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Abstract

Reading is an essential component of language proficiency and a major focus of second/foreign language instruction. Thus, researchers and teachers have tried to explore ways of supporting it. Combining written and auditory input in reading-while-listening conditions (e.g. Chang, 2009) and using pictorial information (e.g. Mautone and Mayer, 2001) are two of the methods commonly used to support reading development and reading comprehension. Our understanding of the effectiveness of these methods mainly comes from studies using post-reading tests that do not indicate how learners engage with these different sources of information nor how online processing is related to levels of comprehension. In addition, the effect of proficiency on the way in which learners process the different sources of input remains to be explored.

The present study addresses these gaps by using eye-tracking technology to investigate children and adult second language (L2) learners' processing of the different input sources in two multimodal reading conditions. Data from first language readers was also collected for comparison purposes. Participants read an illustrated text in two conditions (reading-only, reading-while-listening) while their eye movements were recorded. They were then asked to complete a comprehension test. Results of the study show that children and adult L2 learners spend more time reading the text than processing the images, irrespective of the reading mode. The presence of auditory input in reading-while-listening conditions allows learners to spend more time processing the images, but the processing differences observed between the two conditions do not seem to affect reading comprehension.

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1

Introduction

The ability to read fluently in a second or foreign language is one of the most important skills that language learners need to master in order to become successful language users. In recognition of the difficulties that developing fluent reading skills entails, a prominent concern of researchers and language teachers has been exploring ways to help learners develop their reading skills and supporting them in the often arduous journey of becoming fluent readers.

One way of supporting reading is to present auditory input in combination with written verbal input, in what is known as *reading-while-listening* or *assisted reading*. Reading-while-listening has been shown to support reading comprehension and the development of reading speed and fluency (e.g. Chang, 2009; Chang and Millet, 2015). Another commonly used technique to aid reading comprehension is the use of visual, non-verbal stimuli, such as pictures and images that relate to the content of the text (e.g. Elley and Mangubhai, 1983; Mautone and Mayer, 2001). This is indeed what we find in a variety of English language teaching (ELT) materials such as graded readers and reading activities in English as a foreign language (EFL) textbooks. Supporting written texts with pictures leads to the activation of verbal and non-verbal systems, which, according to Paivio's (1986) Dual Coding theory, improves learning. Thus, the combination of written input, auditory input and pictorial information is believed to aid the reading process, leading to better comprehension, improved fluency, and maximising the learning potential of reading.

However, these conclusions have been drawn from studies that used post-reading tests. Although they point to the benefits of these multimodal reading conditions, they do not tell us how learners process the various input sources and how that processing behaviour relates to comprehension. A better understanding of how learners engage with these different input sources (written text, audio and pictures) will shed light on the benefits of these input modes for reading development, which is necessary if we are to make recommendations about their use and effectiveness.

An examination of the way in which learners process the different input sources in multimodal materials is something that can now be achieved using eye-tracking technology. Eye-tracking allows us to measure learners' eye movements while processing stimuli presented on a computer screen, providing a detailed record of online processing behaviour. Recent eye-tracking research in this area has provided preliminary evidence that the presence of auditory input leads to changes in reading behaviour and in how child L2 learners process the text and images (Serrano and Pellicer-Sánchez, under review). Crucially, the impact that these processing differences have on reading comprehension is yet to be examined. In order to be able to design a well-informed reading programme and make appropriate recommendations to language teachers and learners, it is of paramount importance that we not only have a better understanding of how learners' reading behaviour changes in these different reading conditions but also of how those changes affect their reading comprehension, which is indeed the ultimate goal of reading and reading instruction.

Despite the major role that language proficiency plays in L2 reading comprehension (Grabe, 2009), its effect on learners' processing of the various input sources in multimodal reading materials is still unknown. The combination of visual (non-verbal) and verbal (both written and auditory) input is not unusual in materials currently used for both child and adult L2 learners. The type of reading activities in EFL textbooks, graded readers, language learning websites and mobile applications usually combine both pictures/photographs and texts. Many of the reading texts used in the L2 classroom context are also available with the auditory support, making it easier for teachers to implement reading-while-listening activities in the classroom. However, we do not really have a clear picture of the way in which adding the auditory input affects learners' reading behaviour, particularly in the presence of pictorial information, and of how age and proficiency influence processing. We might hypothesise, for example, that child L2 learners, who are less proficient readers, could be more 'distracted' by pictorial information, relying less on the text; or that the presence of auditory input might provide more of a challenge for children who are still developing their reading fluency.

Here we report the findings of a study examining the processing of input sources in multimodal reading materials (i.e. reading with pictures and reading-while-listening with pictures) in learners of different ages and proficiencies as well as the relationship between processing and subsequent comprehension. The ultimate goal of this study is to provide a better understanding of how learners process text and pictorial information in reading materials in the presence or absence of audio and whether this processing behaviour varies with proficiency. The performance of three different groups of readers (i.e. child L2 learners, adult L2 learners, and L1 readers) is examined.

The urge to explore this topic arose from the need to support classroom decisions about the use of different reading activities with learners of different proficiencies in diverse ELT contexts. When deciding which reading activities to use in the classroom or which activities to recommend that learners do outside the classroom context, or how to implement an extensive reading programme, an important decision is what type of sources of support we are going to provide. Should we have readers focus on the text and avoid the use of pictures? Should we also use auditory input? In order to make these decisions, educators are bound to make assumptions about how learners engage with pictures and audio while reading. The aim of this study is to test these assumptions so that teachers can make decisions about what tasks to use with students that are based on evidence.

The following research questions were addressed in the present study:

- how do children and adult learners process the text and pictorial information in multimodal reading materials in the presence and absence of auditory input?
- are there any differences in reading comprehension levels in the two reading modalities, i.e. reading-only and reading-while-listening?
- is there any relationship between online processing behaviour and levels of reading comprehension?

In order to answer these questions, the three participant groups were asked to read an illustrated narrative in two main conditions (i.e. reading-only versus reading-while-listening). The results of this study contribute to our understanding of the use of multimodal reading materials with learners of different proficiencies and will hopefully lead to better informed recommendations for reading instruction in ELT contexts.

2

Background

Reading-while-listening in the L2 classroom

Many studies have demonstrated that reading is an excellent source of L2 learning (Webb and Chang, 2012). In the L2 classroom context, reading materials are often supported by audio in reading-while-listening conditions (e.g. graded readers or audiobooks).

Several studies have investigated the effects of reading-while-listening in classroom settings with regards to the improvement of a variety of skills, including general language proficiency, vocabulary knowledge, reading comprehension and reading fluency. In the Canadian context, Patsy Lightbown and her colleagues provided support for the positive effect of extensive reading-while-listening in the primary school context. The French-speaking learners who did autonomous extensive reading-while-listening learned as much English as those following teacher-led instruction through an audio-lingual approach (Lightbown, 1992), even in terms of some productive skills, such as pronunciation accuracy (Trofimovich et al., 2009). Moreover, the students following the reading programme demonstrated better attitudes and motivation towards English learning than students receiving regular instruction. These results were replicated in the Catalan context by Tragant et al. (2016), although in this case the extensive reading-while-listening group also received teacher-led instruction for 40 per cent of their L2 English learning time.

In the case of older learners, research by Anna Chang and Stuart Webb also provides evidence for L2 learning through reading-while-listening. Webb and Chang (2014) examined incidental vocabulary learning in reading-while-listening. In their programme, all the students read and listened to the same graded readers in class and then worked on different language activities in which the teacher was also involved (as opposed to the previously described Canadian programme, where learners picked their own books and mostly worked autonomously). The findings reported by Webb and Chang (2014) suggest that a significant increase in vocabulary knowledge occurred after reading-while-

listening to ten graded readers: the reading-while-listening group learned on average 19.68 words from pre- to post-test, while the comparison group only learned 4.43 words.

When compared to silent reading (or reading-only), research studies tend to suggest that reading-while-listening encourages more L2 learning than reading-only. Chang and Millet (2015) examined the differential effects of reading-only versus reading-while-listening on reading rates and comprehension in the case of 64 secondary school students learning English in Taiwan. The results of this study showed that all the participants significantly improved their reading rates and comprehension levels after their extensive reading programme (including 26 graded readers) and they were able to maintain their gains for up to three months. However, the authors also observed that the gains in both areas were more significant in the case of the reading-while-listening group than in the reading-only group. Webb and Chang (2012) report similar advantages for reading-while-listening versus reading-only in the case of incidental vocabulary learning.

Brown et al. (2008) and Chang and Millet (2014) compared reading-while-listening not only to reading-only but also to listening-only modes. In the first study, the reading-while-listening and reading-only led to higher vocabulary gains than the listening-only mode (although the difference between the two reading conditions was not significant). The results of the second study showed an advantage of reading-while-listening over the other two modes examined (i.e. reading-only and listening-only) on the development of listening skills.

In general, the results of previous studies indicate that simultaneous reading-while-listening (bimodal input) tends to promote L2 development of different skills more than receiving unimodal input. Several reasons have been proposed for this superiority of reading-while-listening. On the one hand, reading and listening simultaneously might help the students segment the information in meaningful chunks much more than reading-only, which might lead to improved learning (Webb and Chang, 2012).

Additionally, extensive reading-while-listening might contribute more significantly to reading fluency than reading-only because learners are obliged to read at the pace of the audio input, which, in many cases, is likely to be faster than the students' own pace (Chang and Millet, 2015). Several studies have reported that learners generally enjoy receiving input in a reading-while-listening mode (Brown et al., 2008; Chang, 2009; Chang and Millet, 2014; Lightbown et al., 2002; Tragant et al., 2016; Tragant and Vallbona, in press), and such positive perception might facilitate L2 learning. Chang and Millet (2015) claim that their participants preferred the reading-while-listening mode to the reading-only mode because the sound effects made the stories more interesting. Moreover, the general learner perception was that reading-while-listening helped concentration much more than reading-only. Similarly, reading-while-listening was more effective in keeping learners on task. Another possible advantage of the reading-while-listening mode mentioned by Tragant et al. (2016) is that the dual mode allows the students to approach the task according to their own strengths, and some students would rely more on written input while others would rely more on aural input.

The role of visuals in reading

When, in addition to aural and written input, the materials also include images (as is the case of graded readers and textbook activities), the allocation of students' attention is divided between the three input sources. According to the Dual Coding theory (Paivio, 1986), multimodal conditions are expected to lead to better recall and to increase learning. Based on this assumption, several studies have examined the use of different types of visuals (e.g. illustrations, photos, graphs, diagrams and maps) to support the reading comprehension process. In the L1 context, studies have shown the facilitation effect of experimenter-generated illustrations (e.g. Gambrell and Jawitz, 1993; Purnell and Solman, 1991), student-generated illustrations (e.g. Hall et al., 1997), and diagrams (e.g. Marcus et al., 1996) on learners' comprehension of different types of texts.

In the case of L2 learning, previous research has suggested that the presence of visuals is beneficial for reading comprehension (e.g. Elley and Mangubhai, 1983; Omaggio, 1979). Omaggio examined the effect of different types of pictures (with respect to how many objects they depict or whether they depict scenes from the beginning, main portion or end of the story) on L2 reading comprehension in French. The study concluded that pictures were beneficial for reading comprehension, especially those depicting scenes from the beginning of the story. Including pictorial information together with text and audio has also been found to be helpful for incidental vocabulary learning (Bisson et al., 2014).

On the other hand, in his review of 54 series of graded readers, Hill (2013) suggests that in some cases the presence of images together with text might draw learners' attention away from the text, especially at beginning levels, when it might be harder to infer the meaning of new words from the text alone. As Kiss and Weninger (2016) claim, despite the prominence of visuals in language learning materials, very little is known about how learners engage with pictorial information. In fact, such engagement might be different in reading-only and reading-while-listening modes, which is what the present study aims to analyse. Moreover, we also aim to examine whether learners' engagement with the three input sources under consideration (text, audio and images) is different for children (primary school) and adult (university) L2 learners.

Importantly, the studies reviewed in this section all used post-reading measures that do not really tell us how learners process these different sources of support while reading. This is something that can be investigated using eye-tracking technology. Only a few studies have used eye-tracking to investigate how L2 learners process text and images in different reading conditions. From previous eye-tracking studies in multimodal learning conditions, we know that adult learners make use of pictorial support when learning vocabulary (Bisson et al., 2015). However, when engaged in reading comprehension activities, the time that adult L2 learners spend reading a text and looking at the pictures does not seem to be related to reading comprehension (Chang and Choi, 2014).

In a previous exploratory study, Serrano and Pellicer-Sánchez (under review) explored young learners' engagement with text and images of a graded reader in two reading modes: reading-only versus reading-while-listening. The results of this study suggest that all learners (regardless of reading mode) spent more time processing the text than the images. Additionally, it was found that the learners in the reading-only mode paid comparably more attention to the text than those in the reading-while-listening mode, while the opposite was true for the images. However, Serrano and Pellicer-Sánchez's study did not analyse how attention to this multimodal material was reflected on learners' comprehension. Thus, the present study examines not only how learners of different ages and proficiencies process text and images in two multimodal reading conditions (reading-only and reading-while-listening), but also how processing behaviour is related to comprehension.

3

Methodology

Participants

Data was collected from three participant groups: child L2 learners, adult L2 learners and adult L1 readers. Altogether data from 75 participants was included in the analyses of the study.

Data from the child L2 learners was collected in a primary school in Barcelona (Spain). They were all from grade 6 in primary school (ages 11–12; 14 female and 14 male) and their English proficiency level was A1.1 according to the Common European Framework of Reference for Languages (CEFR). In order to ensure that there were not differences in proficiency within this group, only participants who had a minimum vocabulary size of 1,000 words, as demonstrated by the scores of the X_Lex vocabulary size test (Meara and Milton, 2003), participated in the study (max. = 2,600, min. = 1,100, $M = 1,985$, $SD = 443$). This threshold was chosen to ensure comprehension of the reading materials in the study (see explanation in the next section). After discarding data from two participants who had not completed the comprehension test, data from 28 child L2 learners was included in the analysis.

The adult L2 learners were advanced learners of English from different L1 backgrounds who were studying at the University of Nottingham (UK). They were all undergraduate and postgraduate students who had met the language entry requirement to study at the university. Although collecting vocabulary size data from this group was not possible, their vocabulary size was estimated based on the performance of another group of participants of similar characteristics on the X_Lex vocabulary size test (Meara and Milton, 2003). The vocabulary size was estimated at a mean of 7,777 words (min. = 6,000, max. = 9,666, $SD = 1,000$) and was then considered in the design of materials (see explanation in the next section). Data from a total of 25 L2 adult learners (17 female and eight male) was included in the analysis. Their ages ranged from 19 to 29 ($M = 22.24$, $SD = 2.74$).

Data from 22 L1 readers was also included in the study (19 female and three male) in order to have a baseline for native-like reading behaviour in these conditions. This baseline data allowed us to examine the ways in which adult L2 learners' behaviour differed from that of L1 readers. They were all undergraduate students at the University of Nottingham majoring in a range of subjects. Their ages ranged from 19 to 25 ($M = 19.45$, $SD = 1.57$).

Materials

Participants in the three groups were asked to read a short, illustrated story which included a block of text and one image on each page. The block of text had a similar length on each page (but shorter in the children's narrative). Half of the story was presented in reading-only mode and the other half in reading-while-listening mode. Care was taken in the selection and design of materials to ensure that they were appropriate in terms of the age of the participants (e.g. a children's story may not be engaging for adults and one for adults may not have content that is suitable for children) and proficiency level. Therefore, different materials were used for child and adult L2 learners, whereas the same reading materials were used for the adult L2 learners and L1 readers. It was also important to account for the different factors that could affect participants' eye movements, such as position of the text and images, size of text and images, and characteristics of the visual stimuli (e.g. type of characters and objects depicted and colours used).

For the group of child L2 learners we modified an existing graded reader, *The Canterville Ghost* (Wilde, 2012; original text 1,012 words), making it of an appropriate length for the study (566 words across 14 pages) and ensuring that its vocabulary was mainly within the first most frequent 1,000 words in the English language (94.2 per cent). Since all of the child learners had a vocabulary size over 1,000, this should ensure that there were no comprehension difficulties. Some of the words from the 2,000 band were also known by participants.

For example, before reading the story we checked that the word *ghost* was known by all participants, as this word was crucial for understanding the story. Because *ghost* was a known word, lexical coverage was 96.5 per cent, increasing the likelihood of an adequate level of comprehension (Hu and Nation, 2000). The accompanying images were taken from the original graded reader and were modified so that they all had the same size.

For the group of adult L2 learners and L1 readers, a mystery story (2,055 words in length) was written around a set of 31 images which were taken from the picture stimuli developed by the Arnold Lab (Rosa and Arnold, 2017; <http://jaapstimuli.web.unc.edu/>). The original stimuli consisted of 53 pairs of pictures which together depicted a story. Although these images were developed with a different research aim, they were chosen because they made it possible to create a narrative around them while at the same time having the same style and similar visual features. The narrative was displayed over 31 pages with one block of text and a picture on each page. The text was created to ensure that most vocabulary was within the first 6,000 most frequent words in English (in accordance with L2 adult learners' estimated vocabulary size), in order to avoid potential comprehension difficulties. Ninety-four per cent of the words in the text were from the first 6,000. Two words, *butler* and *chauffeur*, were from the 8,000 band but were introduced to the participants at the beginning of the study, as they were central to the narrative. This means that 96 per cent of the words in the story were likely to be known by the adult learners, in accordance with the recommended threshold of lexical coverage for successful comprehension (Hu and Nation, 2000) (see Appendix A for a sample page of the narrative).

As for the auditory stimuli used in the reading-while-listening condition, for both narratives an audio recording was created by a native speaker of British English for each page of text. In both experiments the relevant audio recording was set to play at the onset of each page in the reading-while-listening condition.

For both groups, half of the story was presented in reading-only mode and the other half in reading-while-listening in a counterbalanced design so that each of the participants would be exposed to the two reading modalities, while at the same time ensuring that the two parts of the story were presented in both modes. The font used for both

experiments was Times New Roman (size 25 in the adults' experiment and 15 in the children's experiment).¹ The images appeared either to the right or left of the blocks of text and the relative positions of the two elements were counterbalanced throughout the experiment.

Eye-tracking in the case of adult learners and L1 readers was performed using an SR Research EyeLink 1000+ (SR Research, www.sr-research.com) at a sampling rate of 1,000 Hz. Eye-tracking in the case of the children was performed using a Tobii T120 (Tobii, www.tobii.com) at a sampling rate of 120 Hz.

Measures

This study used a combination of offline and online measures. The offline measures provided information about the reading comprehension of the participants, while eye-tracking provided measures of the online processing of text and images. Offline and online performance was compared across input modes and participant groups.

Comprehension questions: a comprehension test was designed for each of the narratives. The two tests were designed according to the same principles, while at the same time ensuring the appropriateness of the test for each participant group. In an attempt to explore the contribution of both text and images to comprehension, the test included two sets of items: a set of questions related to the information provided in the text and a set of items related to details of the narrative or of characters displayed in the pictures. The image-related questions could only be answered by information displayed in the images.

In order to create the comprehension test for the children, the narrative was parsed into idea units (i.e. distinct events or actions that occurred in the course of the story) and these were then used to create multiple-choice and true–false comprehension questions. This battery of true–false and multiple-choice items was piloted prior to the experiment with a group of learners of similar characteristics (N = 46). The results of the pilot were used to check the functioning of the potential items. True–false questions were not included in the study as the results showed that they did not work well with children. We also checked how good the questions were in terms of discrimination and level of difficulty. Based on these analyses two text-related items and

¹ The font sizes were different in the two experiments because of differences in the display monitors used and because of a lack of exact correspondence between the size units in the two software packages. The relative size of the text in relation to the image was the same in both experiments.

one image-related item were discarded. This resulted in a comprehension test that consisted of 25 multiple-choice items (16 text-related and nine image-related items). Each test item provided three options and a fourth 'I don't know'. The test was in the learners' L1 (Catalan) to ensure comprehension of the content.

The comprehension test used for the adults' narrative initially consisted of 62 text-based (multiple-choice and true–false questions) and 11 multiple-choice, image-based items. When creating the test items, each page of the narrative was also parsed into idea units and these were used to design one multiple-choice and one true–false item per idea unit (when possible). The multiple-choice items presented three options and a fourth 'I don't know' option to minimise guessing. The 11 image-related, multiple-choice comprehension items were based around details presented in the pictures that were related to the narrative but not mentioned in the text. After administration of the test, the results were inspected to identify poorly performing items that needed to be removed from the final results. The results were used to examine how good the items were in terms of discrimination (the ability to distinguish between learners who know the answer and those who don't) as well as in terms of level of difficulty. Two of the text-based items were discarded because of their negative item discrimination score. The final comprehension results for this study were then based on the remaining 71 items (60 text-based and 11 image-based).

Eye-tracking: the eye-trackers recorded participants' eye movements to the text and the images presented on the computer screen. Different eye movement measures can be assessed and reported. Here we report an analysis of the *dwelt time percentage* measure, which is defined as the percentage of the duration of all fixations made within a particular area of the presented stimuli. Thus, in general terms what we present here is the percentage time that participants spent processing the text and the image areas in the two reading conditions. This percentage measure provides a good indication of the total processing time and of how participants split their attention between the image and the text in each page on the story (see Conklin and Pellicer-Sánchez (2016) for a detailed explanation of the use of eye-tracking in second language learning research).

Procedure

Data collection followed the appropriate ethical procedures and received approval from the University of Nottingham Ethics Committee. Data collected at the University of Nottingham with the two groups of adult participants took place in the Nottingham Psycholinguistics and Language Learning Lab. Data collection in Barcelona with the child L2 learners took place on the school's premises. The equipment was set up in a quiet room specifically dedicated for the experiment for the duration of the study. All participants completed the tasks individually. The adult learners first completed a language background questionnaire to assess their L2 English proficiency and use, while this information was provided by the children's teachers. Participants were then given the task instructions orally. After the set-up and calibration of the equipment participants completed the reading activity while their eye movements were recorded. They were provided with headphones which they wore throughout the experiment. In the reading-only condition participants pressed a key in the keyboard to advance to the next page, whereas in the reading-while-listening condition the page advanced automatically at the offset of the audio recording.

After reading and reading-while-listening to the story, participants completed the comprehension test. The whole procedure lasted around 40 minutes in the case of L1 readers and around 50–60 minutes for child and adult L2 learners.

Analysis

Eye-tracking data was processed using Tobii Studio (for data collected with Tobii T120) and DataViewer (for data collected with EyeLink). After applying the standard procedures for cleaning the data (i.e. discarding short fixations, deleting problematic trials, etc. – for an overview see Conklin and Pellicer-Sánchez, 2016), data for the dwell time percentage was analysed via linear mixed-effect models (see Appendix B for details of the statistical analyses conducted). Since the duration of the trials (and hence the total dwell time) was limited by the duration of the audio recordings in the reading-while-listening condition whereas reading in reading-only trials was self-paced, percentage measures were entered in the models as a way of controlling for differences in trial length.

4

Findings and discussion

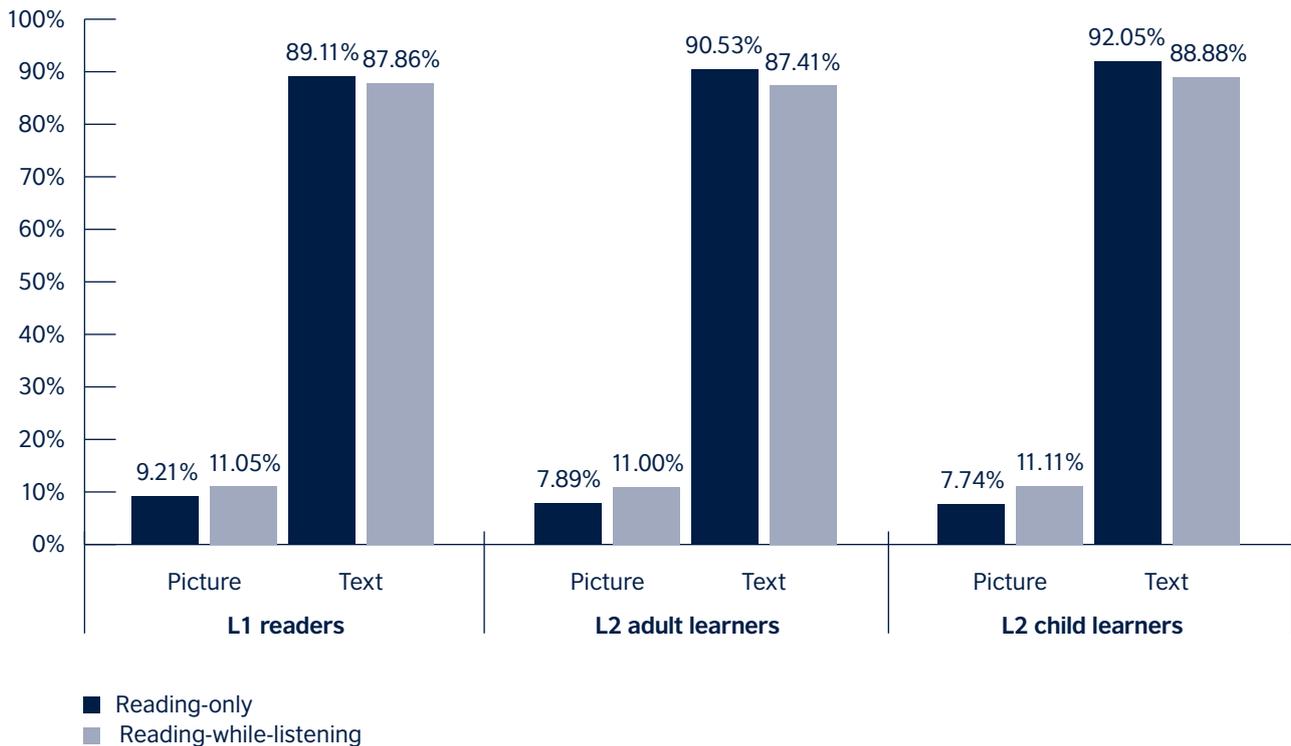
The report and discussion of the main findings is organised around the three main research questions, which will be discussed in turn.

How do children and adult learners process the text and pictorial information in multimodal reading materials in the presence or absence of auditory input?

First of all, we looked at the percentage of time that participants spent processing the text and the images in the two reading conditions (reading-only and reading-while-listening). For this analysis, two regions of interest were defined for each page of the narrative, the image area and the block of text.

Fixations shorter than 80 milliseconds were removed from the dataset (4.62 per cent of fixations lost in the L1 and L2 adults' data set; 0.57 per cent of data lost in the children's data). Figure 1 provides an overview of dwell time percentage for the three participant groups in the two reading modes.

Figure 1: Dwell percentage data by participant group (L1, L2 adults and L2 children) and condition (reading-only and reading-while-listening)



From the results displayed in Figure 1 and the statistical analyses conducted, the following key findings were identified:

- participants in the three groups spent significantly more time reading the text than processing the images in both reading conditions
- all groups spent significantly more time reading the text in the reading-only condition than in the reading-while-listening condition
- conversely, all groups spent significantly more time processing the images in the reading-while-listening condition than in the reading-only condition
- there were no significant differences between the two adult participant groups.

Despite the presence of images in the narratives, all participants in the study spent more time reading the text than looking at the images in both reading conditions (see Figure 1). This is particularly interesting in relation to the child L2 learners, as it shows that, when reading illustrated graded readers, the pictures do not completely take learners' attention from the text, contrary to concerns previously raised (Hill, 2013). This supports previous findings with children (Serrano and Pellicer-Sánchez, under review) and expands this to more advanced and proficient readers. Interesting differences appear in the processing of text and images in the presence of the auditory input. It appears that participants spend more time reading the text in the reading-only condition than in the reading-while-listening and that conversely, more time was spent looking at the images in the reading-while-listening condition. This shows that

the provision of the verbal input through the oral mode allowed participants to check the images more often as they read. Perhaps, as Serrano and Pellicer-Sánchez (under review) argue, providing the text through the auditory mode allows for a better integration of the text and pictures in this type of multimodal materials. Most importantly, when looking at the patterns shown by the three participant groups, contrary to our expectations, no considerable differences are found in the way child and adult L2 learners process the different sources of input in these multimodal reading materials. The results indicate that L2 adult learners processed the text and images in a similar way to L1 readers, which is not surprising, given the advanced level of the L2 learners participating in this study.

Are there any differences in reading comprehension levels in the two reading modalities, i.e. reading-only and reading-while-listening?

The findings in the previous section have shown that the presence of audio led to significant differences in the processing of the text and images in these multimodal reading conditions for the three participant groups. The next question is whether these processing differences would be reflected in differences in the comprehension scores. We might expect that, if there were significant differences in the way in which participants processed the text and the images when the audio was provided, then this might lead to different levels of comprehension. Table 1 reports the per cent correct on the comprehension test for the text-related and image-related questions.

Table 1: Per cent correct on the comprehension test with standard deviation in parentheses by participant group (L1, L2 adults and L2 children) and condition (reading-only and reading-while-listening)

Group	Text-related questions		Image-related questions	
	Reading-only	Reading-while-listening	Reading-only	Reading-while-listening
L1 adults	72.5% (3.2)	69.5% (2.7)	45.5% (4.9)	47.3% (4.5)
L2 adults	80.6% (2.1)	76.2% (2.3)	57.4% (3.4)	49.8% (3.6)
L2 children	53.57% (5.0)	58.48% (5.3)	44.6% (4.7)	42.5% (4.0)

The results of the statistical analyses yielded the following findings:

- the comprehension scores for the L2 adult learners were significantly higher than those of L1 readers
- there were no significant differences between the comprehension scores under the two reading conditions in any of the participant groups (for both the text-related and the image-related questions).

The lowest comprehension scores were attained by the child L2 learners. However, it is important to note that the tests used for the adults and the children were different and the lower scores could just be due to the different level of difficulty of the questions. Contrary to our expectations, results showed that adult L2 learners achieved higher comprehension scores than the L1 readers, indicating a generally better performance on the part of adult L2 learners for both types of questions. This may suggest that the L2 readers were more accustomed to completing this type of language test. Importantly, none of the analyses revealed a main effect of reading condition, showing that there were no significant differences between reading-only and reading-while-listening modalities in terms of participants' level of comprehension, contrary to what previous studies have shown (Chang and Millet, 2015). Thus, the differences that we observed in the processing of the text and images across the three participant groups do not seem to be reflected in differences in comprehension. When the audio was provided, participants in all groups spent less time reading the text and more time processing the images, but this did not seem to affect their comprehension, as similar levels of comprehension are found for both modalities.

Is there any relationship between online processing behaviour and reading comprehension?

Finally, we wanted to explore if there was a relationship between the online processing of the text and images in reading-only and reading-while-listening conditions and participants' level of comprehension. Finding a relationship between the way L2 learners process the text and images in multimodal reading materials and comprehension would allow us to use processing information to predict potential reading and comprehension difficulties.

We examined the relationship between the processing of the text and the images and the two types of comprehension questions (text-related and image-related items). Three main comparisons were conducted (see Appendix B for details of statistical analyses conducted). First, we examined the relation between the time participants spent processing the text and the text-related questions, as the amount of time processing the text could be a predictor of how well the participants had understood the narrative. Second, in order to explore the potential of pictorial support for the comprehension of the narrative, we looked at the relationship between the processing of the images and text-related comprehension scores. Finally, in order to further explore the role of images in multimodal reading conditions, we looked at the relationship between the processing of the images and image-related questions. The following key findings emerged from the analyses:

- processing of text:
 - longer reading time on the text for adult L2 readers was related to higher comprehension scores
 - conversely, longer reading time on the text for L1 readers was related to lower comprehension scores
 - there was no relationship between the processing of the text and scores on the text-related questions for child L2 learners
 - this relationship between the processing of the text and comprehension did not seem to differ by reading condition
- processing of images:
 - more time processing the images was related to higher accuracy in the image-related questions in the case of L2 adult learners and L1 readers
 - longer time processing the images seems to be related to text comprehension only in the case of L1 readers
 - longer time processing the images does not seem to support text comprehension for any of the groups of L2 learners
 - there was no relationship between the processing of the images and any of the comprehension questions for child L2 learners
 - this relationship between the processing of the images and comprehension did not seem to differ by reading mode.

Despite the similar patterns of results for the three participant groups reported in the previous two sections, the analysis of the relationship between processing time and comprehension scores has yielded some very interesting differences among them. It seems that processing information can be used in some way to predict comprehension scores of L1 readers and adult L2 learners, whereas processing time in the case of child L2 learners does not seem to be a predictor of response accuracy. This might be due to the fact that these

three groups of readers are at different stages of reading development: L1 readers and L2 adult readers are fluent, while child L2 learners are still developing both their L1 and L2 reading skills. This makes it more difficult to use processing data to predict child L2 learners' comprehension, as their online processing behaviour might not only be related to comprehension but also to the development of reading fluency.

5

Pedagogical implications and conclusions

The benefits of exposing language learners to large amounts of written input through reading programmes have been well documented. Benefits include: improved reading skills, increased reading fluency, new vocabulary learning and strengthening knowledge of previously known vocabulary, improved attitudes towards reading, and increased motivation towards language learning (Day and Robb, 2015). With this in mind, language teachers, especially in EFL environments, frequently set up programmes designed to foster learners' reading skills. In these programmes, learners are encouraged to read books or texts at an appropriate level and read as much as possible. However, language learners also need exposure to the aural form of the language – something that reading alone cannot provide. With that in mind, educators often turn to reading-while-listening to provide learners with exposure to aural input but with the presence of scaffolding in the form of written input. This allows learners to make use of their knowledge of the written form of the language, which is often more developed in the earlier stages of language learning, while receiving exposure to the aural form. The overall question for teachers, however, is whether presenting the input in two modalities changes the way that the learners interact with a text and whether this may have an effect on comprehension.

The present study has addressed this question and the findings have interesting implications for language teaching pedagogy. So, what do the findings of this study tell us about the use of these two reading modalities and about potential differences among them? This section includes the main conclusions from the study and considers the main pedagogical implications in relation to the two groups of L2 learners participating in the study.

Reading-only and reading-while listening with child L2 learners

We know from previous studies with late primary school children (e.g. Tragant and Vallbona, in press) that reading-while-listening is more popular than reading-only. There are children who do not like the idea of extensive reading but like it if they can read and simultaneously listen to the oral rendition to the text. Despite reading-while-listening being more popular, primary school teachers will be interested to know in which way having the auditory input in reading-while-listening affects the reading process and whether it affects comprehension. What if children pay little attention to the text in reading-while-listening conditions? This would be an important consideration when choosing activities that aim to develop reading fluency. What if children are overwhelmed with the multiple sources of input, having a negative impact on comprehension? The present study indicates that comprehension is not significantly different in the reading-while-listening mode. While the children spent less time on the text and more time on the illustrations when reading-while-listening than when reading-only, their comprehension tended to be as good or better. When discussing the potential advantages of reading-while-listening for classroom and out-of-classroom activities, it is important to consider other potential benefits that were not examined in this study. The present study focused on reading comprehension but benefits in other linguistic skills have also been observed in previous studies. Research with children suggests that learners learn similar amounts of vocabulary under these two learning modes (Serrano et al., 2016). A potential additional benefit of extensive reading-while-listening is the development of a number of skills related to listening fluency (Chang and Millet, 2014; Renandya and Jacobs, 2016).

Based on evidence from this and previous studies with children (e.g., Lightbown, 1992; Tragant et al., 2016), it seems advisable for teachers to promote reading-while-listening among their late primary school students. In class, reading-while-listening can be successfully used in combination with other formats like storytelling, reading-only or listening-only. Exposing students to the same input repeatedly in slightly different formats can facilitate learning and make it appear less repetitive and potentially boring. Outside of the formal class, extensive reading-while-listening seems to be a powerful yet underused tool in EFL contexts. Reading-while-listening to graded readers can have an empowering function: the aural text acts as a scaffold that enables language learners to read texts they could not possibly read on their own. The autonomy that the combination of graded readers plus audio support gives to the learner together with the appeal of using technological devices (e.g. MP3s and tablets) make these materials optimal for use in informal language learning contexts.

In sum, reading-while-listening can be as effective, and possibly more so than reading-only, as well as being more motivational. While it can be easily implemented as an instructional practice activity in the context of the traditional class, it is a powerful language-learning tool in less formal contexts both at school and at home.

Reading-only and reading-while-listening with adult L2 learners

In the case of adult L2 readers, regardless of whether the learners were only reading or reading-while-listening, they had similar levels of comprehension of the image-based and text-based questions, in line with what was found for children. The way adult L2 learners processed the text and images in these multimodal reading conditions was also very similar to what was found for children. There was, however, an interesting relationship between processing time and comprehension scores in the case of adult L2 readers. Processing behaviour seems to be helpful in predicting comprehension in the case of adult L2 readers, but not for child L2 learners. The time L2 adult learners spent reading the text was positively related to comprehension scores, with more time on the text being associated with better comprehension of the narrative.

Moreover, more time spent on imagery resulted in better image-based comprehension. From a pedagogical perspective, this indicates that the teacher should consider the reading goals of the learner when deciding whether the input should be presented in a reading-only mode or a reading-while-listening mode. If the goal of the reading is comprehension of what is explicitly stated in the text then the learners should be encouraged to only read. In these reading situations, it is advantageous to the learner to concentrate their attention on the written text and spend less time on the imagery to increase the likelihood of text-based comprehension. If the learner is reading for more general understanding or reading a text that has multimedia attributes, such as combinations of text and pictures, then the reading-while-listening mode should be encouraged. This allows the learner the freedom to spend time looking at images while still comprehending the text. This is especially true when the associated images have a high degree of relatedness to written text and can possibly add to overall comprehension.

Conclusions

The potential benefits of reading-while-listening have been established in terms of vocabulary learning (see Brown et al., 2008; Webb and Chang, 2014) but there has been less research on the differences in comprehension for reading-only and reading-while-listening. This study addressed this gap through the use of eye-tracking to look at what the learners do with an image-supported text in both input modes. Taken together, the findings of the child L2 learners, adult L2 learners and L1 readers suggest that the way in which readers engage with pictures and textual information in reading-only conditions is very similar. The use of auditory input in reading-while-listening conditions clearly leads to differences in the processing of the text and the images, but the patterns of processing these input sources seem to be very similar across proficiency groups. Based on these findings, there seems to be a certain degree of universality in the way learners of different proficiencies engage with the different sources of information in multimodal reading materials. Importantly, these processing differences do not affect comprehension as response accuracy was similar in reading-only and reading-while-listening conditions.

The results of this study have shed light on how learners make use of the different sources of input in reading activities, which will hopefully help teachers and practitioners make decisions about classroom instruction and recommendations about out-of-classroom exposure. The present study has provided initial evidence of the effectiveness of different reading modes and the relationship between processing and levels of comprehension. Further research should aim at examining the processing of different types of texts. Reading texts of higher levels of difficulty might pose a greater challenge for readers, affecting not only their processing behaviour but also their comprehension. This study has compared performance of the two groups of L2 learners that are perhaps most distinct from each other: child L2 learners who are not only low-proficiency readers but who are also still developing their literacy skills

in their L1; and advanced, adult L2 learners who are proficient readers in both their L1 and L2. This comparison provides some initial understanding of how these multimodal materials work across proficiency groups. The comparable patterns found across the two groups of L2 learners and L1 readers point towards a very similar engagement with multimodal materials. However, future studies should aim at examining the performance of learners of a wider range of proficiencies and ages. Crucially, the present findings contribute to our understanding of the effectiveness of these multimodal reading modes for comprehension but further research should explore the effect that processing differences have on the improvement of other linguistic skills. This will provide a richer picture of the effectiveness of these multimodal reading materials on a variety of skills across ELT contexts.

References

- Bisson, M-J, Van Heuven, WJB, Conklin, K and Tunney, RJ (2014) The Role of Repeated Exposure to Multimodal Input in Incidental Acquisition of Foreign Language Vocabulary. *Language Learning* 64/4: 855–877.
- Bisson, M-J, Van Heuven, WJB, Conklin, K and Tunney, RJ (2015) The role of verbal and pictorial information in multimodal incidental acquisition of foreign language vocabulary. *Quarterly Journal of Experimental Psychology* 68/7: 1306–1326.
- Brown, R, Waring, R and Donkaewbua, S (2008) Incidental vocabulary acquisition from reading, reading-while-listening, and listening to stories. *Reading in a Foreign Language* 20/2: 136–163.
- Chang, AC-S (2009) Gains to L2 listeners from reading while vs. listening only in comprehending short stories. *System* 37/4: 652–663.
- Chang, AC-S and Millett, S (2014) The effect of extensive listening on developing L2 listening fluency: some hard evidence. *ELT Journal* 68/1: 31–40.
- Chang, AC-S and Millett, S (2015) Improving reading rates and comprehension through audio-assisted extensive reading for beginner learners. *System* 52: 91–102.
- Chang, Y and Choi, S (2014) Effects of seductive details evidenced by gaze duration. *Neurobiology of Learning and Memory* 109: 131–138.
- Conklin, K and Pellicer-Sánchez, A (2016) Using eye-tracking in applied linguistics and second language research. *Second Language Research* 32/3: 453–467.
- Day, R and Robb, T (2015) 'Extensive Reading', in Nunan, D and Richards, JC (eds) *Language Learning Beyond the Classroom*. New York: Routledge, 3–12.
- Elley, WB and Mangubhai, F (1983) The impact of reading on second language learning. *Reading Research Quarterly* 19/1: 53–67.
- Gambrell, LB and Jawitz, PB (1993) Mental imagery, text illustrations, and children's story comprehension and recall. *Reading Research Quarterly* 28/3: 264–276.
- Grabe, W (2009) *Reading in a Second Language: Moving from Theory to Practice*. Cambridge: Cambridge University Press.
- Hall, VC, Bailey, J and Tillman, C (1997) Can student-generated illustrations be worth ten thousand words? *Journal of Educational Psychology* 89/4: 677–681.
- Hill, DR (2013) Graded Readers. *ELT Journal* 67/1: 85–125. DOI: 10.1093/elt/ccs067
- Hu, M and Nation, P (2000) Unknown Vocabulary Density and Reading Comprehension. *Reading in a Foreign Language* 13/1: 403–430.
- Kiss, T and Weninger, C (2016) Cultural learning in the EFL classroom: the role of visuals. *ELT Journal* advance online publication. DOI: 10.1093/elt/ccw072
- Lightbown, PM (1992) 'Can they do it themselves? A comprehension-based ESL course for young children', in Courchêne, R, St John, J, Therrien, C and Glidden, J (eds) *Comprehension-based second language teaching: Current trends*. Ottawa: University of Ottawa Press, 353–370.
- Lightbown, PM, Halter, RH, White, JL and Horst, M (2002) Comprehension-based learning: the limits of 'do it yourself'. *Canadian Modern Language Review* 58/3: 427–464.
- Marcus, N, Cooper, M and Sweller, J (1996) Understanding instructions. *Journal of Educational Psychology* 88/1: 49–63.
- Mautone, PD and Mayer, RE (2001) Signaling as a cognitive guide in multimedia learning. *Journal of Educational Psychology* 93/2: 377–389. DOI: 10.1037/0022-0663.93.2.377
- Meara, PM and Milton, JL (2003) *X_Lex: the Swansea Vocabulary Levels Test*. Newbury: Express Publishing.
- Omaggio, AC (1979) Pictures and second language comprehension: Do they help? *Foreign Language Annals* 12/2: 107–116.
- Paivio, A (1986) *Mental representations: A dual coding approach*. Oxford: Oxford University Press.
- Purnell, KN and Solman, RT (1991) The influence of technical illustrations on students' comprehension in geography. *Reading Research Quarterly* 26/3: 277–299.
- Renandya, WA and Jacobs, GM (2016) 'Extensive Reading and Listening in the L2 Classroom', in Renandya, WA and Widodo, HP (eds) *English Language Teaching Today: Linking Theory and Practice*. Cham: Springer.

- Rosa, EC and Arnold, JE (2017) Predictability affects production: Thematic roles can affect reference form selection. *Journal of Memory and Language* 94: 43–60.
- Serrano, R, Andria, M and Pellicer-Sánchez, A (2016) *Science vocabulary learning through reading only vs. reading-while-listening in primary school*. Paper presented at the VIII edition of the AEAL Conference, 7–9 September 2016, Palma de Mallorca, Spain.
- Serrano, R. and Pellicer-Sánchez, A (under review) Young L2 learners' online processing of information in a graded reader during reading-only and reading-while-listening conditions: a study of eye-movements.
- Tragant, E, Muñoz, C and Spada, N (2016) Maximizing Young Learners' Input: An Intervention Program. *Canadian Modern Language Review* 72/2: 234–257.
- Tragant, E and Vallbona, A (in press) Reading while listening to learn: young EFL learners' perceptions. *ELT Journal*.
- Trofimovich, P, Lightbown, PM, Halter, RH and Song, H (2009) Comprehension-based practice: The development of L2 pronunciation in a listening and reading program. *Studies in Second Language Acquisition* 31/4: 609–639.
- Webb, S and Chang, AC-S (2012) Vocabulary learning through assisted and unassisted repeated reading. *Canadian Modern Language Review* 68/3: 267–290.
- Webb, S and Chang, AC-S (2014) Second language vocabulary learning through extensive reading with audio support: How do frequency and distribution of occurrence affect learning? *Language Teaching Research* 19/6: 667–686.
- Wilde, O (2012) *The Canterville Ghost*. Retold by Cadwallader, J. ELI Graded Readers. Recanati: ELI Publishing.

Appendix A: Example of stimuli for the adults' experiment²



This is a mystery story about Sir Barnes and Lady Mannerly, a very secretive couple who, at the time of this story, had been married for twenty years. They were wealthy British people who lived in a beautiful manor and had a passion for the fine arts. They had an impressive collection of expensive paintings and sculptures. They were regular customers in some of the most exclusive galleries in England.

Image above © Jennifer Arnold

² Because of copyright issues a sample of the children's narrative cannot be included. It was designed following the same guidelines, with the only difference being that the text on each page was shorter.

Appendix B: Description about the statistical analyses conducted to respond to each of the research questions

The data was analysed using the lme4 (v1.1.13) package for R (v3.3.2). As the data was collected using different equipment and extracted using different software, different models were fitted for the adults' (including L1 readers and adult L2 learners) and children's data.

Models fitted to the data to answer the first research question

A linear mixed-effect model analysis was first conducted with the L1 readers' and adult L2 learners' dwell percentage data, in order to explore the effects and interactions among the following factors: Condition (reading-only, reading-while-listening), Region (text, image) and Group (L1 readers, L2 adult learners). Two model structures fitted to the adults' dwell time percentage data (L1 readers and L2 adult learners):

- m1) $IA_DT_% \sim \text{CONDITION} * \text{REGION} + (1 | \text{PARTICIPANT})$
- m2) $IA_DT_% \sim \text{GROUP} * \text{CONDITION} * \text{REGION} + (1 | \text{PARTICIPANT})$

The two models were then compared via maximum-likelihood (ML). The addition of Group as a factor did not increase the goodness of fit of Model 2 over Model 1.

Model	Df	AIC	BIC	Log-Likelihood	χ^2 (Df)	p
1	6	-5663.7	-5627.8	2837.8	-	-
2	10	-5664.3	-5604.5	2842.1	8.57 (4)	.07

Another linear mixed-effect model analysis was conducted with the children's dwell time percentage data, with Condition (reading-only, reading-while-listening) and Region (text, image) as factors. The following model structure was fitted to the children's dwell time percentage data:

m1) $IA_DT_ \% \sim CONDITION * REGION + (1 | PARTICIPANT)$

Models fitted to answer the second research question

Another linear mixed-effects model analysis was conducted with the percentage of correct responses in the comprehension test as dependent variable and Condition (reading-only, reading-while listening) as factor. The following model was fitted to the adults' response accuracy data:

m0) $Image_Accuracy \sim CONDITION * GROUP + (1 | PARTICIPANT)$

m0_2) $Text_Accuracy \sim CONDITION * GROUP + (1 | PARTICIPANT)$

Models fitted to answer the third research question

Two models were fitted for the image-related comprehension scores and the text-related comprehension scores, with Condition (reading-only, reading-while-listening) and average dwell time percentage as factors. Group was also a factor in the model fitted to the adults' data. The following models were fitted to the adults' response accuracy data:

m1) $Image_Accuracy \sim avg_DT_ \%_IMAGE * CONDITION * GROUP + (1 | PARTICIPANT)$

m2) $Text_Accuracy \sim avg_DT_ \%_TEXT * CONDITION * GROUP + (1 | PARTICIPANT)$

m3) $Text_Accuracy \sim avg_DT_ \%_IMAGE * CONDITION * GROUP + (1 | PARTICIPANT)$

The following model structures were fitted to the children's data:

m1) $Image_Accuracy \sim avg_DT_ \%_IMAGE * CONDITION + (1 | PARTICIPANT)$

m2) $Text_Accuracy \sim avg_DT_ \%_TEXT * CONDITION + (1 | PARTICIPANT)$

m3) $Text_Accuracy \sim avg_DT_ \%_IMAGE * CONDITION + (1 | PARTICIPANT)$

Any interaction effects found in the analyses were further explored using Tukey contrasts for multiple comparisons with Bonferroni-Holm correction.

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