, we can add to these main functions the informative and the cultural ones, as indicated by Marcelo Wirnitzer (2003). In this sense, and based on the purpose of our project, this type of literature becomes suitable for adapting and popularising scientific texts aimed at a non-adult population group. Yet, before entering the adaptation process, we will expose the characteristics of this genre.

2.2. Features of LIAJ

As Oittinen (2000) and O'Connell (2003) suggest, the main element in literature aimed at children, adolescents, and young people is its recipient.

Lathey (2009) and Di Giovanni (2010) include the speaker as well, since they consider that in this type of literature there is a particular interaction between the speaker and the receiver. In that vein, the authors argue that one may find texts for children written by adults, texts for both children and adults, and texts for adults that children also read, all of them with different characteristics. In addition to these essential features, LIAJ, according to Hunt (in Stojanovic 2012: 10), is characterised by its simple language and style in terms of lexical and grammatical variety, a simple register, and the use of spoken language, repetition, and short sentences. This is because children are supposed to have limited reading abilities compared to adults (Fernández López 2000). Besides, Rudvin & Orlati (in Stojanovic 2012: 10) include other characteristics such as "the preference for dialogues and events instead of introspections and descriptions, the preference for concrete details instead of abstract details, and the preference for a plot that moves quickly"; all this, to facilitate reading to the recipient of the text.

If we refer to speed, McDowell argues that this type of work is characterised by its brevity:

> They [children's books] are generally shorter; they tend to favour an active rather than a passive treatment, with dialogue and incident rather than description and introspection; child protagonists are the rule; conventions are much used; they tend to be optimistic rather than depressive; language is child-oriented; plots are of a distinctive order, probability is often discarded; and one could go on endlessly talking of magic and fantasy and simplicity and adventure. (McDowell 1973: 51)

Another of the main characteristics presented of literature for children is the coexistence of text and illustration, which, for García de Toro (2014), are complementary. This is what Kress & van Leeuwen (2006) refer to as the multimodality of the text, an aspect that we will deal with next:

> In one way or another, illustrators always take stories in new directions; for instance, they stress certain scenes or certain characteristics of the persons described by the author. They add and omit and make the readers of the book pay special attention to certain parts of the story. (Oittinen 2000: 103, 106)

2.3. Multimodality in children's literature

Thanks to digitisation, the concept of multimodality has gained special attention in recent decades. Humanity communicates through words, posture, gestures, images, etc. This combination of text and non-text has been studied by academics from different disciplines (Kress 2009; Mayer 2009; Bateman 2014). On the one hand, linguists have focused on the reception of communication (Jewitt 2009) and have considered the need to study it in context. In this sense, Jewitt (2009) considers that the meaning of a text is determined by all the elements and resources that compose it, depending on whether they are linguistic, terminological, or visual (Kress & van Leeuwen 2006). Therefore, focusing on the scientific texts under study in this paper, Lemke (1998) underlines the relevance of the relationship between the image and the written text in scientific manuals.

If we concentrate on comics, authors such as Cohn (2013) reflect on the textual or grammatical communication combined with the visual language of the images used to create the interaction between the textual structure (syntax) and the structure of the images (narrative structure). This multimodal interaction presents a series of attributes and combinations revealed by Jackendoff (2002) and revised and developed by Martinec & Salway (2005), Royce (2007), Kress (2009), Fricke (2013), and Cohn (2015), among others. For Cohn (2015), the interaction between the textual and the visual information has been studied from different perspectives. On the one hand, much of this research has focused on the physical or semantic relationship between both modalities. In this sense, the studies by McCloud (1993), Hagan (2007), Forceville & Urios-Aparisi (2009), and Kress (2009), among others, stand out. On the other hand, other works have focused on the socio-semiotic interpretation of interactions (Royce 1998, 2007; Kress & van Leeuwen 2001) and the benefits for learning of multimodality (Ayres & Sweller 2005; Mayer 2005, 2009). From all these studies, McCloud's (1993) is the most representative one regarding the description and the visual multimodality of comics, where the author suggests seven categories (in Cohn 2015: 305):

1. Word-Specific – Pictures illustrate but do not significantly add to the meaning given by the text.
2. Picture-Specific – words only provide a "soundtrack" to a visually told sequence.
3. Duo-Specific – Both words and pictures send the same message.
4. Additive – One form amplifies or elaborates on the other.
5. Parallel – Words and images follow non-intersecting semantic discourses.
6. Interdependent – Both modalities are combined to create an idea beyond the scope of either on their own.
7. Montage – Words are treated as part of the image itself.

In brief, in this classification, we can notice the exchange of meaning between *Picture-Specific* and *Word-Specific* modalities in a gradation. Each of the possible interactions acquires a greater meaning. Likewise, the proposal focuses on the receiver, who is the one that produces the interference between all the possible combinations.

Similarly, it is worth highlighting the concept of parallel architecture of Jackendoff (2002), in which the author indicates the components of this interaction (Cohn 2015: 307-308):

> On its own, verbal language uses three primary components: A modality (phonology), meaning (conceptual structure), and grammar (syntactic structure). While some combination of these parts occur in most all linguistic models, Jackendoff's (2002) parallel architecture argues for an equal contribution of each of these structures.

In a very similar way, for Cohn (2015: 308), the three components of visual language are: "A modality (graphic structure), meaning (conceptual structure) and a grammar (narrative structure)". The author explains them in the image below:

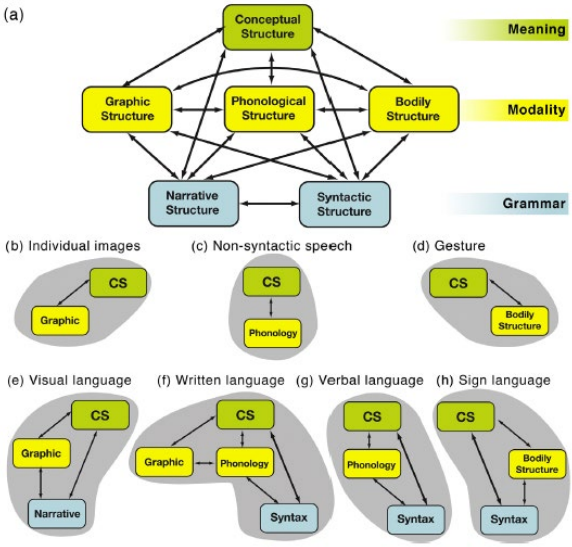


Figure 1. Parallel architecture Cohn (2015: 309)

In this parallel architecture, we can appreciate the possible combinations in which the author incorporates both types of communication: corporal and graphic-visual communication. For the author, it is a unique, holistic system for conceptual expression (Cohn 2015: 309) in which everything depends on the components that are involved. In section (a), the components and interactions of Jackendoff's (2002) and Cohn's (2013, 2015) are integrated, and these components are related to the different interactions (language, writing, signs, gestures, drawings, etc.).

Considering the parallel architecture between the text and the image provided by multimodal texts and placing the recipient of LIAJ at the centre of our study, we consider the use of comics necessary and appropriate for the transmission of scientific knowledge adapted to a young recipient as it enables comprehension and helps the reader interpret complex notions and ideas. Furthermore, reading promotes reflective and critical learning (Naghshineh *et al.* 2008), which is another of its benefits (Ayres & Sweller 2005; Mayer 2005, 2009).

3. Translating and adapting for a young audience

Scientific translation, specifically in the medical field, has acquired a certain peak in recent decades due to the significance of the different sub-areas of this field of knowledge and its impact on the development and evolution of our society (Sánchez Trigo 2005). The *lingua franca* of science is English, hence the relevance of the translator as a transmitter of knowledge (Delisle & Woodsworth 1995). For Sánchez Trigo (2005: 134), "translation is the only tool that can transfer science into different languages and cultures, and it makes the results accessible to the global scientific community." The author focuses on the recipient, since the translation of a medical text can "be of a very diverse nature, not only for doctors, specialists or professionals but also for patients, people from the family or social environment in a broad sense." This is because health affects everyone and, therefore, we can all be the recipients of these texts – children or adults.

In this context, and to bring scientific knowledge closer to patients and their relatives, the project oncoTRAD has been implemented at the University of Córdoba, in which highly specialised scientific texts are translated and adapted to patients and their relatives in a multimodal format and with an accessible and transparent language. To date, the project has delved into adults as the ultimate recipients of the adapted texts, namely cancer patients or caregivers and family members. Thus, the adaptation carried out in the project has been based, mainly, on the determinologisation processes described by Campos Andrés (2013) and Mayor Serrano (2016) and on the adaptation to a multimodal format or genre of Graphic Medicine: comics, infographics, brochures, and illustrations.

Following, and as we previously did for the adaptation of scientific texts for adults (Cobos López 2019, 2021), we will review the adaptation processes of children's literature and put them into practice with the translation and adaptation of a scientific article.

3.1. Adaptation procedures for children

Based on the characteristics of literature aimed at children, adolescents, and young adults and the multimodality of scientific works (Lemke 1998), we understand that scientific knowledge can be disseminated and adapted to

this type of receiver in a more attractive way (Sotomayor Sáez 2005). In order to better define the type of receiver we are going to address, we will focus on children since "several educational experiences have shown a greater reception by children to science-related ideas, compared to adolescents and adults" (Massarani 1999: 1).

To this end, we will first review the existing literature on translation and adaptation of literature for children. Then, we will work out a series of characteristics and strategies to implement in our project. However, before listing them, we must first define what adaptation is. According to the *Diccionario de la Real Academia Española*, one of the meanings of the verb "to adapt" is to modify a scientific, literary, or musical work to be disseminated to a different target audience[3]. In other words, it is a tool of intertextuality in which, considering the receiver, in this case, a child a text is modified (hypotext) and converted into a new text (hypertext).

The translator of a literary text can adopt two different approaches: to remain faithful to the source text or adapt it to the receiver. In this sense, authors such as Klingberg (1980) or Stolt (1980) assume that, in translating for children, we must consider their interests, needs, and knowledge. However, the translator must be as faithful as possible to the source text. Although Klingberg (1980) mentions the adaptation to children and young people, he focuses on the "degrees of adaptation" of the surce text and keeps them in the target text. On the other hand, Stolt (1980) is against adaptation since, in his opinion, it could negatively affect the fidelity of the original text. Shavit (1986) stands between fidelity and adaptation and admits that the translator may modify the target text for a child audience through omissions, changes, substitutions, etc.

Oittinen (2006) is totally in favour of adaptation to the child receptor and understands that the child-reader cannot understand or actively participate in the reading process. For her, in adapted translations all kinds of modifications can be made to the target text since the purpose is to bring the text closer to the child, not only at the terminological level but also at the visual

3. "Modificar una obra científica, literaria, musical, etc. para que pueda difundirse entre público distinto de aquel al cual iba destinada o darle una forma diferente de la original". Available at: <https://dle.rae.es/adaptar>

level. Therefore, we consider that the position of this author is the one that best suits the objectives and approach of our work.

In order to be able to carry out this adaptation centred on the receiver, we will start from the existing classifications. Van Coillie (2005, in Stojanovic 2012: 24), based on the abilities and needs of the child, proposes the following types of adaptation: "a) adaptation of the cultural context (limited experience of the world), b) adaptation of norms and values (educational objectives) and c) adaptation of the plot and language (limited reading skills)." To this, we should add the role of images and illustrations, since our target text will be a multimodal text and our texts will be translated and adapted to images.

a) Adaptation of the cultural context

Translation of cultural references has been extensively studied in Translation Studies, and many different strategies have been put forward. For example, regarding children adaptations, Klingberg (1986) mentions the "adaptation of the cultural context" and, Van Coillie (2005), "domestication and naturalisation." Both authors agree that this is necessary since children have a minimal vision of other cultures. Therefore, they suggest adapting proper and geographical names, games, food, measure units, habits, literary allusions, etc. However, some authors prefer to maintain the references of the original culture, which we know as "foreignization" strategies, or to omit the original cultural reference, which is called "neutralisation" (Van Coillie 2005). To date, there is no consensus regarding which of these strategies is the most appropriate. It will therefore depend on the translator, the image they have of the recipient (O'Sullivan 2005) and, of course, the translation brief.

b) Adaptation of norms and values

Concerning the norms and values in the source culture, something similar happens to what we observed regarding cultural referents and how to adapt them. In this case, Klingberg (1986) proposes the use of "purification." This concept includes the embellishment, expansions, modifications, or omissions so that the values conveyed in the original text correspond to those shown in the target text. As an example of this strategy, O'Sullivan (2005) mentions the inappropriate behaviour of boys and girls, violence, sexual or

religious connotations, etc. Likewise, Stojanovic (2012) includes linguistic norms, i.e., puns, swear words, etc.

c) Adaptation of the plot and language

In this section, we will focus on the child's reading ability and the classification proposed by Van Coillie (2005, in Stojanovic 2012: 26-27):

a. Omission

According to Van Coillie (1999: 37), the omitted parts of the text are the parts that do not contribute to the development of the action of the story, the parts that are boring, rambling, or too long.

With regards to omitting a specific type of word, Van Collie (2005: 27) states that translators often omit adverbs and adjectives that carry an emotional charge. Klingberg (1980: 29) calls this type of omissions 'falsifications' because they offer a falsified reality.

b. Addition

According to Van Coillie (1999: 37-38), there are several ways to add new elements to the source text.

On the one hand, the translator can embellish the text with adjectives or revive it with dialogues, clarify relationships within the text, deepen feelings, elaborate on interesting passages, and insert longer comments. On the other hand, additions can be pretty subtle but offer another, more refined view of the original version.

c. Alteration

According to Van Coillie (1999: 38-39), this type of modification is necessary in parts of the text that cannot be translated literally, for example, in the case of rhymes, alliterations, or puns. The translator must try to produce the same effect on the reader in the target culture. Therefore, the translator is allowed to change parts of the original text.

However, translators often decide to change words and even whole sentences without any justified reason. In this case, Klingberg (1980: 29) speaks of 'mistranslation.' Mistranslation can be very dangerous because children cannot correct mistakes in the same way as adults.

In addition to the strategies proposed by Van Coillie (2005), with which other authors agree, we present below Nikolajeva's proposal (2006, in Martín Fernández 2018: 329-330):

a. Naturalisation
Naturalising or performing a cultural conversion of cultural references (Klingberg 1986; Ben-Ari 1992) is traditionally one of the most present norms in works for children. Two essential factors justify these naturalisations or domestications (Venuti 1995): the pedagogical function of the text and the adult's image of the child. Furthermore, the recipient culture and the moment of translation influence the use of this norm significantly, as well as the age of the recipients, which also seems to be essential: the younger the recipients, the greater the naturalisation of, for example, proper names (Van Coillie 2006: 135).

b. Explicitness
The addition of explaining elements is characteristic in translation, especially for children (Ben-Ari 1992; Fernández López 2000; Ariza & Iglesias Gómez 2011; Barambones Zubiria 2012; Lorenzo 2014). The reasons are, once again, to offer the receiver a more accessible text.

c. Simplification of the text
Simplification is carried out in different ways: eliminating repetitions (Ben-Ari 1992), reformulating both complex structures and long sentences/paragraphs to adapt them to the child's level of comprehension, transforming complicated stylistic and rhetorical figures such as metaphors and satire (Shavit 1986) or complicated or disused lexis (Stolze 2003), etc. To cite one example, simplification techniques have been identified in the dubbings of Disney films (Iglesias Gómez 2009).

d. Omission
Omitting elements can be done either in complete passages, which is not very common in texts for adults but much more frequent in texts for children (Ben-Ari 1992) or for specific elements, depending on the predominant function of the text and/or the social context of the receiving culture. Omissions can be seen as a way to simplify a story in terms of encyclopaedic knowledge,

but it can also be regarded as an attempt to euphemise or purify the text (Klingberg 1986). Lorenzo (2014) calls the latter "omitting paternalism":

> a suppression of elements considered harmful or offensive in the translation itself by the translator or in the revision process by editors, in the case of LIJ, or by adjusters, dubbing directors [...] in the case of audio-visual products (Lorenzo 2014: 37).

e. Euphemising

Euphemising is a widespread language phenomenon, present in television speeches or literature and identified as a norm in audio-visual translation. Euphemising, manipulation, purification, or censorship have been intensively studied in the translation of literature for children or in audio-visual products. A good example is the study on Astrid Lindgren's Pipi Langstrump in French. In the well-known story, the main character's subversive (but never aggressive) behaviour, the ungraceful gestures of the adults, or even the new and almost oral language of the source text were modified to adapt them to the precepts of the time (Helder 1992). *Robinson Crusoe* or *Alice in Wonderland* are other cases of adapted works (almost versioned, in some cases) where the length of the work is modified and/or shortened, eliminating references to religion, rewriting entire passages, or eliminating descriptions of characters, among others (Nikolajeva 2006).

Thus, if we combine both authors who present similar strategies, we can classify these techniques as follows:

- Adaptation of the cultural context: domestication, naturalisation, foreignisation, or neutralisation.
- Adaptation to norms and values: purification.
- Adaptation to the plot and language: omission, addition, or alteration.
- Explicitness.
- Simplification of the text.
- Euphemising.

Similarly, and concerning illustrations, as in our case, we will start from a written text and transform it into a multimodal text in which the images contain either part of the information to be transmitted or the context around it with a view to disseminating a scientific text.

4. Science popularisation for children

Before delving into how we disseminate science to children, we must explain what we understand by the term "disseminate." According to the *Diccionario de la Real Academia*, disseminating (*divulgar* in Spanish) means "to publish, extend, make something available to the public." It is a very general definition, but it mentions the ultimate objective of our project, to make scientific information available to the lay public. For Galán (2003), the term *divulgar* (disseminate) has negative connotations because it is related to *vulgarize*.[4] Counterpoint is the English concept of popularisation, derived from popularise and defined by The Oxford Universal Dictionary as follows: "to make a difficult subject easier to understand for ordinary people." Following this idea, Sagan (1996: 25) offers the following definition: "Popularising science-trying to make its methods and findings accessible to non-scientists," i.e., bringing scientific information closer to a lay public. Establishing certain parallelism, the author defends that science and democracy have similar values since he understands that science should not give or have privileged positions and should be in the public domain. In his own words:

> Science, I maintain, is an absolutely essential tool for any society with a hope of surviving well into the next century with its fundamental values intact—not just science as engaged in by its practitioners, but science understood and embraced by the entire human community. (Sagan 1996: 336)

In particular, Galán (2003) states that scientific popularisation focuses on the receiver, and to achieve this, she uses lexical reformulation procedures, adapting specialised terminology to favour understanding and promote a specific action (explanatory and perlocutionary dimensions). Likewise, the author indicates that both the disseminator and the translator must ensure the semantic coherence of the text by conveying the meaning of the original

4. For the author (Galán 2003: 137-138): "the term dissemination, which means nothing more than the instrumental notion of putting into circulation (disseminating) news, has been associated - by inevitable semantic proximity - with vulgo and vulgar in its pejorative meanings of low social category. Nevertheless, in addition, from this social mark, vulgo is culturally opposed to sapiens, because the low economic condition implies a distance from culture" and contrasts it with the term popularise, which in her words (Galán 2003: 138) is "more in line with the democratic idea of the diffusion of knowledge."

work (in our case, by adapting it); "this makes it possible to establish a thematic thread that integrates new information as the text progresses" (Galán 2003: 150).

For this reason, the work of translators of scientific texts, and specifically those in the field of health that aim to disseminate science, is substantial and not easy. Nevertheless, they are the bridge of communication between science and society, a metaphor that has generated a broad debate on science and the humanities[5] that is still active today and has attracted the attention of researchers from different fields (Galán 2003). In our opinion, the translator is a crucial tool to overcome this barrier or bridge between cultures, between a specialised and a lay receiver.

In our opinion, the translator is the crucial tool for overcoming this barrier or bridge between cultures between a specialized or lay receiver.

Outside the field of translation, the popularisation of science has been mainly concerned with education, not only for medical professionals but also for the general public. However, if we focus on children, there are very few studies regarding science popularisation (Tosi 2016: 110), although we can find several books and projects created to disseminate scientific knowledge. In Spain, for example, the Spanish National Research Council (CSIC)[6] offers families a wide range of resources such as exhibitions, virtual museums, cartoons, videos, games, apps, experiments, or downloadable books to disseminate science. Within the list that they offer, we highlight the following for being aimed at a child audience:

- "Tell me how to become a scientist." Audio stories, songs for children, and original educational activities inspired by women scientists of yesterday and today, including MNCN researchers. From 6 years old.
- *Divulgafichas*: scientific content. Schematic cards that review the scientific rigour of different cultural works (novels, comics, stories for children, sticker albums, films, series, games, video games).
- Resources for teachers from *CSIC at School* and Youtube channel *Museo Virtual de la Ciencia*. Experiments, didactic applications, and

5. For more information, see *The Two Cultures* (Snow 1959).
6. Available at: <https://www.csic.es/es/agenda-del-csic/aprende-ciencia-en-casa-con-el-csic>

classroom experiences to bring science closer to infants and primary school children.
- KIDS.CSIC. Website for infant and primary school children with animated videos, biographies, games, and interactive tests. It includes guides for the classroom and families. Created by *CSIC at School Program*. From 4 to 12 years old.
- Children's short story and painting competition *My visit to the National Museum of Natural Sciences* for children aged 5 to 12.

Among the comics and graphic novels or books for children that they offer on their website, these are the most outstanding:

Comics and graphic novels
- Comic *Sapiens* by Y. Noah Harari, D. Vandermeulen and D. Canave.
- Comic *Neandertal* by Roudier.
- Comic *Historia de la Humanidad en Viñetas*: vol. 1, *La prehistoria*.
- Comic *La divertida historia de la historia*: vol. 1, *La prehistoria*.
- Graphic Novel *Andy y Lucy Neandertal*.
- Graphic Novel *Ötzi. Por un puñado de ámbar.*

Books for children
- *Animales de la prehistoria: Mamut lanudo* (*Mammuthus*).
- Flap Book *Prehistóricos*.
- Visual Book *Cherche et trouve géant dans la Préhistoire*.
- *Viviendo / descubriendo la Prehistoria en el Valle del Lozoya*.
- *Historia Universal. La Prehistoria*.

There are also more recent, private initiatives aimed at children audiences that focus on Graphic Medicine:

- *El gran libro de las enfermed*ades (Kaniewski 2020).
- *El cuerpo humano por dentro/ el cuerpo humano por fuera* (Junyent and Losantos 2019).
- *Alzheimer, ¿qué tiene el abuelo?* (Farmacéutica Lundbeck 2014).

Concerning cancer, the pathology on which our project focuses, the Spanish Association Against Cancer (AECC) website,[7] offers a series of publications aimed at different types of patients. In the children and young people section, for example, we find the following titles:

Let's go to radiotherapy (2006)	Hello friends! First, let me introduce myself. I am Tron, a Radiotherapy machine. Yes, I know I am huge. That is why I am in a room by myself, and there is no room for anyone else. However, don't be afraid of me because I am your friend.
Let's go to chemotherapy (2006)	Hello Friends My name is Quim, and I am a capsule. I am sure you have already seen many capsules in many colours, but I am special. I want us to be close friends because my mission is to help you.
Someone very special is missing (2006)	The book you are holding in your hands is for children and young people aged 9 to 13 who have lost a loved one.
Toby and the flying machine (2006)	Toby lives in a quiet mountain village with his parents, his sister Luli, and granny.
The best medicine (2006)	The school's almond trees seem to have turned on the lights of spring. Their thousands of tiny blossoms illuminate every corner of the courtyard.
The enchanted forest (2010)	The book aims to provide emotional control strategies that can become protective elements against tobacco and alcohol use in the future.
Cut out books (2007)	The game allows children to cut out different outfits reflecting healthy behaviours and swap them on the figures included (a boy and a girl).

7. Available at: <https://www.aecc.es/es/actualidad/publicaciones/ninos-jovenes>

Eating healthy is fun (2009)	I am sure there are foods you love and others you do not, but you should know that the secret to being in shape is eating everything.
Protecting from the sun is fun! (2012)	The sun takes care of us. The sun is a star, the nearest to the Earth, certainly the most important for us and others.
Wiky-2, The little robot (2006)	Through three different games, the most important concepts are developed simply and clearly so that children understand their illness, the treatments, the side effects derived from them, and practical advice to minimise their effect.
Mario's victory (2005)	To smoke or not to smoke. That is the question. Perhaps you have already asked yourself this question like Mario, the main character of our story. We want to show you that it is possible to avoid the trap of smoking.
I am Daniel (2006)	"At the beginning, it was tough. I could not believe it," says Daniel, the main character of our story. Yet... life changes you very quickly. You have to deal with tests, drugs, admissions... So, what has happened to my life? What is happening to me?

Finally, after reviewing how science is transmitted to children in Spain, we can posit that "it constitutes a heterogeneous domain that encompasses a multiplicity of discursive genres, different issuers (scientists, journalists, and disseminators trained in very diverse disciplines) and different media (graphic, audio-visual)" (Gallardo 2013: 57). Therefore, in this paper, we will focus on comics as a tool to popularise and/or disseminate scientific knowledge aimed at a child audience.

5. OncoTRAD – an example of translating and adapting a scientific paper for children

Based on the existing examples in Spain of scientific popularisation and focusing on the OncoTRAD working model, we will now adapt the article *Association Between Soft Drink Consumption and Mortality in 10 European*

Countries, published in *Jamma Internal Medicine* in September 2019.[8] This article deals with a topic that we consider attractive for children and young people: the risk of having excessive sugary drinks. We believe that this type of study should promote changes aimed at raising public awareness of the risk habits in the consumption of these drinks and, with its adaptation, we would like to contribute to its dissemination by informing and educating the child population on healthy lifestyle habits.

The article has already been translated and adapted for an adult audience. You can find the complete translation, illustration, and summary on <www.uco.es/oncoTRAD> or <www.enquetepuedoayudar.org/oncotrad>.

In this paper, based on the adaptation strategies described by Van Coillie (2005) and Nikolajeva (2006) and considering the characteristics of multimodality described by McCloud (1993) and Cohn (2015) based on the methodology put forward by oncoTRAD, we aim to transform the article into a comic aimed at children who have already developed literacy skills (6 to 12 years old) (Cámara 2003). Therefore, we will first select the information we will adapt from the scientific article and deliver it in a table format:

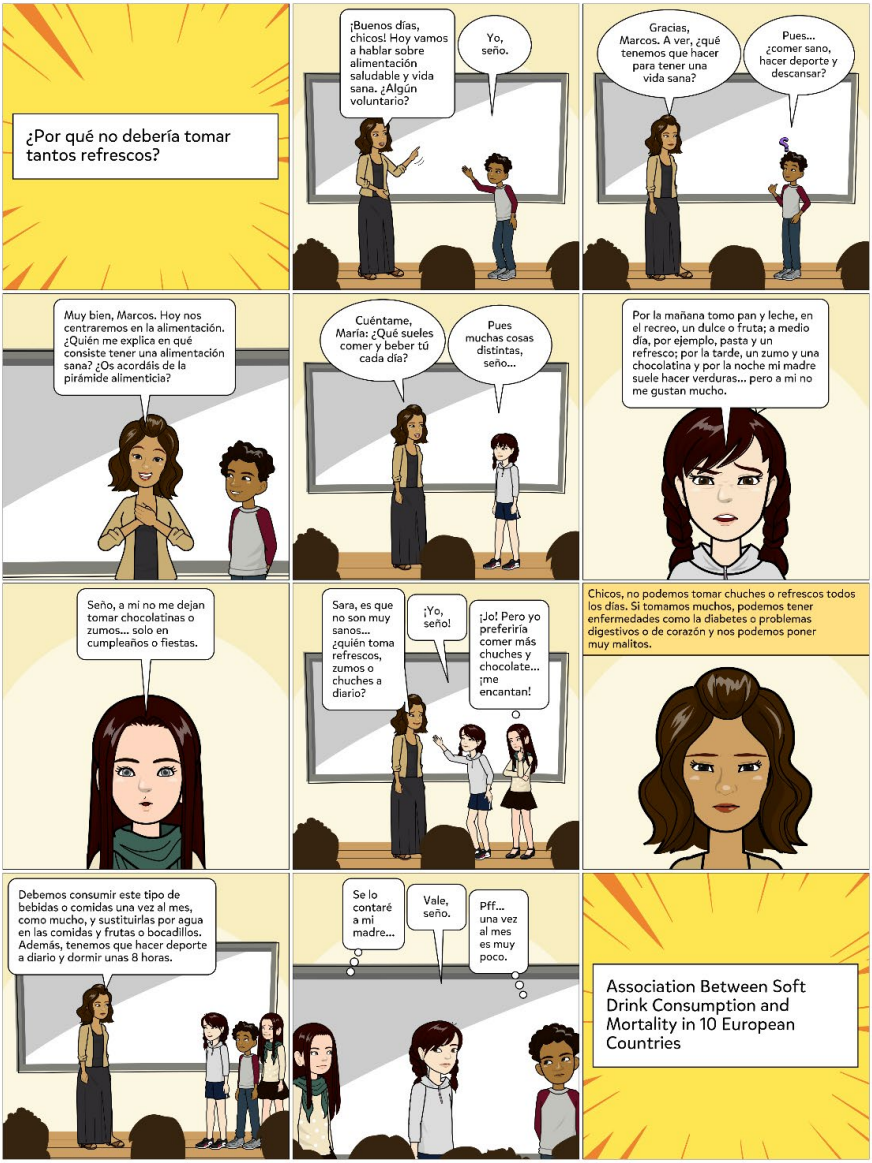
IMPORTANCE Soft drinks are frequently consumed, but whether this consumption is associated with mortality risk is unknown and has been understudied in European populations to date.	**RELEVANCIA** Aunque los refrescos se consumen con frecuencia, se desconoce si su consumo está asociado con el riesgo de mortalidad, ya que esta relación no ha sido estudiada lo suficiente hasta la fecha en poblaciones europeas.
OBJECTIVE To examine the association between total, sugar-sweetened, and artificially sweetened soft drink consumption and subsequent total and cause-specific mortality.	**OBJETIVO** Estudiar la relación entre el consumo total de refrescos azucarados o endulzados con edulcorantes artificiales y las tasas de mortalidad general y mortalidad específica.

8. Available at: <https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2749350>

DESIGN, SETTING, AND PARTICIPANTS This population-based cohort study involved participants (n = 451 743 of the full cohort) in the European Prospective Investigation into Cancer and Nutrition (EPIC), an ongoing, large multinational cohort of people from 10 European countries (Denmark, France, Germany, Greece, Italy, the Netherlands, Norway, Spain, Sweden, and the United Kingdom), with participants recruited between January 1, 1992, and December 31, 2000. Excluded participants were those who reported cancer, heart disease, stroke, or diabetes at baseline; those with implausible dietary intake data; and those with missing soft drink consumption or follow-up information. Data analyses were performed from February 1, 2018, to October 1, 2018.	**DISEÑO, CONTEXTO Y PARTICIPANTES** En este estudio de cohortes de base poblacional se incluyeron participantes (n= 451 743 de la cohorte completa) del estudio prospectivo europeo sobre cáncer y nutrición (EPIC, por sus siglas en inglés), una investigación internacional en curso que reúne participantes de 10 países europeos (Dinamarca, Francia, Alemania, Grecia, Italia, Países Bajos, Noruega, España, Suecia y Reino Unido) seleccionados entre el 1 enero de 1992 y el 31 de diciembre de 2000. Se excluyeron los participantes a los que se les había diagnosticado cáncer, trastornos cardíacos, accidente cerebrovascular o diabetes al comienzo del estudio; a los que presentaron datos inverosímiles de ingesta alimentaria, y a aquellos participantes sobre los que se carecía de información con respecto a su consumo de refrescos o su seguimiento. Los análisis de datos se realizaron desde el 1 de febrero de 2018 al 1 de octubre de 2018.
EXPOSURE Consumption of total, sugar-sweetened, and artificially sweetened soft drinks.	**EXPOSICIÓN** Consumo de refrescos totales, azucarados y endulzados con edulcorantes artificiales.
MAIN OUTCOMES AND MEASURES Total mortality and cause-specific mortality. Hazard ratios (HRs) and 95% CIs were estimated using multivariable Cox proportional hazards regression models adjusted for other mortality risk factors.	**MATERIAL Y MÉTODOS** Tasas de mortalidad general y de mortalidad específica. Se calcularon cocientes de riesgo instantáneo (Hazard Ratios, HR por sus siglas en inglés) e IC del 95 % mediante el modelo multivariante de riesgos proporcionales de Cox ajustado a otros factores de riesgo de mortalidad.

RESULTS In total, 521 330 individuals were enrolled. Of this total, 451 743 (86.7%) were included in the study, with a mean (SD) age of 50.8 (9.8) years and with 321 081 women (71.1%). During a mean (range) follow-up of 16.4 (11.1 in Greece to 19.2 in France) years, 41 693 deaths occurred. Higher all-cause mortality was found among participants who consumed 2 or more glasses per day (vs consumers of <1 glass per month) of total soft drinks (hazard ratio [HR], 1.17; 95% CI, 1.11-1.22; P < .001), sugar-sweetened soft drinks (HR, 1.08; 95% CI, 1.01-1.16; P = .004), and artificially sweetened soft drinks (HR, 1.26; 95% CI, 1.16-1.35; P < .001). Positive associations were also observed between artificially sweetened soft drinks and deaths from circulatory diseases (_2 glasses per day vs <1 glass per month; HR, 1.52; 95% CI, 1.30-1.78; P < .001) and between sugar-sweetened soft drinks and deaths from digestive disease (_1 glass per day vs <1 glass per month; HR, 1.59; 95% CI, 1.24-2.05; P < .001).	**RESULTADOS** En total se reclutaron a 521 330 individuos. Se incluyeron en el estudio 451 743 (86,7 %) individuos con una media (DE) de edad de 50,8 años (9,8) de los cuales 321 081 (71,1 %) eran mujeres. Durante una media (rango) de 16,4 años de seguimiento (de los 11,1 años en Grecia a los 19,2 en Francia), se produjeron 41 693 muertes. Se observó una mortalidad general elevada entre los participantes que consumían 2 o más vasos al día (vs. aquellos que consumían <1 vaso al mes) del total de refrescos (coeficiente de riesgo [CR], 1,17; 95 % IC, 1,11-1,22; *p* < ,001), de refrescos azucarados (CR, 1,08; 95 % IC, 1,01-1,16; *p* = ,004) y de refrescos con edulcorantes artificiales (CR, 1,26; 95 % IC, 1,16-1,35; *p* < ,001). Además, se encontraron asociaciones positivas entre los refrescos con edulcorantes artificiales y las muertes causadas por enfermedades del aparato circulatorio (≥2 vasos al día vs. <1 vaso al mes; CR, 1,52; 95 % IC, 1,30-1,78; *p* < ,001) y entre los refrescos azucarados y las muertes causadas por enfermedades del aparato digestivo (≥1 vaso al día vs. <1 vaso al mes; CR, 1,59; 95 % IC, 1,24-2,05; *p* <,001).
CONCLUSIONS AND RELEVANCE This study found that consumption of total, sugar-sweetened, and artificially sweetened soft drinks was positively associated with all-cause deaths in this large European cohort; the results are supportive of public health campaigns aimed at limiting the consumption of soft drinks.	**CONCLUSIONES** Se hallaron asociaciones positivas entre el consumo de refrescos totales, azucarados y endulzados con edulcorantes artificiales y la mortalidad general en esta cohorte europea de gran tamaño, por lo que los resultados respaldan las campañas de salud pública dirigidas a limitar el consumo de refrescos.

We will use the results and context sections from the relevant information extracted in the chart to carry out the social awareness-raising work meant for the present work. There is a direct association between excessive consumption of sweetened soft drinks and mortality, which is supported by public health campaigns aimed at limiting the consumption of soft drinks. With our adaptation, we intend to inform children (6-12 years old) about the harm caused by excessive consumption of soft drinks through the adaptation of the referenced scientific study. To do this, we will use the *Pixton* tool to create a comic based on the characteristics of LIAJ (simple language and style, simple register, use of spoken language, repetition, and short sentences, preference for dialogues and events, concrete and non-abstract details, fast-moving plot and coexistence of image and text) and the adaptation processes of literature for children (adaptation to cultural context, adaptation to norms and values, adaptation of the plot and language, explicitness, simplification, and euphemising). Finally, we will contextualise it in a school, where children are educated and receive these instructions:


¿Por qué no debería tomar tantos refrescos?
¡Buenos días, chicos! Hoy vamos a hablar sobre alimentación saludable y vida sana. ¿Algún voluntario?
Yo, seño.
Gracias, Marcos. A ver, ¿qué tenemos que hacer para tener una vida sana?
Pues... ¿comer sano, hacer deporte y descansar?
Muy bien, Marcos. Hoy nos centraremos en la alimentación. ¿Quién me explica en qué consiste tener una alimentación sana? ¿Os acordáis de la pirámide alimenticia?
Cuéntame, María: ¿Qué sueles comer y beber tú cada día?
Pues muchas cosas distintas, seño...
Por la mañana tomo pan y leche, en el recreo, un dulce o fruta; a medio día, por ejemplo, pasta y un refresco; por la tarde, un zumo y una chocolatina y por la noche mi madre suele hacer verduras... pero a mí no me gustan mucho.
Seño, a mí no me dejan tomar chocolatinas o zumos... solo en cumpleaños o fiestas.
Sara, es que no son muy sanos... ¿quién toma refrescos, zumos o chuches a diario?
¡Yo, seño!
¡Jo! Pero yo preferiría comer más chuches y chocolate... ¡me encantan!
Chicos, no podemos tomar chuches o refrescos todos los días. Si tomamos muchos, podemos tener enfermedades como la diabetes o problemas digestivos o de corazón y nos podemos poner muy malitos.
Debemos consumir este tipo de bebidas o comidas una vez al mes, como mucho, y sustituirlas por agua en las comidas y frutas o bocadillos. Además, tenemos que hacer deporte a diario y dormir unas 8 horas.
Se lo contaré a mi madre...
Vale, seño.
Pff... una vez al mes es muy poco.
Association Between Soft Drink Consumption and Mortality in 10 European Countries

6. Conclusions

After reviewing characteristics of literature for children, adolescents, and young people, together with the adaptation processes aimed at a children audience based on OncoTRAD's work methodology, we can transform a scientific article into a comic for children with an educational, popularising objective.

Throughout this process, the relevance of multimodal texts in Graphic Medicine and their use as a tool for disseminating scientific knowledge through mechanisms such as translation and adaptation becomes clear.

With comics as a reference, we underline the value of converting a scientific text into a readable story, thus giving it accessibility and visibility. The benefits of these multimodal texts for learning and empowering society are also confirmed: when we read a story, we make it our own; it becomes an instrument that shapes us, especially when we are children.

In this way, science and the humanities converge in Graphic Medicine as an instrument for community translation and a bridge of communication between scientific research and society.

Following the present study, and in order to analyse the reception of texts translated and adapted for children, we will extend this research with further papers in which we will address the possible improvements or the essential characteristics offered by the transmission of scientific knowledge through this multimodal genre.

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Proyecto OncoTRAD: <www.uco.es/OncoTRAD> & <www.enquetepuedoayudar.org/oncotrad>

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