

**Assistive Technologies for Dyslexia: Punctuation and its Interfaces with Speech**

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Date: 31/08/2020

Charikleia Triantafyllidou

## Assistive Technologies for Dyslexia: Punctuation and its Interfaces with Speech

Charikleia Triantafyllidou

Considering the well-documented issues of dyslexic students with the use of punctuation, the main purpose of this dissertation is to create a Computer-Assisted Language Learning (CALL) tool that assists dyslexic learners in improving their punctuation skills. This tool, called *PunkBuddy*, encompasses a Text-to-Speech (TTS) interface, a punctuation correction interface, and a chatbot. *PunkBuddy* is tailored to assist dyslexic students of English in Ireland on their transition from Primary School to the Junior Cycle. The dissertation presents the process of developing *PunkBuddy* on the basis of research findings.

Examining the use of punctuation in textbooks and in real life, the dissertation first presents the findings of a text analysis, which are compared with the results of a perception test. For the perception test, English teachers were asked to demonstrate their punctuation choices on unpunctuated texts chosen from the textbooks used in the text analysis. The conclusion from this study was that there is a notable discrepancy between the prescribed use of punctuation in textbooks and the actual use of punctuation by expert native-speakers of English specifically trained to teach the language. The implication of these findings is that the design of CALL tools, such as *PunkBuddy*, should take into account these discrepancies and provide suggestions, rather than automatic corrections.

In order to examine whether using TTS technologies for proof-listening would be suitable for dyslexic students, the dissertation summarises findings regarding prosodic sensitivity in dyslexia and the interfaces between prosody and punctuation. The results indicate that linguistic prosodic sensitivity is impaired in dyslexia and that prosodic skills are a predictor for punctuation skills. However, they also suggest that there is potential in using auditory training to improve prosodic sensitivity, an implication applicable to the design of *PunkBuddy*.

Aiming to define the main objectives for the development of dyslexia software, the dissertation then outlines a resource audit reviewing relevant existing software. Stemming from this resource audit, a number of learner, task, and teacher desiderata are presented. These include explicit instruction, meaningful feedback, scaffolded tasks, language and task authenticity, flexibility in classroom use, as well as technical aspects related to interface design, portability, and ease of use.

Finally, the dissertation presents the development of *PunkBuddy* on the basis of the previous findings. Its development considers the needs of the learner group, theories of language acquisition, and the desiderata of CALL development for dyslexic students. Technical aspects and limitations are also discussed, suggesting improvements needed for future development, especially in order to provide students with individualised feedback by tracking their progress.

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## Chapter 1: Introduction

### 1.1. Background

The objective of this dissertation is to tap into the application of assistive technologies for the improvement of punctuation use in dyslexic learners, a field which is generally under-researched. Recent developments in Computer-Assisted Language Learning (CALL) emphasize the need for accessibility, as seen for example in the framework of Rosell-Aguilar (2017, p. 247). Meanwhile, many CALL games and applications are tailored to address the needs of dyslexic learners (Daud & Abas, 2013; Ostiz-Blanco et al., 2018; Rello et al., 2017; Serrano et al., 2016; Vasalou et al., 2017), while various writing assistants are generally available, including *Ghotit* and *Ginger* (see Chapter 4). However, most writing assistants provide automatic punctuation correction without offering training for self-improvement. This study is focusing more specifically on improving the punctuation of dyslexic learners, while taking advantage of the affordances of Text-to-Speech (TTS) technology. It presents the development of a CALL tool called *PunkBuddy* (PunkBuddy Website, 2020), which incorporates a TTS interface used for proof-listening of punctuation, a punctuation correction interface which provides suggestions for improvement, and a chatbot aiming at helping dyslexic students learn through interactions.

Considering that punctuation significantly affects the clarity and coherence of a text, little attention has been paid to ways of improving punctuation in the writing of dyslexic students. Some studies examine punctuation errors in dyslexic adults, as seen for instance in Mortimore and Crozier (2006). Interestingly enough, however, the researchers group grammar and punctuation errors and do not examine punctuation on its own (2006, pp. 245-246). More recent studies examine the use of punctuation by dyslexic students in languages other than English (Feka, 2016; Protopapas et al., 2013; Tops et al., 2013), finding mixed results, which seem to be dependent on the language. While the impact of deep orthographies on punctuation are beyond the scope of this study, it is notable that English is a language characterised by a fluid punctuation system. Baron (2001) is one of the researchers observing the fluctuating nature of punctuation in English throughout the time. Stemming from this, dyslexic students of English would have to encounter not only the reading difficulties that render proof-reading ineffective, but also an inconsistent punctuation system, which seems to be dependent on semantics and not only syntax (Heggie & Wade-Woolley, 2018). Moreover, in studies analysing errors in dyslexic writing, punctuation errors are often ignored. For instance, Rello et al. (2012, 2014) have compiled a corpus of dyslexic writing, but they only classify word-level and phrase-

level errors. In corpus research it would be useful, especially for teachers, to consider punctuation errors since they affect the coherence and cohesion of a text.

Another gap in the available literature is detected in the research regarding the interfaces between speech and punctuation, especially in the perception of punctuation in dyslexic learners. Admittedly, drawing clear connections between elements of prosody and punctuation is not an easy task due to the “schizophrenic” relationship between written prosody (i.e. punctuation) and oral prosody (Baron, 2001, pp. 62-63). Heggie and Wade-Woolley (2018), Veenendaal et al. (2014), and Wolff (2002), acknowledge that oral prosody is realised in writing through punctuation, but also explain that the relationship between the two is not straightforward, resulting in students having to learn how to use punctuation through instruction and not being able to acquire it. Focusing on dyslexic learners, Goswami et al. (2010) outline the impact of auditory processing difficulties on prosodic awareness without drawing inferences regarding the use of punctuation. Finally, some research has been conducted in the field of prosody training with dyslexic learners, yielding positive results (Reynor, 2009). This study, however, was focusing on reading fluency, rather than on the use of punctuation in writing. Another study using prosodic training is that of Calet et al. (2017), which showed positive effects of prosodic training on punctuation skills, but focused on non-dyslexic learners. It would thus be interesting to consider whether a form of prosody training through TTS would have a similar impact on punctuation use in writing for dyslexic students.

## **1.2. Aims and Structure**

The ultimate purpose of this dissertation is to create a CALL prototype tool, called *PunkBuddy*, aiming at assisting dyslexic students in improving their punctuation. For the development of *PunkBuddy*, I will be extensively referring to the **TATL** (Theory, Actions, Technology, Learner,) framework, as proposed by Ní Chiaráin and Ní Chasaide (2015). Starting with the learner group, *PunkBuddy* is tailored to address the needs of students in the Irish education system, assisting their transition from Primary School to the Junior Cycle. It considers the educational, personal, and emotional needs of the students at this age. Its earliest stage of implementation is the final grade of Primary School and it is made to assist learners throughout the first year of Junior Cycle, as well as potentially throughout the rest of secondary education.

To recap the functionalities of *PunkBuddy*, as mentioned in 1.1, it consists of two main components:

- (a) A TTS component; this offers dyslexic learners the chance to proof-listen their text and correct it on their own based on what they hear before moving on to step 2.
- (b) A punctuation correction interface; this offers dyslexic learners suggestions on improving their punctuation and advises them on sentence length.

Finally, the artefact includes a chatbot, aiming at helping dyslexic students learn through interaction. However, the chatbot remains at a very early stage of development and currently exists as an additional component to the main CALL tool. Currently, it can advise students on the rules of using punctuation, utilising the benefits of explicit instruction. At a later stage, it would be able to provide further examples and better tailored assistance, for instance help with a particular context of punctuation in which a student struggles.

### **1.2.1 Dissertation Outline**

The process of developing *PunkBuddy* involves several research questions and objectives. As a result, there are two groups of research questions addressed in this dissertation.

The first group of research questions addresses punctuation, literacy instruction, and cognitive processing in dyslexia. These questions are:

- (a) RQ 1.1.: What are the discrepancies between the rules and the actual use of punctuation?
- (b) RQ 1.2.: Is prosodic sensitivity impaired in dyslexia and what are the interfaces between prosody and punctuation?

RQ 1.1. is addressed by comparing the results of a text analysis with those of a Perception Test performed by English teachers (see Chapter 2). The results of this study inform the design of the punctuation correction interface by setting a range of acceptable ways of punctuation and offering suggestions, rather than automatically punctuation. In other words, since there seems to be no one correct way to punctuate, *PunkBuddy* should not be following prescriptive rules of punctuation.

RQ 1.2. addresses the interfaces between speech and punctuation by focusing on prosodic sensitivity in dyslexic learners and looking into neurocognitive findings (see Chapter 3). Examining these findings offers an insight into the roots of punctuation issues in dyslexic students and informs the remediation processes that can be used, especially in the case of using TTS technology. Additionally, the relationship between prosodic skills and punctuation is examined. In other words, if prosodic

awareness is impaired in dyslexia, would listening be an effective way of correcting punctuation and improving these skills in the long run?

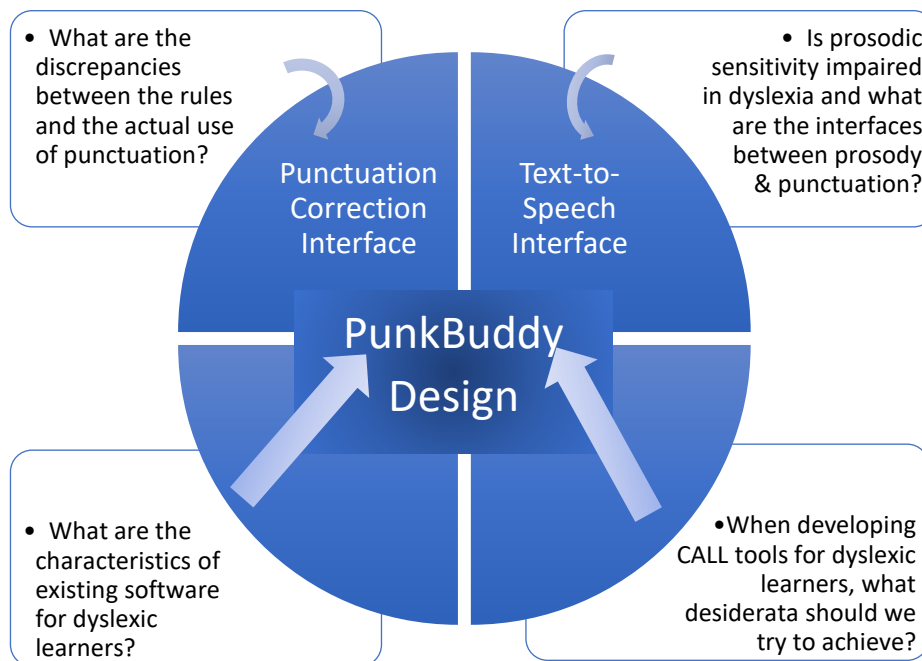
The second group of research questions addresses the practical considerations and issues in CALL development. These questions are:

- (a) RQ 2.1.: What are the characteristics of existing software and CALL tools for dyslexic learners?
- (b) RQ 2.2.: When developing CALL tools for dyslexic learners, what desiderata should we try to achieve?

RQ 2.1. is addressed by conducting a resource audit to examine and evaluate the pre-existing CALL software for the learner group in question, as the characteristics of currently available tools inform the development of *PunkBuddy*. RQ 2.2. stems from this evaluation and attempts to outline some student, task, and teacher desiderata that are to be considered when developing CALL tools for dyslexic learners (see Chapter 4 both for RQ 2.1. and RQ 2.2.). The structure and the research questions in this dissertation are summarised in the graph below.

**Figure 1**

*The Research Questions of this Dissertation Aiming at the Development of PunkBuddy*



### **1.3. Introducing the Learner Group**

Following the TATL framework, this section summarises the learner group that *PunkBuddy* addresses. The needs of the learners are at the core of the CALL development and inform all decisions made throughout the process.

#### **1.3.1. Educational and Cognitive Needs**

The transition from primary to secondary education is especially important due to the changes in written assessment. According to the official Junior Cycle curriculum, writing has a prominent place in assessment, both in the form of classroom-based assessment, as well as in final assessment tasks (N.C.C.A, 2019; N.C.C.A, 2020). However, writing in Primary School is mostly in the form of free writing, without any explicit instruction on composition writing (N.C.C.A, n.d). Dyslexic learners might encounter issues during this transition phase, considering their difficulties with writing.

Some books in the Junior Cycle include explicit instruction on punctuation, as seen for instance in *Kingdom 1* (Allsopp et al., 2018) and *Great Expectations 1* (Leddin, 2014), and the use of *PunkBuddy* aims at enhancing this instruction. Meanwhile, it allows students to work autonomously in the classroom as well as on their own, which assists both teachers who might not be able to help each student individually, as well as students themselves as they manage to work and improve on their own.

Finally, regarding cognitive needs, it is important to consider whether students will be able to acquire the input they receive it at this age. Kuhn et al. (2010, p. 236) point out that children cannot fully understand the discourse elements of prosody fully until they are adolescents, which implies that the implementation of *PunkBuddy* at an earlier stage would not be as useful for the learners.

#### **1.3.2. Dyslexia-specific Needs**

Dyslexic learners have been found to have deficits in phonological awareness, which is reflected in their writing. According to the Phonological Deficit Hypothesis, phonological processing is impaired in dyslexia, thus impacting both reading and writing (Snowling, 1998; Rack, 2018). Meanwhile, issues with reading render proof-reading ineffective, as students fail to detect their errors. This is especially the case with punctuation, which is often misused or absent in dyslexic texts (Feka, 2016, pp. 16-17). Therefore, dyslexic learners need a tool that facilitates the proof-reading process and helps them add punctuation.

### **1.3.3. Emotional Needs**

Finally, apart from the educational requirements of the curriculum and the personal characteristics of dyslexic learners, it is important to consider emotional factors. Studies on dyslexic adolescents have shown high skill-specific anxiety levels (Piechurska-Kuciel, 2010). Moreover, Eissa (2010) reports issues at socialisation and lower self-esteem, as well as higher scores in depression, aggression, and social problems in dyslexic adolescents (p. 23). Taking the above into account, this artefact aims at minimizing anxieties by assisting students in improving the quality of the texts and providing them with a safe space for interactions. To elaborate, while interaction and collaborative writing have generally yielded positive results (Lee et al., 2016), peer-interaction might not be as useful in this case. Instead, autonomous use of a punctuation correction interface and Human-Computer Interaction (HCI) in the form of a chatbot are ways to avoid personal interactions which might generate stress, while providing students with a chance to improve their writing skills.

## Chapter 2: Punctuation, Literacy Instruction, and Dyslexia

### 2.1. Introduction

The purpose of this chapter is to examine the discrepancies between the prescribed use of punctuation and its actual use by speakers of a language (RQ 1.1.). Discovering these discrepancies, their types and the degree to which they exist informs the processes of literacy instruction. For instance, while there is a noticeable trend towards explicit instruction of punctuation, the variety of acceptable ways to punctuate is not fully communicated to students. Pinpointing the range of acceptable punctuation methods then informs the development tools such as *PunkBuddy*, whose objective is not to automatically correct, but to train students. Training means that *PunkBuddy* should suggest changes and provide an encouraging environment accepting multiple ways of punctuation. Ultimately, setting a solid pedagogical base for the instruction of punctuation does not only assist dyslexic students, but it is also useful for the general student population.

### 2.2. Methodology

For the purpose of this study, I am comparing the use of punctuation in Junior Cycle English textbooks with the use of punctuation by English Teachers in post-primary education in Ireland. This is achieved by contrasting the results of a text analysis with those of a perception test involving English teachers. Below, I am outlining my choice of texts and participants and the tools used for the text analysis and the perception test.

#### 2.2.1. Text Analysis

The textbooks used in this study are all first-year Junior Cycle English textbooks, in accordance with the learner group chosen and taking into consideration that *PunkBuddy* aims at preparing students for secondary education. Specifically, the textbooks used are *Kingdom 1* (Allsopp et al., 2018) and *Great Expectations 1* (Leddin, 2014), both of which were provided for free on the *educateplus.ie* website due to the COVID-19 pandemic. From this point on in the text of this dissertation, the two textbooks will be referenced by their titles to ensure readability. The excerpts chosen are strictly non-literary texts, as the stylistics of literary writing may affect the use of punctuation. Overall, the text analysis used approximately 23,000 words of text, which were analysed on *Voyant Tools* to determine the average sentence length. The full texts are available in the corpus, which is available online and referenced below.

Additionally, a qualitative analysis was conducted, both manually and through *Voyant Tools*, in order to determine the main trigger words and phrases for punctuation. Punctuation marks that do not serve linguistic or semantic functions were removed from the text in order to avoid interferences in the qualitative analysis. The marks removed include:

- Decimal separators (numbers, prices)
- Punctuation in websites and e-mail addresses
- Dots in acronyms and abbreviations (P.S., Co., etc.)
- Ellipses where text was omitted.

### **2.2.2. Perception Test**

The purpose of the perception test was to examine the spontaneous use of punctuation by experts of the English language who are in charge of teaching the learner group addressed in this study. Therefore, the target group of the test is native speakers of English who are qualified to teach English in post-primary Irish schools. The test takers were either still in training or graduates and were asked to declare their status and level of English knowledge at the beginning of the study. It is particularly important to explore how English teacher perceive punctuation, as they teach the use of punctuation and correct the students' text according to this perception. The role of English teachers in punctuation correction is especially relevant in the case of the highly unpunctuated texts of dyslexic students. For this reason, the perception test takers were provided with completely unpunctuated texts and were free to punctuate according to their own judgement.

The participants were obtained through volunteer sampling, as the test was shared with all Irish higher education institutions offering Professional Master of Education programmes, which qualify English teachers for post-primary education, as well as with post-primary teachers through social media. Considering the impact of the COVID-19 pandemic, responses were received from Trinity College Dublin, University College Cork, and Maynooth University. Regarding social media, the test was posted on Twitter, LinkedIn, and on the "Post Primary English Teachers – Ireland" Facebook group. A sample size of 10 full responses was obtained within a month.

The perception test was distributed on the *LimeSurvey* platform, which provides a high level of data protection for participants. Responses were anonymised and IP addresses were not collected. A response ID was automatically assigned to each response and these IDs were used to analyse the results of the study. The participants were informed on the use of their responses for research



purposes, as well as on their option to withdraw from the test at any point without having their data used. Ethics approval for this perception test was provided by the Phonetics and Speech Laboratory at the School of Linguistic, Speech and Communication Sciences of Trinity College Dublin, as part of the “Speech technology in educational games and platforms for Irish” research project, for which approval has been provided by the School’s Ethics Committee. The ethics approval was obtained in 2018 and is valid until 2023. While this Perception Test is not being delivered through the medium of Irish, it aims to gather necessary underpinning linguistic data that will eventually inform the development of personalised, adaptive Irish language learning platforms and is thus relevant to the research objectives of the project. The ethics approval letter for the research project is attached in Appendix A, along with the full perception test and its instructions in Appendix B.

The perception test consisted of five unpunctuated texts, which participants were encouraged to punctuate on the basis of their own judgement and without consulting any sources. The texts were chosen from *Kingdom 1* and *Great Expectations 1* on the basis of the text analysis, which showed the contexts where punctuation occurs. The texts chosen had an average length of 177 words and combined a variety of writing styles and genres. To ensure that attention issues would not emerge, participants were encouraged to spend approximately 15 minutes on the test. The full texts and their sources are in Appendix C.

- Text 1: Short diary entry – 138 words
- Text 2: Short paragraph from debate; argumentative writing – 151 words
- Text 3: Paragraph from article – 248 words
- Text 4: Short paragraph from personal narration; unstructured essay – 137 words
- Text 5: Paragraph from book review – 159 words.

Taking into account the fact that the test could not be conducted in person, the responses are treated in good faith and are considered truthful. Further details on the potential of replicating this study in the future are outlined in the final chapter of this dissertation.

Regarding the methodologies used to analyse the results of the perception test, a mixed-methods approach was used to determine both quantitative and qualitative differences between the original texts and the texts of the respondents. In order to quantitatively measure the differences between the punctuation used in the original texts and the respondents’ texts, a point system was used. To elaborate, a point was assigned for each punctuation mark used in the original text. In the respondents’

texts, a point was assigned for each punctuation mark used in accordance with the original text and a point was subtracted for each punctuation mark omitted or used in a different way, for instance a comma instead of a semi-colon. Qualitatively, the texts were analysed manually and the qualitative findings are summarised in 2.3.2 and 2.4. below. For the qualitative analysis, divergences from the original texts were categorised on the basis of various criteria, including trigger contexts for punctuation and grammatical or ungrammatical differences in segmentation.

## 2.3. Results

### 2.3.1. Text Analysis

The text analysis on *Voyant Tools* showed that the average sentence length ranged from 16.3 to 18 words per sentence, with *Great Expectations 1* being the textbook with slightly longer sentences and higher vocabulary density. While both textbooks provided a wide variety of non-literary text types, such as reviews, articles, diaries, biographies, and advertisements, among others, *Great Expectations 1* also showed slightly higher vocabulary density. These findings are summarised in the image below, taken from the *Voyant Tools* corpus (Voyant Tools Corpus, 2020).

**Figure 2**

*Text Analysis Data via VoyantTools*

<span>Summary</span> <span style="background-color: #0070C0; color: white; padding: 2px;">Documents</span> <span>Phrases</span>					
	Title ↑	Words	Types	Ratio	Words/Sentence
1	Great Expectations	13,773	3,594	26%	18.0
2	Kingdom	9,230	2,361	26%	16.3

This corpus has 2 documents with 23,003 total words and 4,795 unique word forms. Created about 15 hours ago.

#### Document Length:

- Longest: [Great Expectations](#) (13773)
- Shortest: [Kingdom](#) (9230)

#### Vocabulary Density:

- Highest: [Great Expectations](#) (0.261)
- Lowest: [Kingdom](#) (0.256)

#### Average Words Per Sentence:

- Highest: [Great Expectations](#) (18.0)
- Lowest: [Kingdom](#) (16.3)

Most **frequent words** in the corpus: [people](#) (62); [new](#) (49); [time](#) (45); [school](#) (44); [life](#) (42); [day](#) (41); [family](#) (39); [like](#) (38); [way](#) (32); [written](#) (31); [said](#) (30); [story](#) (30); [know](#) (29); [born](#) (28); [dogs](#) (28); [play](#) (28); [book](#) (27); [work](#) (27); [year](#) (27); [cats](#) (26); [film](#) (26); [make](#) (26); [think](#) (26); [dublin](#) (25); [i'm](#) (25); [old](#) (25); [just](#) (24); [called](#) (23); [going](#) (23); [it's](#) (23)

Regarding the qualitative analysis of the texts, the following table summarises trigger words, phrases, and grammatical or syntactic contexts where punctuation usually occurs. The most frequent punctuation marks triggered in these contexts are commas, followed by hyphens and semi-colons. It is important to note that this analysis summarises some frequent contexts where punctuation occurs in the texts, but does not look into deeper into the syntax and semantics of all punctuation. For instance, the table mentions that non-restrictive relative clauses take a comma, but does not analyse how these clauses occur and how an automatic punctuation detection system could differentiate between the semantic of a restrictive versus a non-restrictive relative clause. Finally, it is important to note that this table is not free of exceptions. For instance, while in conditionals a comma is normally used with the if clause when the main clause follows, this is not always the case. The conditional clause taken from the Text 1 of the Perception Test does not use a comma with the if clause:

“If I set aside two hours every evening I think that should be enough to complete most of the work” (Kingdom 1, p. 5).

**Table 1**

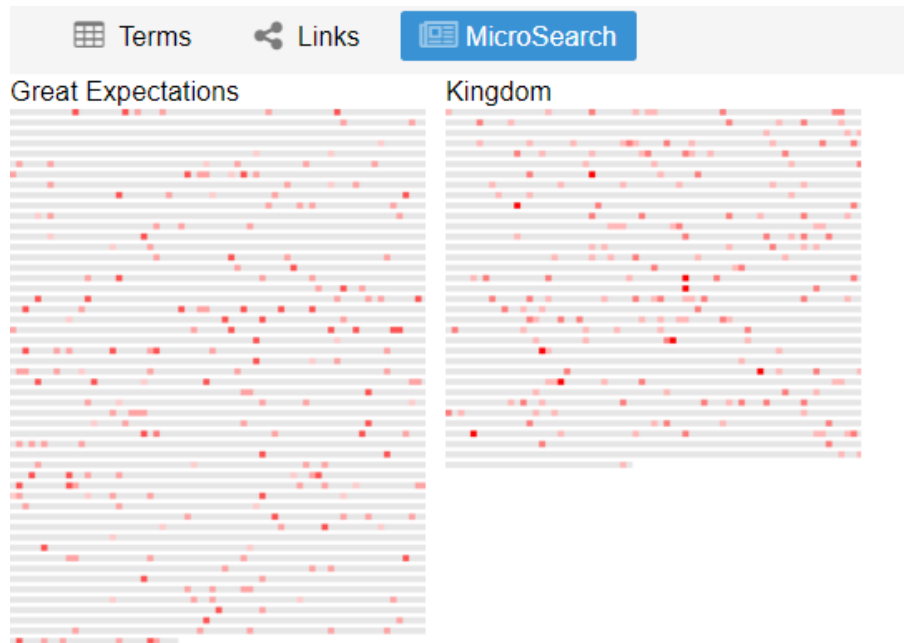
*Contexts of Punctuation in Kingdom 1 and Great Expectations 1*

Contexts Where Punctuation Occurs	
<b>Conjunctions</b>	as, but, so, though
<b>Adverbials &amp; introductory adverbial clauses</b>	instead, however, firstly, secondly, finally, ultimately, alternatively, eventually, in my opinion, in conclusion
<b>Salutations</b>	Dear Sir/Madam, Dear Diary,
<b>Tag questions</b>	...isn't it?
<b>Non-restrictive relative clauses</b>	“Jon, who lives in squalor after his mother had left him” (Kingdom, p. 258)
<b>Conditionals</b> – after the if clause when the if clause precedes the main clause	“If you're looking to pick up tools in Dublin, I found that Kennedy Art had the best supply of nibs and ink.” (Kingdom 1, p. 13)
<b>Responses</b>	No, .... / Yes, ...
<b>Co-ordinate adjectives</b>	“...the itchy, uncomfortable, horrible, nylon/polyester uniform...” (Great Expectations 1, p. 32)

More detailed data is available on the *Voyant Tools* corpus for this text analysis (Voyant Tools Corpus, 2020). The *MicroSearch* visualisation below shows the presence of some punctuation triggers and their density in the texts extracted from the two textbooks (MicroSearch Visualisation, 2020).

**Figure 3**

*The MicroSearch Visualisation on Voyant Tools Shows the Potential Punctuation Triggers in the Text*



In a more detailed analysis, the second visualisation shows the contexts of some punctuation triggers. Due to the size of the table, an extract is presented below. The full table is available on the online corpus (Contexts Visualisation, 2020).

It is important to note that punctuation triggering words depend on their context and the grammatical structures in which they exist. For instance, the word “as” is a trigger word for punctuation when used as a conjunction, but not in phrases such as “as well as”, “known as”, and comparative structures. The *Voyant Tools* Corpus also includes the full texts used, the frequencies of terms analysed, and document details including word counts and distinctive words showing the type of vocabulary used in each textbook (Voyant Tools Corpus, 2020).

Figure 4

*The Contexts Visualisation on Voyant Tools Shows the Potential Punctuation Triggers in Context*

Contexts				
Document	Left	Term	Right	
2) King...	that I would never forget.	dear	Scott, It feels as though	
2) King...	mom and dad said hi.	dear	Ms Carty, I am writing	
2) King...	time we play a round!	dear	Sir/Madam, I am writing	
2) King...	reply. Yours faithfully, Enda Whelan	dear	Manager, I am writing to	
2) King...	Shakespeare's Julius Caesar: 'The fault,	dear	Brutus, is not in our	
2) King...	day before it grew dark.	eventually	, Dad finished his dinner and	
2) King...	York in the 1950s, and	eventually	blossoms there. Her own parents	
2) King...	he became a bartender, and	eventually	he was discovered by another	
2) King...	guidance of Tom Oakley. He	eventually	receives a letter from his	
2) King...	than dogs for three reasons.	firstly	, cats are more independent. Secondly	
2) King...	main reasons for this argument.	firstly	, written homework is an unnecessary	
1) Great...	a career as a writer.	however	, his natural talent came through	
2) King...	do, ever, was write novels.	however	, my parents, both of whom	
2) King...	in failing health, with separation –	however	dangerous – the only alternative to	
2) King...	the actions of future generations.	however	, family traditions can sometimes cause	
2) King...	school task for us students.	in conclusion	, I believe that this house	
2) King...	sleep a wink last night.	in fact	, you were probably scrolling through	
2) King...	to agree that cats do	in fact	make better pets than dogs	
1) Great...	all of the main characters.	in my opinion	, there aren't any weak elements	
1) Great...	like the name Walter, so	instead	was called Jack. He worked	

As mentioned in 2.2.2., on the basis of the text analysis findings, five texts were chosen to be included in the Perception Test (see Appendix C). These texts included the following contexts of punctuation:

- Conjunctions: as, but
- Adverbials: firstly, secondly, meanwhile, finally, literally
- Salutations
- Non-restrictive relative clauses
- Coordinate adjectives

### 2.3.2. Perception Test

The results from the Perception Test are summarised in the tables below for each text. As explained in 2.2.2., each participant was anonymised and assigned an ID by the *LimeSurvey* platform.

The tables summarise the different types of punctuation used in each text; they also present the divergences from the original text using the point system explained in 2.2.2 and are colour-coded accordingly. In every table, the first row shows the punctuation used in the original text, followed by the punctuation in the responses. Each row mentions the total number of punctuation marks used, the differences observed from the original text, and the points assigned to each respondent. The maximum number of points is determined by the number of punctuation marks used in the original texts. For instance, in Text 1, the original text had 21 punctuation marks. The text of R48 is the one closest to the original, while the text in R33 is the one with the most differences.

**Table 2**

*Results of Text 1 from the Perception Test*

Texts	Full stops	Commas	Apostrophes	Excl. points	Semi-colons	Total	Differences	Points
Original	12	5	4			21	0	21
R9	9	4	4			17	5	16
R14	10	5	4			19	8	13
R18	11	4	4			19	7	14
R26	11	5	4			20	4	17
R29	11	3	4			18	6	15
R33	13	11	3			27	15	6
R34	9	4	4	1	1	19	8	13
R37	10	4	4		1	19	9	12
R40	11	3	4		1	19	5	16
R48	12	2	4			18	3	18

It is noteworthy that, while the quantity of punctuation marks used by each respondent does not differ substantially from the original texts, it is the way in which they are used that shows divergence from the original. There are also some examples of more “creative” use of punctuation, as seen for instance in R33, R34, R37 and R40 in Text 2, who use hyphens, quotes, colons, semi-colons and exclamation points not present in the original texts.

**Table 3***Results of Text 2 from the Perception Test*

	Full stops	Commas	Apostrophes	Hyphens	Quotes	Excl. points	Semi-colons	Colons	Total	Diff.	Points
Orig.	7	9	2						18	0	18
R9	7	7							14	6	12
R14	4	8					1	1	14	7	11
R18	4	6	2				3		15	7	11
R26	5	3	1						9	7	11
R29	8	5	2						15	5	13
R33	6	8	2	1	2			1	20	7	11
R34	6	5	2	1		1			15	6	12
R37	6	6	2		2		1		17	6	12
R40	7	6	2	2				1	18	6	12
R48	7	6	2						15	3	15

Similarly, in Text 3 semi-colons are preferred as a way of pausing instead of full stops and commas. In R14, R26, R34 and R40 there are fewer full stops and commas, while some semi-colons are used. Across all texts, discrepancies are evident in the use of quotation marks, which are not deemed necessary by participants in most cases, as seen in Text 3 and Text 5. Finally, slashes are only used in the original text in Text 4 and brackets are only used in one of the responses, namely R9 in Text 4.

**Table 4***Results of Text 3 from the Perception Test*

	Full stops	Commas	Apostrophes	Hyphens	Quotes	Excl. points	Semi-colons	Total	Diff.	Points
Orig.	14	16	3	3	2			38	0	38
R9	11	8				1		20	20	18
R14	9	11	1				2	23	22	16
R18	8	12	2					22	20	18
R26	10	10	1				1	22	21	17
R29	9	18	3					30	13	25
R33	13	16	4	1				34	12	26
R34	10	13	2	2		1	1	29	12	26
R37	12	12	3					27	14	24
R40	12	13	3				1	29	11	27
R48	13	14	3					30	16	22

**Table 5***Results of Text 4 from the Perception Test*

	Full stops	Commas	Apostr.	Hyphens	Excl. points	Semi-colons	Colons	Slashes	Brackets	Total	Diff.	Pts.
Orig.	5	18	5	2	2	1		1		34	0	34
R9	8	14	1		1				2	26	19	15
R14	2	24	4	2						32	15	19
R18	4	10								14	26	8
R26	5	9	4	2						20	22	12
R29	4	19	4	1	1					29	16	18
R33	4	20	5	3	2	1	1			36	11	23
R34	6	18	4	2	2	1				33	12	22
R37	12	12	4		4					32	14	20
R40	9	10	4		2		2			27	21	13
R48	5	15	5	1	1		1			28	11	23

**Table 6***Results of Text 5 from the Perception Test*

Text	Full stops	Commas	Hyphens	Quotes	Colons	Total	Differences	Points
Original	7	11	2	2	1	23	0	23
R9	8	14				22	15	8
R14	7	14		2	1	24	5	18
R18	6	8				14	9	14
R26	5	9				14	17	11
R29	6	12				21	9	14
R33	7	11			1	19	9	14
R34	6	11	3			20	12	11
R37	7	11			1	19	12	11
R40	8	11			1	20	9	14
R48	6	13	1			20	14	9

The following table categorises and summarises the qualitative findings of the Perception Test to show how the respondents' texts differed from the original. The table shows the number of texts, out of 50 texts in total, where inconsistencies and differences occurred in the use of punctuation, as compared to the original texts. It also includes some errors and ungrammatical instances noted; for instance the lack of apostrophes or segmentation that produced ungrammatical sentences. The



qualitative findings are analysed in the Discussion section below, along with unique cases that did not fit within the categories mentioned in the table.

**Table 7**

*Qualitative Analysis of the Responses from the Perception Test*

Categories of differences	Number of texts
Lack of comma with trigger word "as"	16
Lack of comma with trigger word "but"	17
Lack of comma with adverbials	12
Lack of comma with non-restrictive relative clauses	6
Lack of apostrophes	10
Lack of double comma (other type of segmentation)	4
Lack of double comma	20
Lack of comma with co-ordinate adjectives	6
Different segmentation or use (grammatical)	25
Different segmentation (ungrammatical)	6

## 2.4. Discussion

This section discusses the qualitative findings stemming from the results of the Perception Test and considers the implications of these findings for literacy instruction and dyslexic students. There are several aspects considered in this qualitative and they include:

- (a) Instances where punctuation in the original texts is not used in the contexts found to be triggering punctuation
- (b) Ungrammatical cases and errors that have not been detected in the respondents' texts
- (c) Sentences whose length exceeds the average sentence length determined through the text analysis
- (d) The contexts of double comma and Oxford comma use in both the original and the respondents' texts, as well as the use of comma in relative clauses.

First of all, as mentioned briefly in 2.3.1., there are cases in the original texts where a comma is expected, but it is actually omitted. Two of those cases are in Text 1 of the Perception Test with the lack of a comma after the introductory adverbial "lately" and after the if-clause of a conditional:

“*Lately* I feel as though the time is flying by and I won’t get all of my school projects finished in time for Easter. If I set aside two hours every *evening* I think that should be enough to complete most of the work.” (Kingdom 1, p. 5).

Interestingly enough, five out of ten respondents have used a comma with the conditional (R14, R33, R34, R37, R40), while seven out of ten have used a comma with the adverbial “lately” (R14, R18, R26, R29, R33, R34, R37). In that case, one would ask how the text would be corrected in the context of literacy instruction. This is a more complicated issue in the context of CALL development; when developing a punctuation correction interface, the question of which punctuation choices are correct still persists.

Regarding the cases of ungrammaticalities and errors, there are 16 such instances in the texts collected, 10 of which have to do with apostrophe use. Apostrophes were excluded from the texts provided to the participants, as seen in Appendix B. In most of the responses, apostrophes were either used correctly, or excluded only in cases that did not cause errors, such as the word “cos” in Text 4, written with an apostrophe in the original text. The lack of an apostrophe can create confusion between personal and possessive pronouns (e.g.: *it’s* and *its*) and between plurals and possessives (e.g.: *students* and *student’s*). Such issues were detected in ten texts; for instance in four out of ten responses in Text 2 (R9, R14, R26, R29) there is this phrase:

“[...] \*there are no proven statistics to say that written homework is of benefit to a students development[...].”

Similar issues are detected in some instances where the lack of segmentation produces ungrammatical sentences. This is seen for instance in response R26 in Text 2, where the lack of full stops creates a 60-word-long ungrammatical sentence:

“[...] \*Let me start by introducing myself I am Lucy Garvey and I am a third-year student at St Martin's Community College I strongly believe that using our time in the evening to watch television, listen to music play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.”

This example is not meant to show that teachers do not know how to use punctuation; it rather exemplifies how the lack of punctuation may remain undetected. If teachers do not detect the lack of punctuation within a text, this has some implications for literacy instruction in the classroom. Since dyslexic students may indeed produce completely unpunctuated texts and since some teachers may

not be able to correct all punctuation errors, this adds further support for the need of a punctuation correction tool. Considering, though, that the Perception Test encouraged participants to punctuate spontaneously, these errors might be due to lack of attention or due to fatigue. Perhaps in a more focused environment the participants would not have omitted punctuation. These human factors, however, are also part of classroom teaching, especially when a teacher has to divide their attention to multiple students and texts. Therefore, a software allowing students to work autonomously and providing them with immediate feedback in the classroom would not only be beneficial for the students themselves, but also for the teachers.

Regarding the sentence length, there are some instances where pauses (i.e.: commas, semi-colons, colons) are used instead of full stops, producing lengthier sentences. The most extreme of these instances is a 78-word-long sentence in response R26 to Text 3:

“This condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out; the poor thing could only lie on his stomach, thankfully for him, the Mia Foundation in Rochester New York took him in it was this little puppy's lucky day, when the foundation which takes in animals with birth defects, that might otherwise be put down, agreed to help him and so began his journey to recovery.”

Overall, commas seem to be the punctuation mark in which the most inconsistencies and issues are observed. One issue is the Oxford comma preceding the conjunction “and”, which is used originally in Text 4, but is omitted in nine out of ten responses:

“I come home from school on a bitter December evening, exhausted , mentally drained from irregular Irish verbs, algebra, reams of French vocabulary, and boring history.”

A similar issue is detected in double commas, which are highly used originally in Text 5, but are not used or used inconsistently in all responses. The question would then be in what contexts double commas occur and how these contexts could be incorporated in a punctuation correction interface. Based on the texts available, it appears that most double commas occur with adverbials, as seen for instance in Text 5:

“At their new school, meanwhile, they quickly make two firm friends[...]

“[...]while Tippi, literally, looks the other way[...]

Therefore, a punctuation correction interface should advise that a punctuation precedes and follows these adverbials, but this is not a rule consistently applied in all writings. Inconsistencies are overall noticed in all responses to the Perception Test; for instance, within the same response a comma is used with the trigger word “as” in one sentence, but not in the next one. This is observed in multiple responses to Text 1, such as in R26 below:

“[...]I was nervous about the swans *as* Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call into Aunt Mary, in the nursing home, as I haven’t seen her in a few weeks.[...]”

Finally, an issue of punctuation contexts emerges with non-restrictive relative clauses, which seem to be highly dependent on the semantics of a sentence. For instance, response R9 in Text 5 does not use a comma with non-restrictive relative clauses:

“[...]Yasmeen who is HIV positive and Jon who lives in squalor after his mother had left him.[...]”

## 2.5. Implications and Conclusion

The findings of this chapter bring forward the following implications regarding the *PunkBuddy* interface:

- (a) Sentence length: Based on the results of the text analysis (see 2.3.1.) and the observations on sentence length (2.4.), students are prompted to punctuate after 15 words, with a second warning given at 19 words. Sentence length is dependent on the content; for instance, if the student is writing a text analysing a literary piece, longer sentences are also acceptable. At this stage of development, however, *PunkBuddy* cannot customise its feedback according to the text input.
- (b) Suggested corrections: Students are offered hints on the basis of contexts triggering contexts. However, since punctuation depends on personal preference (see 2.4.), corrections are neither mandatory nor automatic. Finally, some corrections are hard to implement, due to their dependence on semantics, such as non-restrictive relative clauses (see 2.3.1.).

Overall, this study has shown that there are significant discrepancies between the prescribed use of punctuation in English textbooks and the actual use of punctuation by English teachers. These discrepancies affect literacy instruction, not only for dyslexic students struggling with punctuation, but also for the general student population. Presenting a number of frequently-occurring examples of

punctuation does not suffice to cover all exceptions and possibilities. Therefore, practice is required for these rules to be internalised. However, when punctuation is checked by a software, rather than by a teacher, it is important to ensure that there will not be any discrepancies between what is taught in the classroom and what is advised by the software. Since punctuation rules seem to be dependent on the semantics of a text and influenced by personal preference, *PunkBuddy* offers suggestions for improvement.

Considering that there were several instances in which the lack of punctuation remained unnoticed, it would be interesting to examine the cognition involved in the perception and production of punctuation. The next Chapter attempts to tap into this by examining neurocognitive findings on the interfaces between prosodic perception and punctuation.

## Chapter 3: Prosodic Processing and Punctuation in Dyslexia

### 3.1. Introduction

So far, this study has shown that there are significant individual variations in the use of punctuation, even among individuals who are experts on the use of English (RQ 1.1.). The question would then be how these individual variations occur. There are several factors weighing in; punctuation instruction received, writing styles, potentially age and attention. However, it would be interesting to consider whether there is any neurocognitive basis explaining the use of punctuation, especially in dyslexic individuals. As briefly mentioned in 1.1., punctuation can be defined as the representation of prosody in writing, though the relationship between the two is not as straightforward. Still, it is important to examine whether prosodic processing is impaired in dyslexia, as that affects the development of the current tool (RQ 1.2.). If dyslexic students struggle at recognising the prosody of language, a tool offering a proof-listening interface might not be useful. This chapter aims at addressing this research question by providing a review of cognitive and neurolinguistic findings. It begins by outlining the methodologies used in the neurocognitive research of dyslexia and then moves on to recent findings, which are then connected to theories of dyslexia, in an attempt to re-define the Phonological Deficit Hypothesis.

### 3.2. Research Methods

Regarding the assessment of language skills, a wide variety of standardised tests are available depending on the language used and the skills measured. For instance, Veenendaal et al. (2014) use such tests to assess vocabulary, syntactic awareness, and speech prosody in Dutch. It is noteworthy that the tests they use date back to 1993, which bears the question of whether these tests are updated and whether the methodologies used in cognitive research are valid when they use standardised tests created over two decades ago. This question of research methodologies is outside the scope of the current study, but informs the research instruments that should be used in future research; for instance if *PunkBuddy* is tested with dyslexic students in the future, the use of such standardised tests should be evaluated beforehand.

On the other hand, many researchers use tasks that are part of frequently updated tests and combine those with their own experimental tasks or neurocognitive measures. Such an example is the PEPS-C test used to assess prosody by Marshall et al. (2009). The PEPS-C tasks are part of a non-standardised test, last updated in 2015, available in English and in multiple regional dialects, which

combines receptive and productive tasks with to assess prosodic abilities. Other such tests are the Test of Word Reading (TOWRE), originally published in 1999 and updated in 2012 and the Wechsler Intelligence Scale for Children (WISC), last updated in 2014, which are used by Power et al. (2016). It is still noteworthy, however, that the researchers appear to be using parts of the original TOWRE test, and the WISC-III, published in 1991. These tests were combined with a Noise-Vocoded Speech (NVS) paradigm, which tests receptive and productive skills with the repetitions of acoustic stimuli, as well as with an experimental phonological task and neurological measures, adding to the reliability of the study (Power et al., 2016, p.3). Finally, Heggie and Wade-Woolley (2018) also use the Woodcock Reading Mastery Test (WRMT), whose most recent revision was published in 2012. The researchers combine this test with two experimental tasks; a prosodic awareness measure using stress identification and stress manipulation tasks (Chan & Wade-Woolley, 2018), and a punctuation performance test using a cloze design (Heggie & Wade-Woolley, 2018, pp. 198-201).

Finally, in an attempt to decode the neural processes behind prosody and dyslexia, some researchers combine experimental tasks and neurological methods. When researching dyslexia and prosody in particular, Goswami et al. (2010) use a reiterant speech task, the DeeDee task, initially introduced by Kitzen (2001). This task removes phonetic information from words and phrases, but retains the stress and rhythm patterns and is widely used in relevant research regarding prosody, mostly in adapted versions to suit the participants and their age group (Cumming et al., 2015; Goswami et al., 2010; Goswami et al., 2013; Goswami et al., 2016). The DeeDee tasks are often combined with other tasks, such as Rapid Automatic Naming (RAN) tasks to test short-term memory (Goswami et al., 2016). Regarding neurological methods, Electroencephalography (EEG) and Event-Related Potentials (ERPs) are the most frequently used ones within the field of prosody. For instance, Männel et al. (2017) combine a variety of standardised language tests in German and behavioural tasks with EEG to determine the degree of impairment in prosody for literacy-impaired children. Furthermore, ERPs are used to examine auditory perception and determine hemispheric activation in dyslexia, as seen in Sabisch et al. (2006). Finally, Hämäläinen is one of the researchers providing the deepest insights on ERPs and dyslexia and outlines the main findings in the field of auditory processing and dyslexia in Hämäläinen et al. (2013).

### **3.3. Elements of Prosody**

Traditionally, prosody is presented in the hierarchical structure of Nespor & Vogel (1986), where syllables form feet, feet form words, and words form phrases and where emphasis is placed on stressed

and unstressed syllables. Considering the context of this dissertation, many of the studies discuss elements of prosody reflected in writing through punctuation. Punctuation allows the parsing of written text and disambiguates writing, for instance in the case of garden-path sentences (Heggie & Wade-Woolley, 2018, p. 191). Similarly, prosody breaks up continuous speech for parsing (Kuhn et al., 2010, p. 235). Prosody chunks speech into units that allow disambiguation, creating “a cognitive skeleton that allows one to hold an auditory sequence in working memory” (Kuhn et al., 2010, p. 235). Even though syntax and prosody interact, the relationship between the two is not completely straightforward, as mentioned in 1.1. and 3.1.

Most studies agree that there are specific elements of prosody that are relevant to the process of chunking speech into parsable units: pitch, stress, duration, and pausing all contribute to the chunking process. For instance, Kuhn et al. (2010, p. 235) explain that word-final lengthening, declination, and pausing usually signify the end of a unit. Apart from pitch, the encoding of amplitude modulations appears to be important for speech intelligibility, as Goswami (2019a, p. 6) argues, which implies that amplitude might also play a key role in the processing of prosody. Similarly, Heggie and Wade-Woolley (2018) point out the importance of pitch and pause and state that intonation affects the semantic perception of information as emphasis is placed on certain constituents (p. 190); this also shows an example of interfaces between prosody and syntax. Moreover, they explain the importance of commas, which “appear to facilitate processing whenever they appear in conjunction with a clause boundary, whether or not they are required for disambiguation” (2018, p. 192), which shows that pauses influence speech intelligibility. Finally, they clarify that syntactic boundaries can sometimes occur without prosodic boundaries and this is precisely the aspect of interfaces between prosody and syntax that has not been deciphered yet and perhaps one that influences the perception and use of punctuation. In a similar explanation, Veenendaal et al. (2014, p. 523) state that “text reading prosody entails appropriate phrasing, use of pauses, correct word and sentence boundaries, and general expressiveness during text reading” and provide a detailed analysis of speech and written prosody.

### **3.4. Recent Findings**

Overall, recent findings suggest that linguistic prosodic sensitivity is impaired in dyslexia and show that prosody and punctuation might interact both in reading and writing performance. This section provides an overview of such findings spanning over the last decade.

Extended research on prosodic processing and dyslexia has been conducted by Usha Goswami. Goswami et al. (2010) outline the research that has been done regarding phonological awareness,



especially in terms of the “perception of the speech envelope and of the slower amplitude-driven modulations that are important for speech intelligibility” (p. 996). They place particular emphasis on rise time, which is correlated with the onset of stressed syllables, and whose impairment affects prosodic processing. This study also cites works discussing the importance of prosodic sensitivity for reading comprehension, and brings attention to the lack of research on the links between prosodic sensitivity, phonological awareness, and decoding (2010, p. 998). It is indeed noteworthy that this is an under-researched field, with even fewer studies tapping into production of written prosody, i.e. in the form of punctuation, rather than prosodic perception and reading fluency. The findings of the study include impairments in phrase-level prosodic cues (2010, p. 1015), which is relevant to punctuation and the segmentation of sentences into prosodically distinct phrases. In a later study, Goswami et al. (2016) focused on word-level prosody and showed short-term memory effects, with dyslexic participants having difficulties at retention of prosodic structures. The implications of these findings for the development of *PunkBuddy* are discussed in 3.8.

The impairment of prosodic processing in dyslexia is especially relevant to the interfaces between prosody and syntax. Indeed, non-linguistic prosody does not appear to be impaired in dyslexia (Caccia & Lorusso, 2019). First of all, Sabisch et al. (2006) prove that prosodic information is accessed during auditory comprehension, but their ERPs study shows that dyslexic children do not rely on that prosodic information to decode meaning. The ERPs show lack of activation in areas in charge of prosodic processing, which are further discussed in 3.5. below, thus indicating deficits in prosodic processing. Agreeing with these findings, Honbolygó et al. (2016) also showed the importance of prosody for the construction on meaning and the interfaces between prosody and syntax. Similarly, Marshall et al. (2009) report impairments where syntax interacts with prosody, for instance in chunking (p. 480), but observe no or little evidence of prosodic impairments in the cases where prosody does not interact with linguistic meaning. Finally, one recent study focuses specifically on the interfaces between prosody and punctuation. Heggie and Wade-Wolley (2018) present evidence that prosodic awareness is a strong predictor of punctuation ability in adults and that punctuation and prosody facilitate reading comprehension. Specifically, they studied receptive and productive prosodic awareness and productive punctuation ability in literate, educated adults and found statistically significant correlations between prosodic awareness and punctuation skills.

Stemming from the above, one may argue that since prosodic sensitivity is impaired in dyslexia, using TTS technologies for punctuation correction is counter-intuitive. There is, however, some

evidence that auditory and prosodic training can be used to improve neural processing in dyslexia, as well as short-term auditory memory and punctuation. Goswami (2011, 2019a, 2019b) offers a neural oscillations perspective towards prosodic processing and proposes that auditory training can improve neural processing in dyslexia. In Goswami (2019a), she reports slower neural processing and atypical oscillatory function in dyslexic people at bands relevant to prosodic processing and speech intelligibility, i.e. the theta and delta bands. As explained in Goswami (2011, 2019b) and Thomson et al. (2013), there is potential in using a remediation programme based on rhythm and music in the form of syllable patterns in order to improve prosodic processing. The remediation programme suggested focuses on children prior to instruction age and appears to be relevant mostly to explicit segmental prosody. In an older project, Goswami adapted a Finnish game, *GraphoGame Rime*, to its English version. *GraphoGame Rime* is a phonics game using rhyme and musical interventions to train dyslexic students and was found to be efficient in primary school interventions regarding the improvement of reading and spelling skills (Ahmed et al., 2020). For further reading on *GraphoGame Rime*, see Kyle et al. (2013) and Richardson and Lytinen (2014). Currently, Goswami is working on the Botnar project, aiming at developing assistive auditory technologies for dyslexia.

Regarding short-term auditory memory, Zygouris et al. (2018) present a remediation programme with various activities for nine-to-eleven-year-old Greek dyslexic students. Their programme included tasks where students had to memorise words and sentences they heard for auditory training. The effect of this programme was measured through a clinical neuropsychological battery of tests and ERPs and was found to be significantly effective for auditory short-term memory with substantial effect sizes. Moreover, the pre-remediation ERPs showed increased latency in the P300 waveform for dyslexic students dealing with auditory stimuli, while these high frequencies were not observed post-remediation. The programme of Zygouris et al. (2018) shows that incorporating explicit prosody training in dyslexia remediation can be effective and that this improvement can be measured neurocognitively.

Finally, Calet et al. (2017) present a fluency training programme for non-dyslexic students primary school students, using prosody training for expressive reading and punctuation. Their pre- and post-test measures included tasks where students had to read aloud punctuated text giving the proper expression according to the punctuation, as well as tasks where students had to insert punctuation in written text. Additionally, prosodic reading was measured using a scale measuring skills in volume, intonation, pauses, and phrasing. The training programme included both implicit and explicit prosody,

with silent reading and reading aloud repeated tasks, as well as oral and spelling activities focusing on stress sensitivity, intonation sensitivity, and punctuation. A statistically significant effect was detected in the improvement of prosodic reading, punctuation, as well as in sentence comprehension. While this study is not focusing on dyslexia, it shows the impact of prosody training on punctuation skills and the potential of such training. A similar intervention with dyslexic students would demonstrate whether prosodic training would also be applicable to dyslexia and the TTS interface of *PunkBuddy* would be one way to test this hypothesis and investigate the rate and degree of improvement when using TTS for proof-listening.

### **3.5. Physiological Factors**

Even though some light has been shed on the neural processes behind prosodic sensitivity, Goswami (2019a) admits that the physiology underlying these processes has not been completely understood. As a result, this section will be summarising some findings regarding cerebral anatomy and auditory processing or prosodic sensitivity, without presenting conclusive observations.

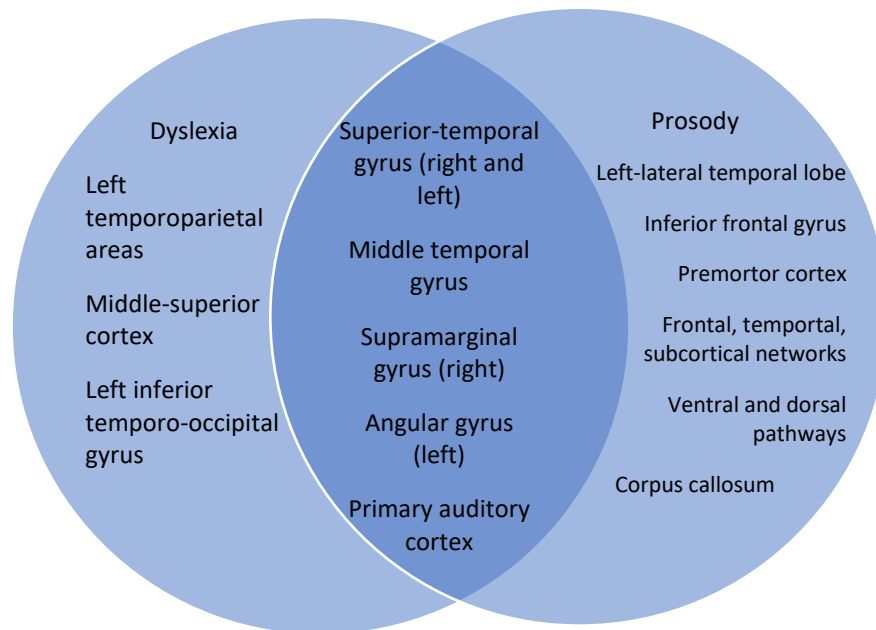
Generally, the consensus on the dyslexic brain has been that it shows asymmetries and hypoactivation or deficits in the left hemisphere, especially in the left temporoparietal areas, the middle-superior temporal cortex, and the left inferior temporo-occipital gyrus (Hadzibeganovic et al., 2010; Norton et al., 2015; Rapcsak et al., 2009; Vlachos et al., 2013; Zhao et al., 2016). However, more recent findings indicate that the causes of dyslexia are not exclusively due to impairments in the aforementioned brain regions. Ramus (2014) reports findings regarding phonological processing which reveal the involvement of the “primary auditory cortices, superior and middle temporal gyri, and supramarginal gyri” (p. 274) in dyslexia.

Regarding prosody in particular, several studies point out areas in the brain involved in prosody, though most of them refer to non-linguistic prosody, while only a few studies focus specifically on dyslexic people. The general consensus is that prosody is a faculty of the right hemisphere. Miller et al. (2008) report findings of prosodic processing being right lateralised in the superior temporal gyrus and the middle temporal gyrus, but also involving the left lateral temporal lobe. These findings focus more on the processing of emotional prosody, while the response to neutral voice prosody was found to be left lateralized in the inferior frontal gyrus and premotor cortex (2010, p. 269). Likewise, Frühholz et al. (2012) also examine emotional prosody and report that the frontal, temporal, and subcortical network are involved in prosodic processing. Sammler et al. (2015) focus specifically on the connectivity involved in prosody and show the role of ventral and dorsal pathways for prosodic processing. Their

findings indicate “dual processing streams for prosody in the right hemisphere” (2015, p. 3083). Finally, Sammler et al. (2010) examine the role of the corpus callosum and find that its posterior portion allows the streams in charge of prosody and syntax to communicate.

To conclude, a few studies focus specifically on the physiology of prosodic processing and dyslexia. Sabisch et al. (2006) point out that prosodic processing is usually associated with a right fronto-temporal network, which they confirmed through their ERP study examining auditory comprehension in dyslexic children. The lack of activation in this area and the hemispheric distribution showed both that this part of the brain is indeed involved in prosodic processing and that dyslexic children did not rely on prosodic information, as opposed to the children in the control group. Finally, Goswami (2019a) reports that 2 Hz (delta oscillatory) band stimulation results in higher activation in a right-lateralised region on the supramarginal gyrus, which is also associated with prosodic processing. However, she also brings attention to other brain areas in the left hemisphere, namely the left superior temporal gyrus and the left angular gyrus.

The findings mentioned above are presented in the following graph. The aim of this graph is to show the overlapping brain areas involved in prosody and presenting deficits in dyslexia. The primary auditory cortex is part of the superior temporal gyrus, which is why it is included in the overlapping areas. However, this graph remains an indicative visualisation based on the studies mentioned in this section and does not present conclusive findings on the physiology of prosody in dyslexia.

**Figure 5***Brain Areas Showing Deficits in Dyslexia and Involved in Prosodic Processing***3.6. Genetic Factors**

Dyslexia is generally considered a heritable condition, with many studies grouping participants on the basis of family risk for dyslexia (Beelen et al., 2019; De Vos et al., 2017; Grimm & Schulz, 2017). In the case of auditory processing, genetic factors seem to come into play, especially with the KIAA0319 gene. This gene is involved in neuronal migration and has been found to contribute to “gray/white matter volumes, brain circuitry, and brain activation patterns during reading-related tasks” (Eicher & Gruen, 2013, p. 204). Szalkowski et al. (2012) found that the KIAA0319 affects neuronal migration in embryonic development and causes impairment in rapid auditory processing without affecting working memory. Similarly, Neef et al. (2017) found that the KIAA0319 can impair phoneme processing. It is important to note, however, that these findings generally relate to auditory processing and further studies would need to confirm their relevance to prosodic processing in particular.

Other candidate risk genes for dyslexia are the DCDC2 (Eicher & Gruen, 2013; Marino et al., 2014; Neef et al., 2017; Poelmans et al., 2011), the FOXP2 (Eicher & Gruen, 2013), as well as the DYX1C1

(Eicher & Gruen, 2013; Poelmans et al., 2011). Finally, Berninger & Richards (2010) explore the relationship between the genetics and the treatment of dyslexia and provide a summary of interdisciplinary research on genetics, neurology, and dyslexia treatment.

### **3.7. Neurocognitive Findings & Theories of Dyslexia**

The main benefit of neurocognitive research is that it enhances our understanding of dyslexia and its underlying processes, therefore informing theories of dyslexia and language acquisition. Cognitive theories of dyslexia suggest that deficits in visual perception and auditory processing are at the main cause of dyslexia, rather than deficits in linguistic components (Wright et al., 2000). On the contrary, the Phonological Deficit Hypothesis identifies the issues at phonological processing as the cause of dyslexia. Recent findings, such as those mentioned in this chapter, point towards the direction of cognitive theories of dyslexia; however, the goal of this section is not to dismantle the Phonological Deficit Hypothesis. Instead, I suggest that we should re-define the Phonological Deficit Hypothesis, in order to make it inclusive of recent developments and findings. For instance, the fact that linguistic prosodic sensitivity appears to be impaired in dyslexia affects phonological awareness and phonological processing in general. Therefore, the issue at phonological processing remains; it is its underlying nature and definition that we might need to reconsider.

Multiple studies have outlined the nature of deficits in dyslexia beyond phonological representations. One theory is that of access deficits, where the phonological representations themselves are intact, but the access to them is impaired. Ramus and Szenkovits (2008) explain that task requirements, especially short-term memory, affect the performance of dyslexic participants in experiments and suggest that access deficits would also explain the cognitive deficits in dyslexia. Furthermore, Fostick and Revah (2018) identify working memory and auditory temporal processing as significant predictors for phonological awareness. Therefore, they propose a re-definition of dyslexia as a multi-deficit condition, having tested and confirmed the multi-deficit hypothesis for dyslexia (2018, pp. 24-26). Overall, these findings do not deny that issues of phonological awareness exist; they rather argue about the origins of these issues. Therefore, a reformulation of the Phonological Deficit Hypothesis in such a way that integrates these findings would account for the deficits in cognition, memory, and access to phonological representations. By defining the Phonological Deficit Hypothesis on the basis of its effect, i.e. the deficits at phonological awareness, we could potentially incorporate all findings relevant to phonological awareness. While establishing a theoretical framework for dyslexia is beyond the scope of this study, considering these aspects is important for future research. For

reference, a recent theoretical framework attempting to encapsulate all aspects of dyslexia is Goswami's Temporal Sampling Framework (Goswami, 2011).

### 3.8. Implications and Conclusion

This chapter has examined a wide spectrum of recent neurocognitive research to answer the second research question of this dissertation (RQ 1.2.), regarding prosodic processing and dyslexia. The main conclusion drawn is that linguistic prosodic processing is indeed impaired in dyslexia, but not to an irreversible degree. There seems to be potential in auditory training that would enhance prosodic sensitivity, though some genetic and anatomic findings show that these impairments might be part of the dyslexic brain itself. Since this is generally an under-researched field, attempts such as Goswami's Botnar project will show whether it is possible to train dyslexic children using auditory stimuli.

The findings of this chapter bring forward the following implications regarding the *PunkBuddy* interface:

- (a) Text-to-Speech use: Based on the studies of Gosawmi (2011, 2019a, 2019b) and Zygouris (2018) mentioned in 3.4., using TTS to proof-listen to text might be beneficial in improving prosodic sensitivity in the long run.
- (b) Configuration of the Text-to-Speech Interface: Considering the findings regarding short-term memory (see 3.4. and 3.7.), dyslexic students might encounter difficulties at retaining the text they hear in memory to apply corrections. Therefore, the TTS interface prompts students to listen to their text every 50 words in order to control the length of the input received and minimising short-term memory effects.

Finally, it is important to mention certain limitations in this field of research. First of all, Hadzibeganovic et al. (2010) point out the need for more cross-linguistic research on the neurology of dyslexia. It is possible that testing prosody and punctuation in non-English speaking individuals would not yield the same results as those of Heggie and Wade-Woolley (2018). Furthermore, there are some studies that argue in favour of prosody being intact, such as Geiser et al. (2014) and Männel et al. (2017). Age might also be a factor weighing in the impairment of prosody, an aspect that has also not been longitudinally researched. Finally, another issue is the intelligibility of synthetic speech for dyslexic learners. Giannouli and Banou (2019) researched the intelligibility of synthetic speech in primary and post-primary dyslexic students in Greece and found that words and sentences were statistically significantly easier to parse in natural speech. However, texts were intelligible due to

contextual clues and the difficulties encountered with words and sentences were absent in the text comprehension condition. One issue in this study is that, while the TTS system the researchers used was advanced enough to replicate prosody to a high degree, they did not implement the use of TTS in the classroom, which has showed to improve ratings of intelligibility for speech synthesisers (Ní Chiaráin & Ní Chasaide, 2017). Moreover, Greek and English are widely different in phonological nature and, therefore, testing *PunkBuddy* would allow a more comprehensive view on synthetic speech intelligibility for dyslexic students.



## Chapter 4: Software for Dyslexia and CALL Development

### 4.1. Introduction

So far, this dissertation has explored the characteristics of punctuation and its use, as well as the characteristics of the learner group that *PunkBuddy* addresses. Shifting the focus to technology, this chapter provides a resource audit of dyslexia-specific software and evaluates them in an attempt to outline their main characteristics (RQ 2.1) and summarise the main objectives that future CALL software for dyslexia should be achieving (RQ 2.2.).

Due to the nature of this study and the space limitations involved, this chapter cannot provide an extensive review of all software available. The software selected for review fulfils the following criteria:

- (a) Dyslexia-specificity: Spellcheckers, punctuation and grammar software are generally popular and widely available; however, this chapter focuses on software tailored specifically for dyslexia
- (b) Relevance to *PunkBuddy*: software for dyslexia is not limited to writing assistants and TTS apps, but the reviews of this study are chosen based on their relevance to the development of *PunkBuddy*
- (c) Being up-to-date: the purpose of this chapter is not to criticise older software or show the evolution of CALL development. Therefore, the software chosen is either recently developed or recently updated.

### 4.2. Evaluation Frameworks

For the reviewing process, I will combine and adapt two CALL evaluation frameworks: Rosell-Aguilar's (2017) "State of the App" taxonomy and Hubbard's (2006) evaluation framework. The "State of the App" has been chosen because it is inclusive of software relevant to this study, specifically those tools "not designed for language learning but useful for language learners" (Rosell-Aguilar, 2017, p. 250). Some of the software mentioned in these reviews, for instance *Ghotit*, is not tailored for language teaching and learning, but it facilitates this process for dyslexic learners. Additionally, the "State of the App" addresses all aspects of technological design and interactivity and is relevant to both apps and computer software, despite its name. Finally, maintaining task-based learning at its core, it sets solid criteria for language learning, taking into account attention, communicative outcomes, engagement, productive skills, and authenticity, among others (Rosell-Aguilar, 2017, p. 252).

In order to provide the reviews in a brief, yet compressive way, I will be using a table adapted from Rosell-Aguilar's (2017, p. 253) framework. His table takes into account all aspects of CALL aspect and is especially learner-oriented, while integrating pedagogy and thus relating to teaching. Nevertheless, the needs of the teacher are not adequately addressed within this taxonomy, which is why I have added a section in the table to address those needs. For this purpose, I will be using Hubbard's (2006) evaluation framework, which considers "teacher fit" in the evaluation process (p. 14). Within the teacher's needs, I will also be including aspects of classroom management, syllabus fit, and learner training (Hubbard, 2006, pp. 14-17). Overall, there is some overlap between these aspects; for instance, one may list syllabus fit under pedagogy and learner training under user experience. Therefore, this is an indicative evaluation template, subject to personal preference and individual perspective. It is important to note that my table does not apply to all software; for example, a reading assistant does not usually include engaging activities. However, it also serves the purpose of reviewing software that goes beyond the limits of assistive technologies, such as games for dyslexia. An issue detected with many evaluation frameworks is that they are mostly suitable for researchers rather than educators due to their length and detail-oriented approach, as seen for instance in the TPACK framework (Koehler et al., 2014) or the framework of McMurry et al. (2016). By summarising the main points of evaluation for dyslexia software within a table, I am aiming at providing an evaluation tool that is accessible to teachers and other practitioners interested in such software.

**Table 8**

*Evaluation Framework for Dyslexia Software*

Language Learning	Pedagogy	Teacher Fit
<p><b>Listening:</b> Does the software provide audio in the target language?</p> <p><b>Writing:</b> Does the software offer opportunities to write in the target language and exercises for writing practice?</p> <p><b>Reading:</b> Does the software provide a readable environment for dyslexic learners?</p>	<p><b>Teaching:</b> Does the software present, explain, or model language or does it just test it?</p> <p><b>Progress:</b> Does the app allow the user to track progress or see previous attempts?</p> <p><b>Scaffolding:</b> Do activities in the software progress in difficulty in a way that supports the learner?</p> <p><b>Feedback:</b> Does the software provide feedback? Is it just right/wrong or with meaningful explanations?</p> <p><b>Differentiation:</b> Does the software offer different levels depending on</p>	<p><b>Approach fit:</b> Is the software flexible enough to fit within various approaches to language teaching?</p> <p><b>Classroom management:</b> Is the software flexible enough to be used individually, in pairwork, and in group work?</p> <p><b>Syllabus fit:</b> Is the software appropriate for multiple types of syllabi? Is it tied to a specific topic only?</p>

	ability? Can these be accessed directly? <b>Engagement:</b> Does the app keep the user interested or are activities repetitive?	<b>Training:</b> Will the software require training for the teacher and the learner? Is there a big learning curve?
User Experience		Technology
<b>Interactivity:</b> Is engagement with the software content active or passive? <b>Customisability:</b> Does the software offer options based on the user's preference? <b>Price:</b> Is there a paywall? <b>Registration:</b> Does the software require the user to register? <b>Advertising:</b> Does the software include pop-up ads? Are these distracting?		<b>Interface:</b> Is the interface clear and uncluttered? <b>Navigation:</b> Is the software intuitive to navigate, with clear menus and options? <b>Instructions:</b> Does the software offer instructions on how to use it? <b>Stability:</b> Does the app freeze or crash? <b>Portability:</b> Is the software available on multiple platforms? Does it support offline work?

### 4.3. Resource Audit: Software Reviews

In order to cover a variety of software types, below I am reviewing a writing assistant, a reading assistant, and two apps combining various tools for dyslexia. Furthermore, I am providing some studies of more extensive dyslexia software reviews for further reading.

#### 4.3.1. *Ghotit – Dyslexia Writing and Reading Assistant*

*Ghotit* is an assistant tailored specifically for dyslexia and dysgraphia and, while there is a wide variety of software with similar functionalities, *Ghotit* has been chosen for its focus on punctuation. The *Ghotit* website provides an extensive list of punctuation error types that the software detects and corrects. These punctuation errors include cases dependent on sentence semantics, such as relative clauses. In order to test whether *Ghotit* detects punctuation errors as claimed, the texts provided in the Perception Test were used to check if the corrections given by *Ghotit* matched the original texts provided in the textbooks. Overall, testing *Ghotit* for punctuation using the texts of the Perception Test showed that the automatic punctuation correction did not fully match the actual use of punctuation in the original texts, with *Ghotit* suggesting some minor changes, which sometimes produced ungrammatical results, as seen below. All suggested changes are marked with green or red underlining and are revealed upon clicking on them. The text in the first screenshot is Text 1 from the Perception Test and, along with some expected corrections, such as a comma for the adverbial “lately” and after the if-clause, *Ghotit* suggests a full stop after “as”. In Text 2 and Text 3, *Ghotit* suggests some additional commas and the replacement of a full stop with a comma (see red underlining in the third screenshot).

Figure 6

*Text 1 from the Perception Test: Ungrammatical Correction Suggested*

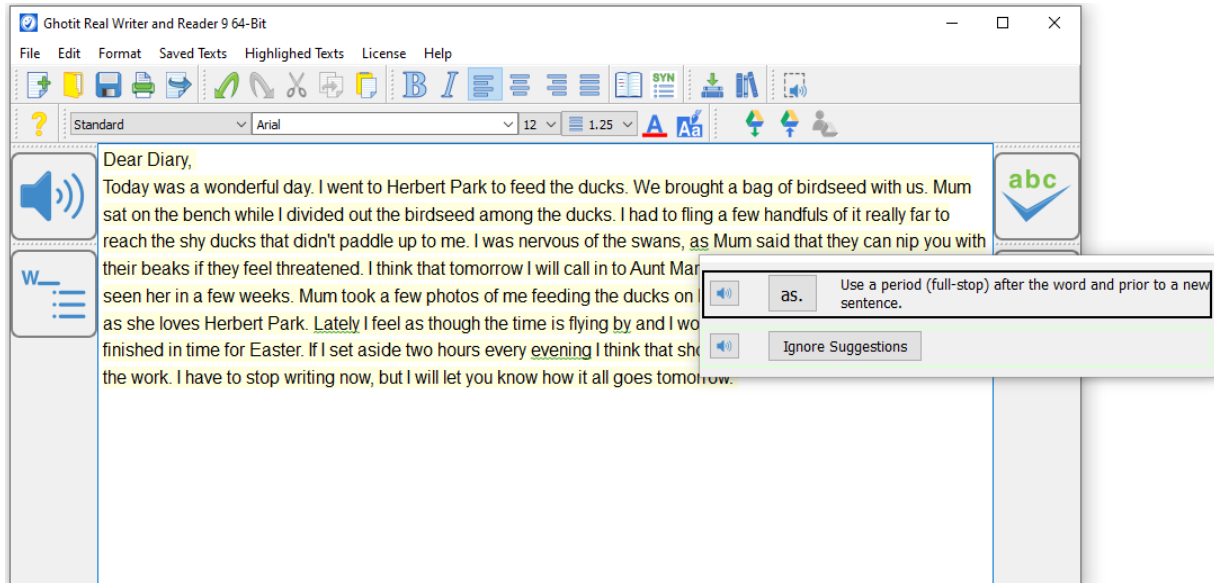


Figure 7

*Text 2 from the Perception Test: Additional Corrections Suggested*

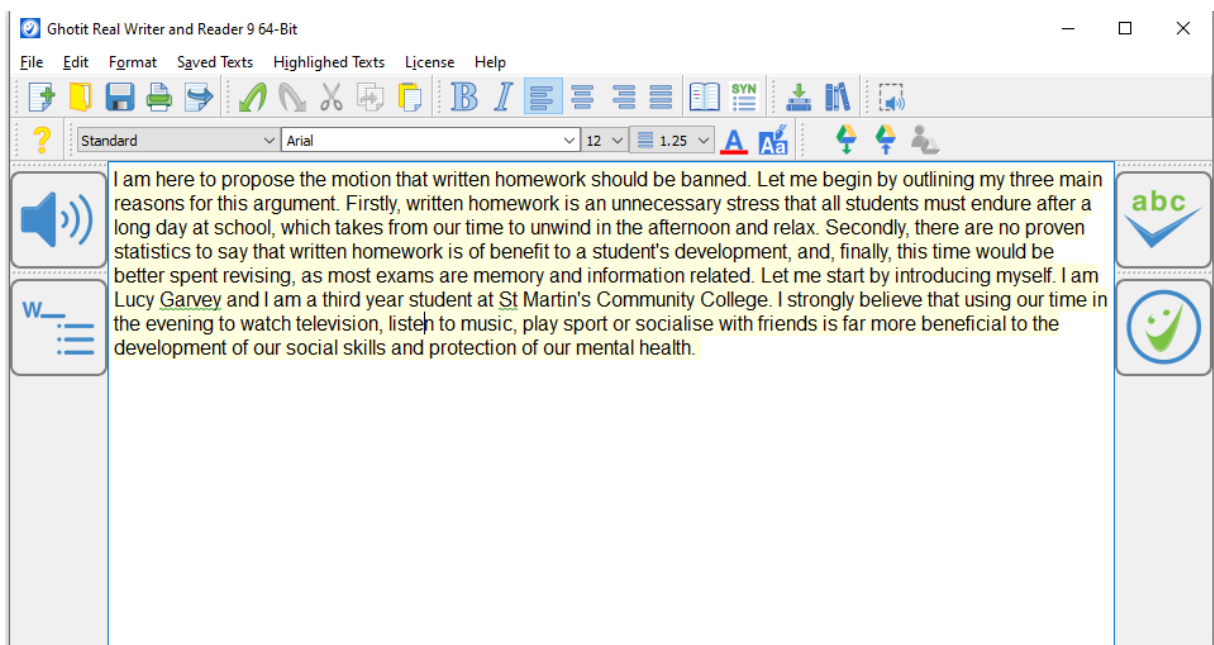
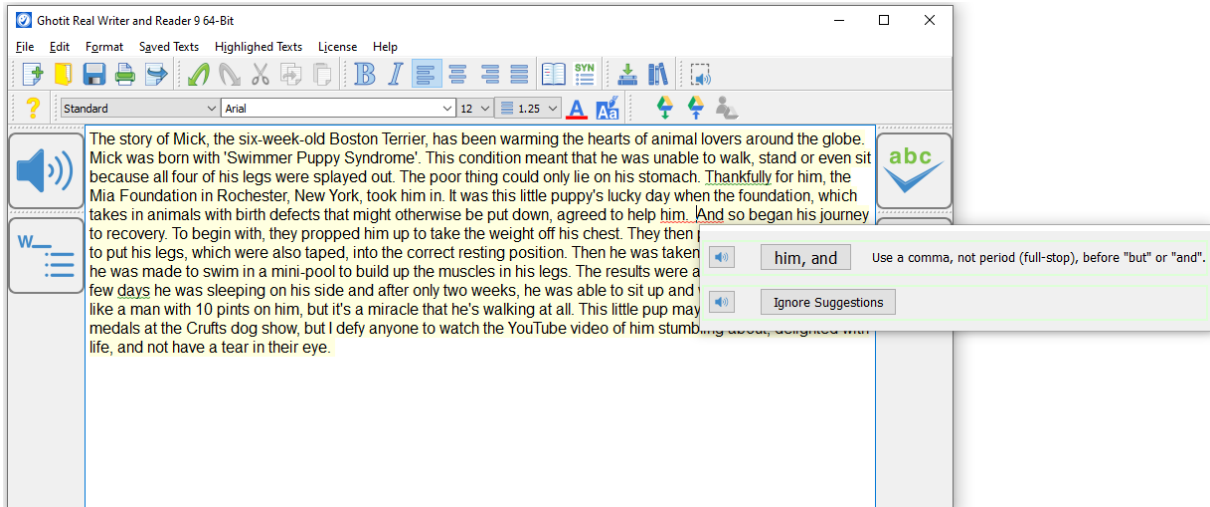


Figure 8

## Text 3 from the Perception Test: Additional Corrections Suggested



When provided with the respondents' texts, Ghotit suggested some changes close to those of the original texts, such as adding a comma for non-restrictive relative clauses in R9 from Text 5, as seen below. These corrections are applied to R9 from Text 5 of the Perception Test, the one scoring the lowest among the responses (see 2.3.2.). Finally, when provided with a completely unpunctuated text, Ghotit was unable to segment it into sentences. As seen with the unpunctuated Text 5 below, only a few suggestions for punctuation are made, all of which have to do with commas, rather than full stops.

Figure 9

*R9 from Text 5 of the Perception Test: Suggestions for Commas*

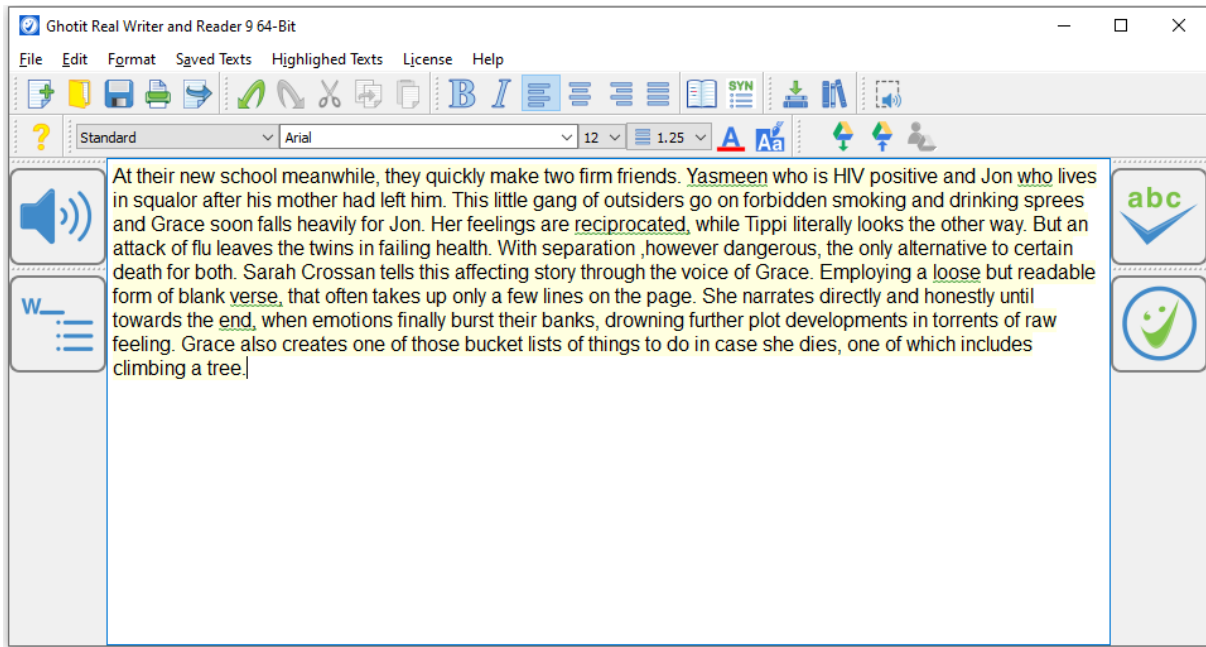
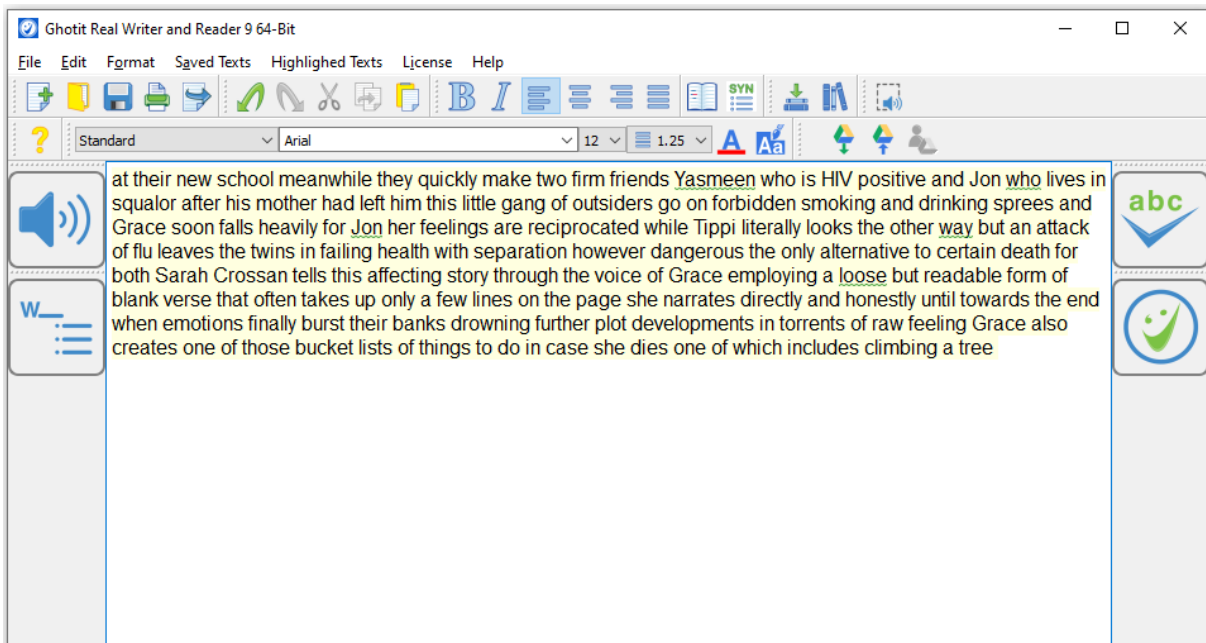


Figure 10

*Unpunctuated Text 5 from the Perception Test: No Sentence Segmentation*



These findings show that the punctuation correction technologies currently available are not advanced enough to mimic the corrections provided in real life by teachers. Therefore, dyslexia software cannot yet replace teacher feedback and manual corrections, while future CALL development would need to focus more on developing software that can be used autonomously by students. Part of the technology behind *Ghotit* is explained in Iakobashvili & Chermesh (2012), though this patent explains the methods for spell-checking, rather than for punctuation correction. An alternative context-sensitive method for spellchecking is described in Bassil & Alwani (2012), who also discuss the accuracy of *Ghotit*. More screenshots showcasing the punctuation correction of *Ghotit* are included in Appendix E.

**Table 9**

*Evaluation of Ghotit*

Language Learning	Pedagogy	Teacher Fit
<p><b>Listening:</b> Provides audio in target language (feedback, prooflistening)</p> <p><b>Writing:</b> Provides opportunities for writing</p> <p><b>Reading:</b> Readable environment, but could use improvements, especially in spacing</p>	<p><b>Teaching:</b> Explains language use and gives definitions</p> <p><b>Progress:</b> No progress tracking</p> <p><b>Feedback:</b> Feedback with meaningful explanations</p> <p><b>Differentiation:</b> No difficulty differentiations</p>	<p><b>Approach fit:</b> Can be used for most reading and writing activities</p> <p><b>Classroom management:</b> Suitable mostly for individual work</p> <p><b>Syllabus fit:</b> Topics can be assigned if needed, but the software remains flexible</p> <p><b>Training:</b> Younger students would require training</p>
User Experience		Technology
<p><b>Interactivity:</b> Active interactivity; user chooses how to use feedback</p> <p><b>Customisability:</b> High customisability</p> <p><b>Price:</b> Payment required, two-week trial available</p> <p><b>Registration:</b> Required</p> <p><b>Advertising:</b> None</p>		<p><b>Interface:</b> Cluttered interface</p> <p><b>Navigation:</b> Relatively clear navigation, but could be less cluttered</p> <p><b>Instructions:</b> Detailed manual and help available</p> <p><b>Stability:</b> Good</p> <p><b>Portability:</b> Available on all platforms and mobile devices, supports offline work</p>

Generally, *Ghotit* is a software that allows customisation, provides feedback and explanations, and includes some accessibility features, such as reading aloud. It could, however, provide easier-to-use settings for a more readable environment. For instance, users can edit background colours, but,

especially for children, these background colours could be limited to those suitable for dyslexia, such as those mentioned in Rello & Bigham (2017). Similarly, the fonts available could also be limited to dyslexia-friendly fonts. Adding distractions and more features than needed does not serve this particular learner group and its needs. For young students, these features might also interfere with the studying process, i.e. a student might end up experimenting with fonts instead of focusing on writing.

Another writing assistant, not aimed specifically at dyslexic learners, but following similar concepts of suggestions for corrections, is *Ginger*. *Ginger* includes progress-tracking technologies, which are explained in Zangvil (2011) and Feldman-Simon & Fitzpatrick (2010); the latter also provide an extensive description of the software's features, including the use of TTS for proof-listening and feedback (p. 21). Moreover, Daniels & Leslie (2013) present a study with twelve university students and discuss the efficiency of *Ginger*, *Grammarly*, and the *Microsoft Word* spellcheckers. *Ginger* was generally found to have advantages over other spellcheckers, both due to its accuracy and its user-friendly interfaces. Apart from *Ghotit* and *Ginger*, other software with similar features include *ClaroRead*, which is recommended by the British Dyslexia Association (Assured Dyslexia Products, n.d.), and *TextHelp*.

#### **4.3.2. *Dyslex.ie* – Reading Assistant**

*Dyslex.ie* is a browser extension functioning as a reading assistant, ensuring that content viewed on a browser is easily readable. *Dyslex.ie* has been developed by a team of students at Dublin City University (DCU) who collaborated with DCU Professor, Dr Ellen Reynor and the CEO of Dyslexia Association Ireland, Dr Rosie Bissett. The software was launched on June 26 2020 and has been chosen as an example of recent research-led software developed by an Irish university.

The main advantage of *Dyslex.ie* is that it is fully customisable; it provides a questionnaire and then tailors its settings based on the responses. The questions are worded in such ways to be easily comprehensible by young learners, as seen below. Moreover, the software remains customisable after the quiz and the user can take the test again at any point. While this software has no direct application to punctuation, providing dyslexic learners with a customisable readable environment is one of the main requirements for dyslexia-specific software. *Dyslex.ie* is an example of software that removes the clutter, keeping navigation straightforward and free of distractions. Ultimately, creating a user-friendly



interface for dyslexic students facilitates the proof-reading process, which is also relevant to punctuation correction. More screenshots of the *Dyslex.ie* questionnaire are in Appendix E.

**Figure 11**

*The Dyslex.ie Questionnaire*

Question 1.

**Do you mix up letters that are similar in shape?**

Yes →

No →

Question 5.

**Do you see text jump around the page?**

Yes →

No →

Question 6.

**Do you see the letters bunched together?**

Yes →

No →

Figure 12

*The Options Offered by Dyslex.ie*

Close ×

**Text enhancements** ?

---

**Text size**

↕ Small 
○
○
 Big

**Line height**

≡ Small 
○
○
 Big

---

**Boxes around paragraphs** ?

---

**Font** ?

Calibri | ▾

---

**Line focus** ?

**Change words per line** ?

---

**Split up syllables** ?

---

**Color tint** ?

---

**Background tint** ?

---

**Test again**

You can complete the Dyslexi test another time if you like.

Start again

Table 10

*Evaluation of Dyslex.ie*

Language Learning	Pedagogy	Teacher Fit
<b>Reading:</b> Provides a highly-tailored readable environment	<p><b>Progress:</b> Does the app allow the user to track progress or see previous attempts?</p> <p><b>Scaffolding:</b> Might “train” the user on reading better; the user can then re-calibrate the extension as they learn to read. It does not re-calibrate itself automatically</p> <p><b>Differentiation:</b> Assesses reading ability and is tailored based on that assessment</p>	<p><b>Approach fit:</b> Requires an internet connection in the classroom; teachers not preferring the use of the Internet in the classroom might not use it</p> <p><b>Classroom management:</b> Best for individual work, due to the customised experience provided</p> <p><b>Syllabus fit:</b> As a reading assistant, it can be used for all topics, but it might not function with e-books</p> <p><b>Training:</b> Easy to use, might need guidance for the questionnaire</p>
User Experience		Technology
<p><b>Interactivity:</b> Active interactions and options</p> <p><b>Customisability:</b> High degree of customisability</p> <p><b>Price:</b> Payment required, 8-week trial available</p> <p><b>Registration:</b> Requires questionnaire to start</p>		<p><b>Interface:</b> Cluttered interface</p> <p><b>Navigation:</b> Relatively clear navigation, but could be less cluttered</p> <p><b>Instructions:</b> Detailed manual and help available</p> <p><b>Stability:</b> Good</p> <p><b>Portability:</b> Available on all platforms and mobile devices, supports offline work</p>

Despite its benefits, there are two issues with *Dyslex.ie* at the moment: the lack of cross-platform compatibility and the lack of transparency regarding the research done for its development. Currently, *Dyslex.ie* is only available as a browser extension. It cannot work with text processors or online shared documents, such as Google Docs and, therefore, it cannot be used to proof-read texts. Cross-platform compatibility requires more development, so this feature might be added in the future. Regarding research, the *Dyslex.ie* website states that “the software features have been informed by best practice and guided by an ongoing review of international peer-reviewed research and primary research in the form of user feedback” (Dyslex.ie Website, n.d.). In order to exemplify the findings involved in the development of *Dyslex.ie*, the website could include references and reports.

Additionally, testing the software and publishing results on its implementation and evaluation would add to the credibility of the statement made.

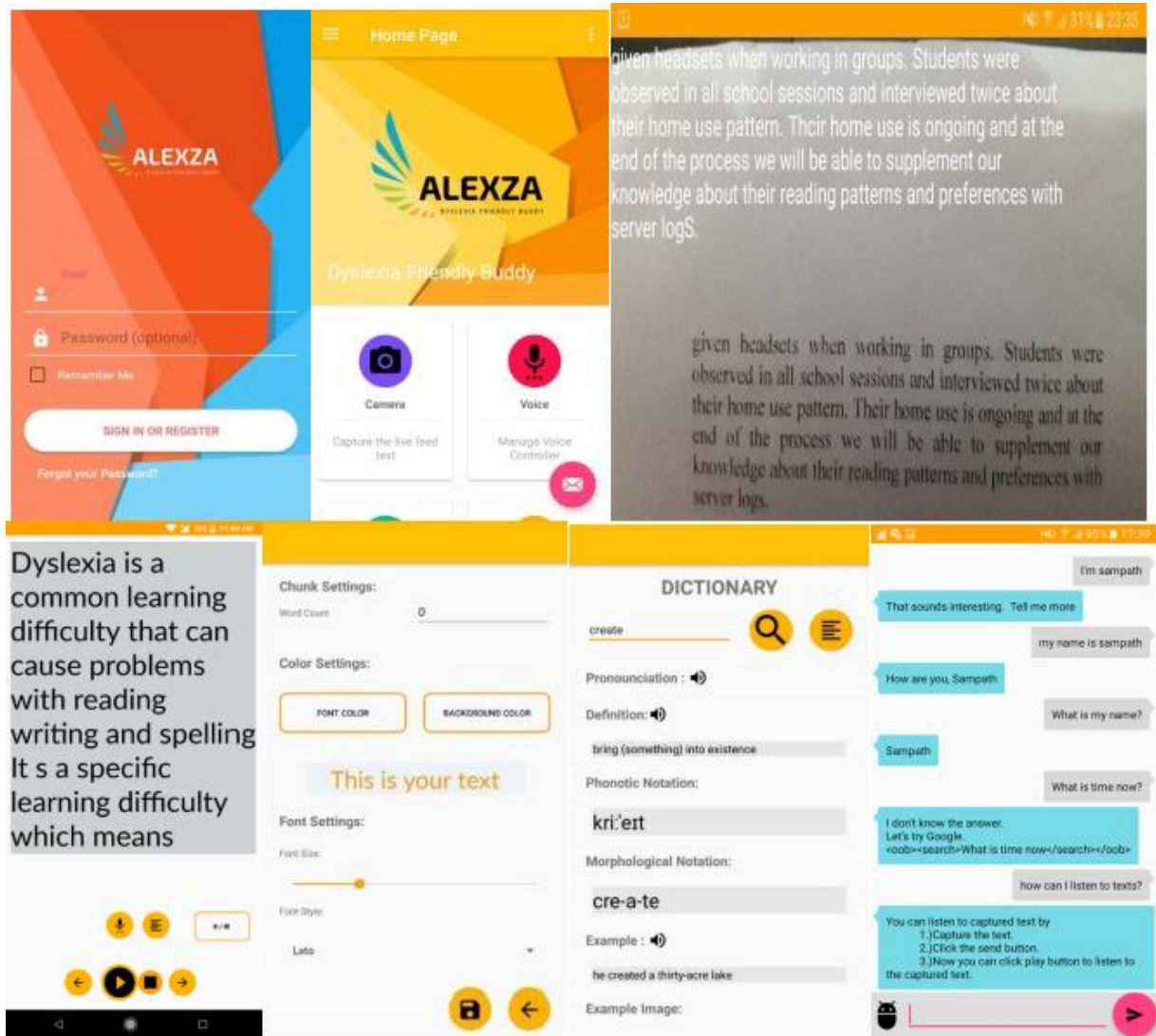
Another popular browser extension with features similar to those of *Dyslex.ie* is *Helperbird*, which was also initially developed in Ireland and has now expanded to the United States. *Helperbird* includes more features than *Dyslex.ie*, such as TTS support, dictionaries, spellchecking, and dictation, and can be used with Google Docs. For young learners, an abundance of features might interfere with their studying process and function as a distraction, but for older learners this extension is a comprehensive solution. Pricing-wise, *Helperbird* requires monthly payments for its pro version, while a free version with fewer features is available.

#### **4.3.3. ALEXZA – Dyslexia Friendly Buddy App**

An example of research feeding into the development of an app for dyslexia is *ALEXZA*, created at the Sri Lanka Institute of Information Technology and presented by Rajapakse et al. (2018). The researchers present their work in a comprehensive paper, which outlines the characteristics of dyslexic learners and the underlying causes of dyslexia and includes a review of similar applications. Their paper also discusses the potential of gamification for educational technologies and explains the affordances of technologies using Artificial Intelligence (AI) and Machine Learning (ML) concepts, such as in the development of a chatbot included in *ALEXZA*. Moreover, their app is informed by feedback provided by dyslexic participants, especially regarding the voice characteristics of the TTS, among other features (2018, p. 5). Finally, the researchers acknowledge the need for multi-lingual support for such apps, which would be relevant to the bilingual environment of Ireland, as well as for refugee and migrant students and for the development of apps for learners of English as a foreign language internationally.

Figure 13

The ALEXZA Interface (Rajapakse et al., 2018, p. 5)



**Table 11***Evaluation of ALEXZA*

Language Learning	Pedagogy	Teacher Fit
<p><b>Listening:</b> Provides audio in target language (reading aloud)</p> <p><b>Writing:</b> Provides some opportunities for writing with its chatbot feature</p> <p><b>Reading:</b> Provides features that enhance readability (highlighting, fonts, OCR, chunking)</p>	<p><b>Teaching:</b> Explains language by providing definitions</p> <p><b>Scaffolding:</b> Facilitates scaffolding by providing word definitions based on difficulty</p> <p><b>Differentiation:</b> Differentiation by difficulty of vocabulary</p>	<p><b>Approach fit:</b> Flexible with all teaching approaches</p> <p><b>Classroom management:</b> Could be used both individually and for pair- or group-work, though that would require a high level of collaboration between learners</p> <p><b>Syllabus fit:</b> Can be used with most text types and print and could therefore also suit a wide range of syllabi</p> <p><b>Training:</b> Unknown; appears to be easy to use</p>
User Experience		Technology
<p><b>Interactivity:</b> Active interactivity and choices, especially with the chatbot</p> <p><b>Customisability:</b> Low customisability, though the choices of fonts and colours has been informed by users' preference and research</p> <p><b>Price:</b> Free app</p> <p><b>Registration:</b> Required</p> <p><b>Advertising:</b> Unknown</p>		<p><b>Interface:</b> Clear interface, straightforward options</p> <p><b>Navigation:</b> Easy navigation and automatic scrolling</p> <p><b>Instructions:</b> Offers help through a chatbot</p> <p><b>Stability:</b> Unknown</p> <p><b>Portability:</b> Only available on mobile devices; supports offline work</p>

This app stands out for using neural networks to identify hard words that might need explanations and to provide simpler synonyms. As a result, instead of overloading the users with available definitions, the app focuses on the words that might be more difficult to comprehend. Additionally, the chatbot adds another level of individualised assistance. Overall, the choice of all elements in this app has been justified and tested by the researchers, which shows an example of good practice for the development of educational technologies.

Nevertheless, the app also has a few drawbacks. The main issue at the moment is that the app is not downloadable, which means that the researchers might be working on it again. Therefore, this review is based on an available demo and the presentation of the app in Rajapakse et al. (2018). As a result, some aspects, such as the stability of the app, remain unknown. Additionally, due to being an

app, *ALEXZA* is not available on other platforms. However, most of its features can work without an internet connection.

#### **4.3.4. *Dyslexia.ai – Tools & Games for Dyslexic Students***

*Dyslexia.ai* is an app developed in Ireland, which has been available for open beta testing since September 2019. *Dyslexia.ai* has been chosen for this resource audit not only as an example of recent Irish software for dyslexia, but mostly because it provides a combination of gamified learning, progress tracking for a customised learning experience, and augmented reality (AR).

The *Dyslexia.ai* app practises all skills. Listening is practised by hearing and spelling words, writing is practised by spelling exercises, while reading and speaking are practised by reading aloud words and sentences increasing in difficulty. The app also includes phonics, an Online Character Recognition (OCR) interface that facilitates reading and presents text in chunks, and progress tracking with achievements and rewards. While the app is free, the progress tracking option is available with a monthly subscription. Overall, this app facilitates phonological awareness for younger learners by providing them with opportunities to spell and read, while progress tracking ensures that the activities are not repetitive, providing students with comprehensible, yet increasingly harder input.

Below, you can see the range of activities that *Dyslexia.ai* offers, along with the profile interface and the content of some categories. More screenshots showing the activities themselves, the OCR interface, and part of the registration processes are in Appendix E.

Figure 14

The Dyslexia.ai Interface

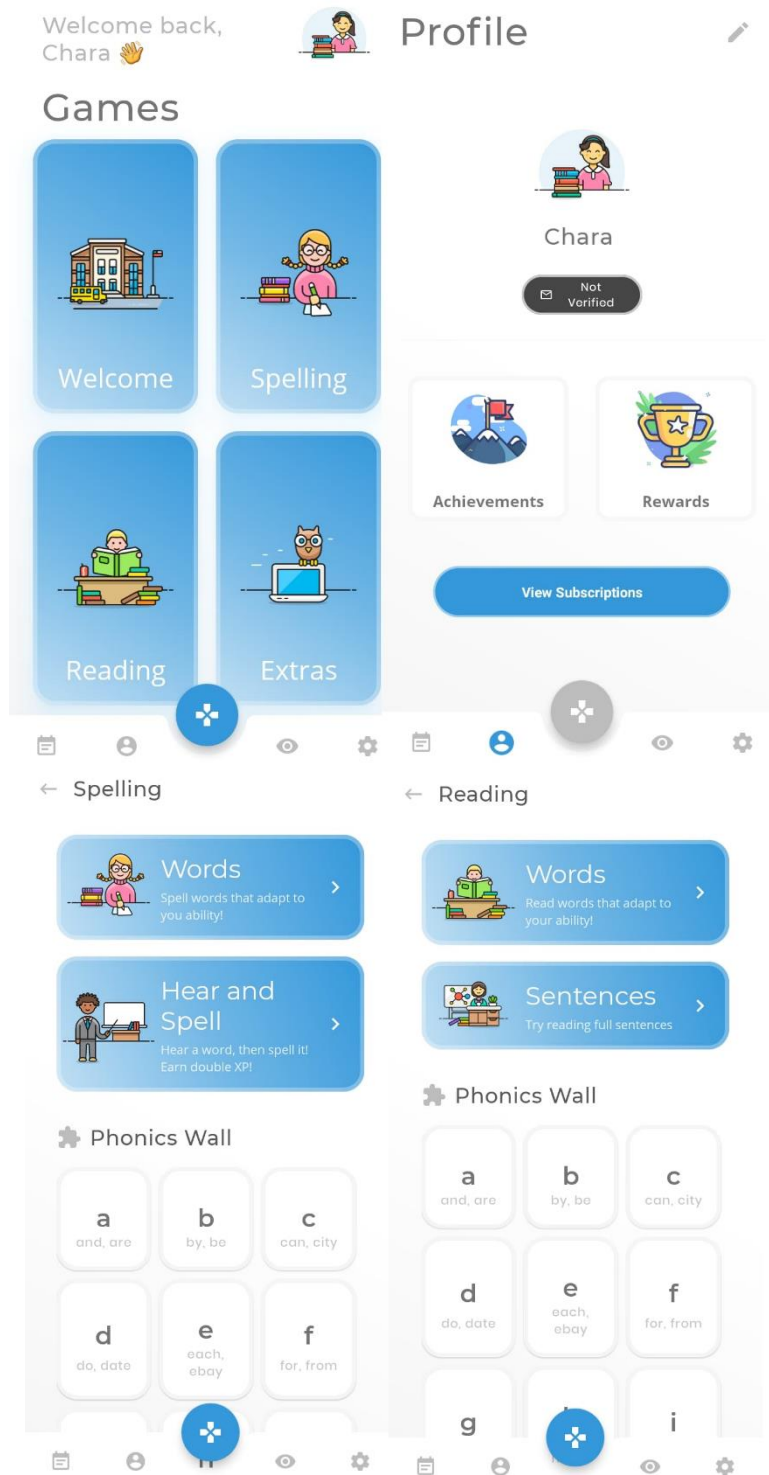




Table 12

*Evaluation of Dyslexia.ai*

Language Learning	Pedagogy	Teacher Fit
<p><b>Listening:</b> Provides audio feedback for reading-aloud and for spelling exercises</p> <p><b>Writing:</b> Writing practice provided</p> <p><b>Reading:</b> Provides both a readable environment and some opportunities for reading words and sentences</p>	<p><b>Teaching:</b> Models and tests language through gamified quizzes, but does not explain it</p> <p><b>Progress:</b> Tracks progress and changes accordingly</p> <p><b>Scaffolding:</b> Activities presented in escalating difficulty</p> <p><b>Feedback:</b> Feedback provided, but without explanations</p> <p><b>Differentiation:</b> Level of difficulty increasing</p> <p><b>Engagement:</b> Variety of activities keeping students engaged, especially younger ones; AR used to visually amplify the app</p>	<p><b>Approach fit:</b> Can only be used to practice language based on forms; also cannot be used without mobile devices and an internet connection</p> <p><b>Classroom management:</b> Mostly suitable for individual work</p> <p><b>Syllabus fit:</b> Only suitable for spelling/writing exercises in the classroom or as a tool to read printed texts easier through the OCR</p> <p><b>Training:</b> Easy to use with clear instructions</p>
User Experience		Technology
<p><b>Interactivity:</b> Active interactions using both the screen and the microphone</p> <p><b>Customisability:</b> Increasing difficulty levels and some appearance settings</p> <p><b>Price:</b> Free to download, monthly registration required for progress tracking</p> <p><b>Registration:</b> Required</p> <p><b>Advertising:</b> None</p>		<p><b>Interface:</b> Clear interface, simple options</p> <p><b>Navigation:</b> Easy to navigate with icons</p> <p><b>Instructions:</b> Simple-worded instructions provided</p> <p><b>Stability:</b> Unstable; freezes frequently</p> <p><b>Portability:</b> Only available as an Android app and requires an internet connection</p>

Although the theoretical background behind the development of the app is not explained, it is obvious that the app relies on the form of the language rather than its meaning. *Dyslexia.ai* does not provide word definitions or further examples in order to create mappings between form and meaning. Therefore, while students might succeed at improving the spelling and the pronunciation of words and phrases, these skills are not practised within the context of real-life language use. As a result, this also limits the possibilities of integrating the app into classroom teaching, since it would be mostly suitable for autonomous work. Testing the app with learners would allow a more comprehensive evaluation regarding the efficiency of the app. Generally, however, the gamification features and the AR options might increase motivation and produce positive results.

Regarding the technical aspects of the app, it is indeed obvious that it is still in beta, due to its bugs and stability issues. For instance, when playing the spelling game, it was impossible to exit the game without restarting the app and there were several instances when a restart was required due to the app freezing. Moreover, slow loading times and visual bugs were detected. Another issue is the lack of portability; even for students with tablets in a well-equipped classroom, only Android tablets would support the app. Recommending the app for self-study at home would also limit students who do not have access to any mobile devices.

#### **4.3.5. Dyslexia Software Characteristics**

On the basis of the software reviewed above and in order to address RQ 2.1., the main characteristics of current software for dyslexia are:

- a) Assistive Technology Support: All software includes accessibility options, such as reading aloud via TTS and customising or chunking text via OCR.
- b) Customisability: Most software offers customisability options, providing dyslexic students with a tailored experience. However, sometimes there are more options than needed, as seen in *Ghotit*.
- c) AI-Informed Methods: AI is becoming part of recent software for dyslexia with chatbots and progress tracking. However, automatic corrective feedback has not yet reached a high level of accuracy.
- d) Paywalls: Most software either requires a subscription or offers free trials, thus requiring payment in the long run.
- e) Autonomous Learning: Most software currently available is suitable for individual study, rather than use in the classroom or for pair- and group-work.

#### **4.3.6. Further Readings**

More extensive reports and reviews are provided by Rakopoulou (2020), Wei et al. (2020, pp. 5-7,) Indal & Mavéus (2019), Satapathy (2019), Ili Farhana (2018), Madden (2012), and Draffan (2002). Additionally, innovative research on using prosody for dyslexia software is presented by Sbattella et al. (2014), while Rello et al. (2015) present the design of a spell-checker specifically tailored for Spanish dyslexic learners. Finally, another example of gamified software for dyslexia is *Dyetective*, which incorporates a screening tool and an abundance of games and exercises for the treatment of dyslexia (Rello et al., 2016; Rello et al., 2017).

#### **4.4. CALL Development Desiderata**

On the basis of the resource audit, this section summarises the learner, task, and teacher desiderata to be considered when developing CALL tools for dyslexic learners, addressing RQ 2.2. Having detected the benefits and drawbacks of the software currently available, this list aims at informing future CALL development, as well as at providing a framework for the development of *PunkBuddy*. The degree to which these desiderata are achieved by the current version of *PunkBuddy* is discussed in Chapter 5.

##### **4.4.1. Learner Desiderata**

The main learner desiderata to be considered when developing CALL tools for dyslexic learners are:

- a) Customisability: While dyslexic learners share some characteristics, personal preference also weighs in. For instance, Grigorovich-Barsky (2013) and Rello and Baeza-Yates (2016) explain that there are various fonts preferred by dyslexic learners to a different degree.
- b) Explicit instruction: Most dyslexia software uses Text Enhancement (TE) to draw attention to potential errors or difficult forms. TE on its own can only draw attention to forms, but when combined with feedback, it can contribute to language comprehension (De La Fuente, 2014; De Santis, 2008; Rassaei, 2020)
- c) Feedback: providing input or enhancing input without explanations does not facilitate acquisition of language forms; on the contrary, attempting to connect form with meaning is in line with most contemporary theories of language, such as the Input Processing Theory (VanPatten, 2004), which will be explained below. Additionally, providing feedback in multiple forms, such as in auditory format, is preferred by dyslexic learners and the developers of dyslexic software. Finally, immediate feedback ensures that the learner can work on their own to improve their writing, which promotes learner autonomy.
- d) Clear interface: Even though it might be tempting to add an abundance of features and options, tools for dyslexic students, and especially children, should provide an interface free from distractions. Each added feature should serve a specific purpose according to the needs of the learner group.

##### **4.4.2. Task Desiderata**

Regarding the tasks that learners are prompted to complete when using dyslexia software, there are the following desiderata:

- a) **Authenticity:** Repetitive exercises might enhance audio-visual memory (Zygouris et al., 2018), but the language presented in CALL tools should model the real-life use of the language. Therefore, authentic communicative tasks and authentic linguistic input should be at the core of CALL development. This includes the authenticity and naturalness provided by TTS synthesizers.
- b) **Scaffolding:** Progress tracking is a feature that requires more sophisticated technical development, which is why many tools are not able to track the student's progress and provide individualised content. However, as we are moving towards more advanced AI-informed technologies, such as Intelligent Tutoring Systems (ITS), providing dyslexic students with differentiated content would facilitate their learning process.

#### **4.4.3. Teacher Desiderata**

Though teacher desiderata sometimes overlap with learner desiderata, the main teacher desiderata to be considered when developing CALL tools for dyslexic learners are:

- a) **Portability:** The main issue most teachers would have to face is the lack of technical equipment in a classroom or the lack of funding to purchase software. Ensuring cross-platform compatibility and making CALL tools freely available is an essential step towards inclusive educational technologies.
- b) **Flexibility:** Ideally, for a teacher who want to integrate technology in teaching, CALL software should be developed to support pair-work and group-work and be flexible enough for use with various approaches and topics.
- c) **Ease of use:** Learners might adapt to new technologies easier; however, it is still important for teachers to know how to use a software in order to provide support to their students when needed. Immediate feedback is also relevant to ease of use. If students are provided with feedback through the software, the teacher's intervention is minimised.

#### **4.5. Implications and Conclusion**

This chapter has conducted a resource audit of recent software for dyslexia and outlined their main characteristics (RQ 2.1.). This resource audit then informed the desiderata of CALL development for dyslexia (RQ 2.2.). Overall, while significant progress has been made in dyslexia software development, the feedback offered by such software is not advanced enough to substitute or replace teacher feedback. This is especially the case in punctuation correction (see 4.3.1.). Moreover, incorporating

progress tracking methods requires a sophisticated level of development, which is why most software cannot yet provide scaffolded tasks and differentiated instruction.

The findings of this chapter bring forward the following implications regarding the *PunkBuddy* interface:

- (a) Customisability: It is important to offer users options, at least on the level of appearance, in order to provide an optimal user experience (see 4.3.5. and 4.4.).
- (b) Paywalls: Developing *PunkBuddy* as part of a university project should ensure that the software is accessible and provided for free. Assistive and educational technologies must be accessible for all students, regardless of their socioeconomic status (see 4.3.5. and 4.4.3.).

## Chapter 5: The Development of *PunkBuddy*

### 5.1. Introduction

This chapter outlines the development of *PunkBuddy* based on the TATL framework (Ní Chiaráin & Ní Chasaide, 2015). It summarises theories of language acquisition informing CALL development and the needs of the learner group based on the findings from previous chapters, before moving on to the actions promoted by *PunkBuddy* and the technologies used for its development. The features of *PunkBuddy* are explained in detail and are evaluated on the basis of the learner, task, and teacher desiderata explained in 4.4.

### 5.2. Language Acquisition Theories

This artefact encompasses three theories: Schmidt's (1990) Noticing Hypothesis, VanPatten's (2004) Input Processing Theory, and Vygotsky's (1986) Sociocultural Theory. Schmidt's (1990) Noticing Hypothesis supports that the first step towards learning is noticing of forms and it is widely cited in CALL research (De La Fuente, 2014; Radwan, 2005; Rassaei, 2020; Zou et al., 2019). Schmidt (1990) explains that awareness is an essential for step for input to be transformed into uptake, which is acquired knowledge. He also adds an intermediary step between input and uptake, called intake; noticing ensures that input is first converted into intake in order to be acquired. Text Enhancement (TE) and proof-listening through the TTS are used in *PunkBuddy*, prompting learners to notice lack or misuse of punctuation in their writing.

VanPatten's (2004) Input Processing Theory supports that emphasis on meaning is essential for input to be transferred from working memory to long-term memory. His theory suggests that meaning is processed before form, which is particularly relevant for punctuation teaching. Even though several guides provide specific instructions on how punctuation is to be used, its real-life implementation varies (see Chapter 2). Therefore, teachers first need to explain the meaning behind pauses, while students themselves are to experience how the lack of these pauses impacts their text by proof-listening their text through the TTS. In *PunkBuddy*, the rules of punctuation are explained through the chatbot. Additionally, one of the main principles of the Input Processing Theory is the "Availability of Resources Principle" (VanPatten, 2004, p. 14), according to which the input should be tailored in such a way that does not drain the student's attentional resources. This is especially relevant to the design of dyslexia software interface (see 4.4.1.). Generally, overloading the students with input beyond their attentional resources disrupts language acquisition. Moreover, customisability in CALL

tools for dyslexia would ensure that students receive as much input as they can handle, for instance definitions only for difficult words and punctuation corrections based on their skills.

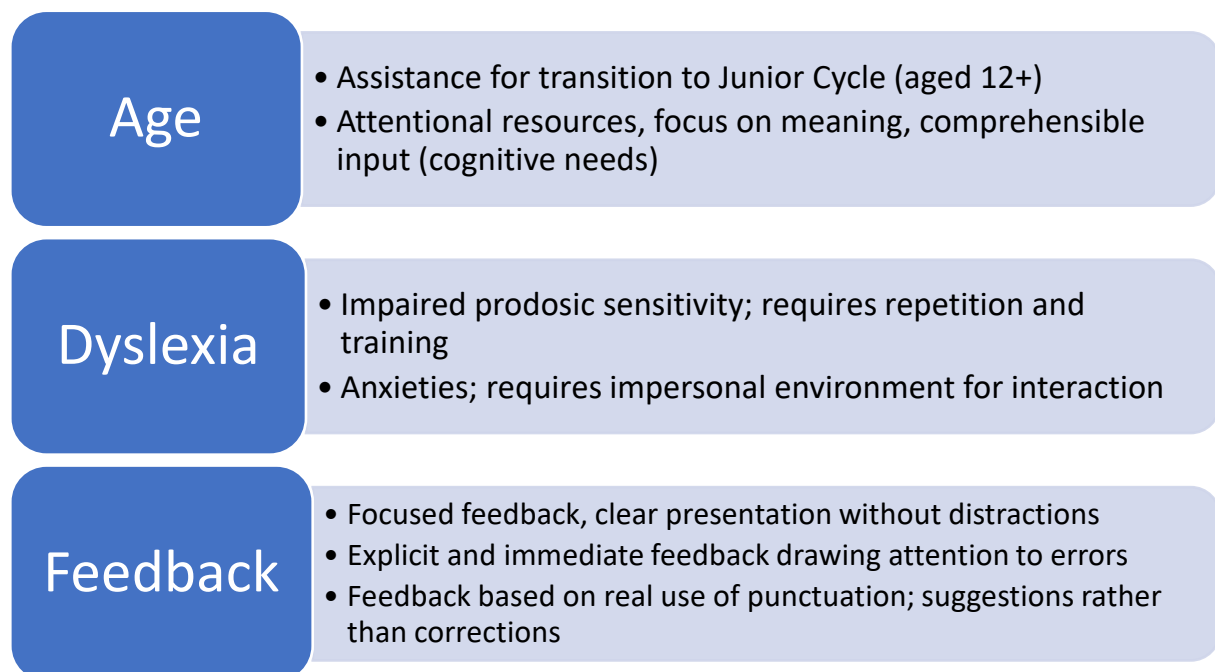
Finally, Vygotsky's (1986) Sociocultural Theory, states that learning is achieved through scaffolded interaction. Scaffolding is relevant to CALL design and evaluation (see 4.2. and 4.4.). Additionally, learning through interaction is relevant to the chatbot created for *PunkBuddy*, even though its interactive capabilities are still limited. Other modes of peer-interaction are also popular with CALL, but for this specific learner group I am considering the emotional needs mentioned in 1.3.3. Therefore, choosing a mode of interaction that minimises anxieties while providing individualised assistance allows learning through interaction. For the benefits of using chatbots in language learning, see Arispe (2014).

### 5.3. Learner Group

The needs of the learner group have already been outlined in 1.3., while Chapter 3 extensively discussed the cognitive processes in dyslexia, focusing on prosodic processing. To summarise the characteristics of the learner group of *PunkBuddy*, I am outlining its needs and characteristics in the figure below.

**Figure 15**

*The Learner Group of PunkBuddy*

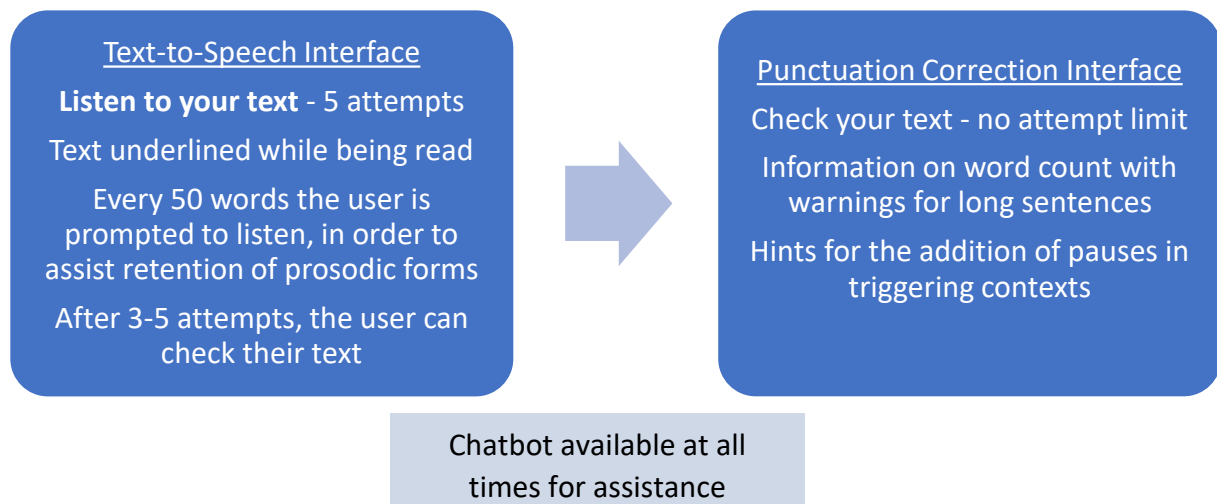


#### 5.4. Actions and Technology

First, *PunkBuddy* prompts users to listen to their composition and add punctuation as needed. Users proof-listen their text at least three times before moving on to the punctuation correction interface. This interface provides hints for the improvement of punctuation and informs user on their sentence length. Meanwhile, the chatbot remains available for assistance at all times, providing explicit instruction on the meaning of punctuation marks. The actions prompted by *PunkBuddy* are summarised in the graph below.

**Figure 16**

*The Actions Prompted by PunkBuddy*



*PunkBuddy* is deployed on a *Vercel* website built with *React* and *Typescript* and it has been set up by Luke Lau, MSc Computer Science graduate from Trinity College Dublin. It is accessible through the *PunkBuddy* website (<https://punkbuddy.vercel.app/>), while the steps of its development are visible through its public GitHub Repository (<https://github.com/triantac/punkbuddy>). *PunkBuddy* uses the open-source MIT License, making its code available to all parties interested.

##### 5.4.1. The Text-to-Speech Interface

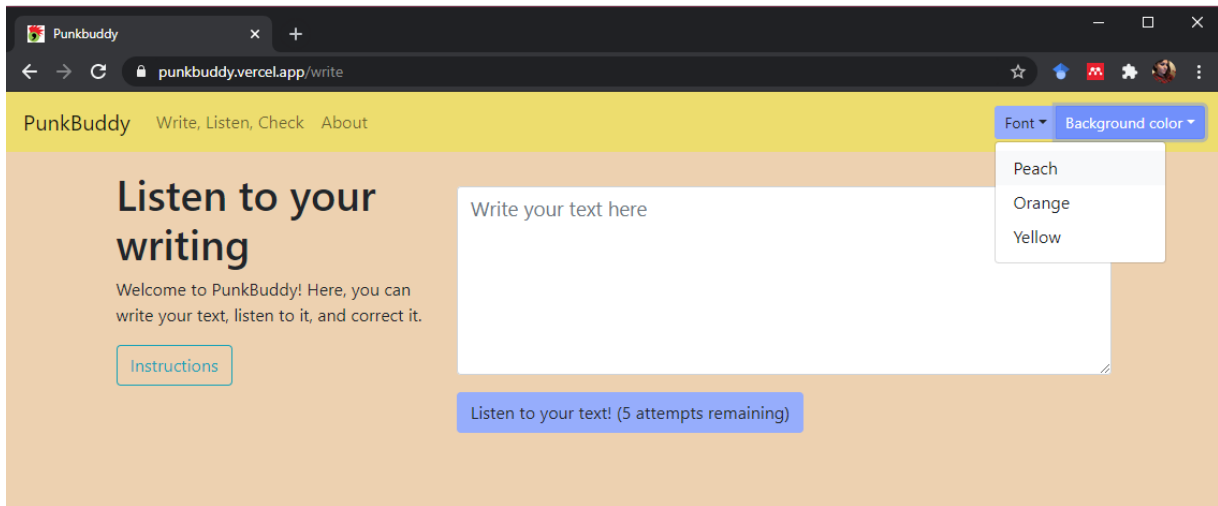
When entering the website, the user is prompted to write their text and listen to it. Instructions are visible only when hovering over them in order to minimise the clutter of text on the screen. The user can choose between three fonts and between three background colours, all of which have been chosen based on the findings of Rello and Baeza-Yates (2016) and Rello and Bigham (2017). Their



findings suggested that Arial, Open Dyslexic, and Courier are among the most readable fonts and that yellow, peach, and orange provided the most readable backgrounds.

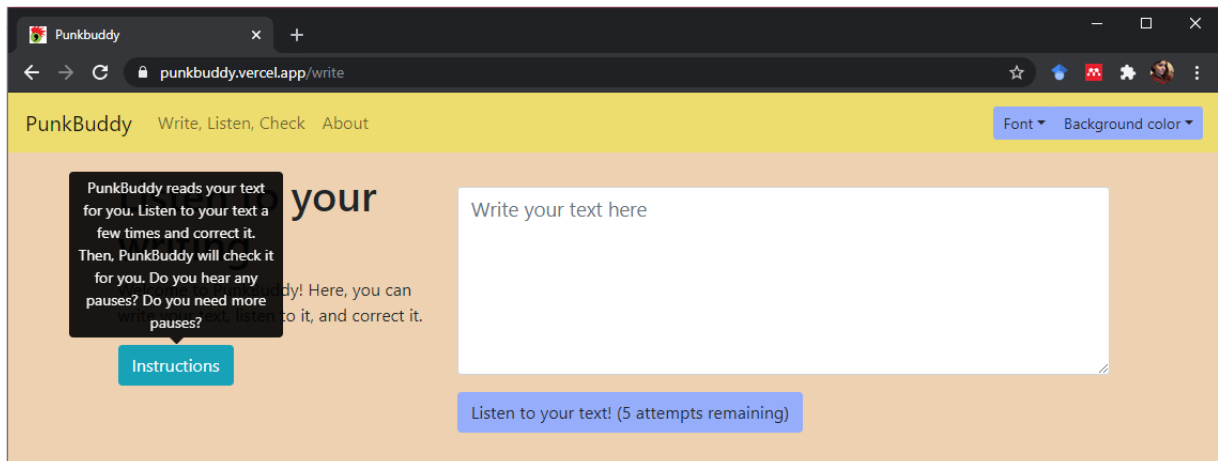
**Figure 17**

*Customisability Offered by PunkBuddy*



**Figure 18**

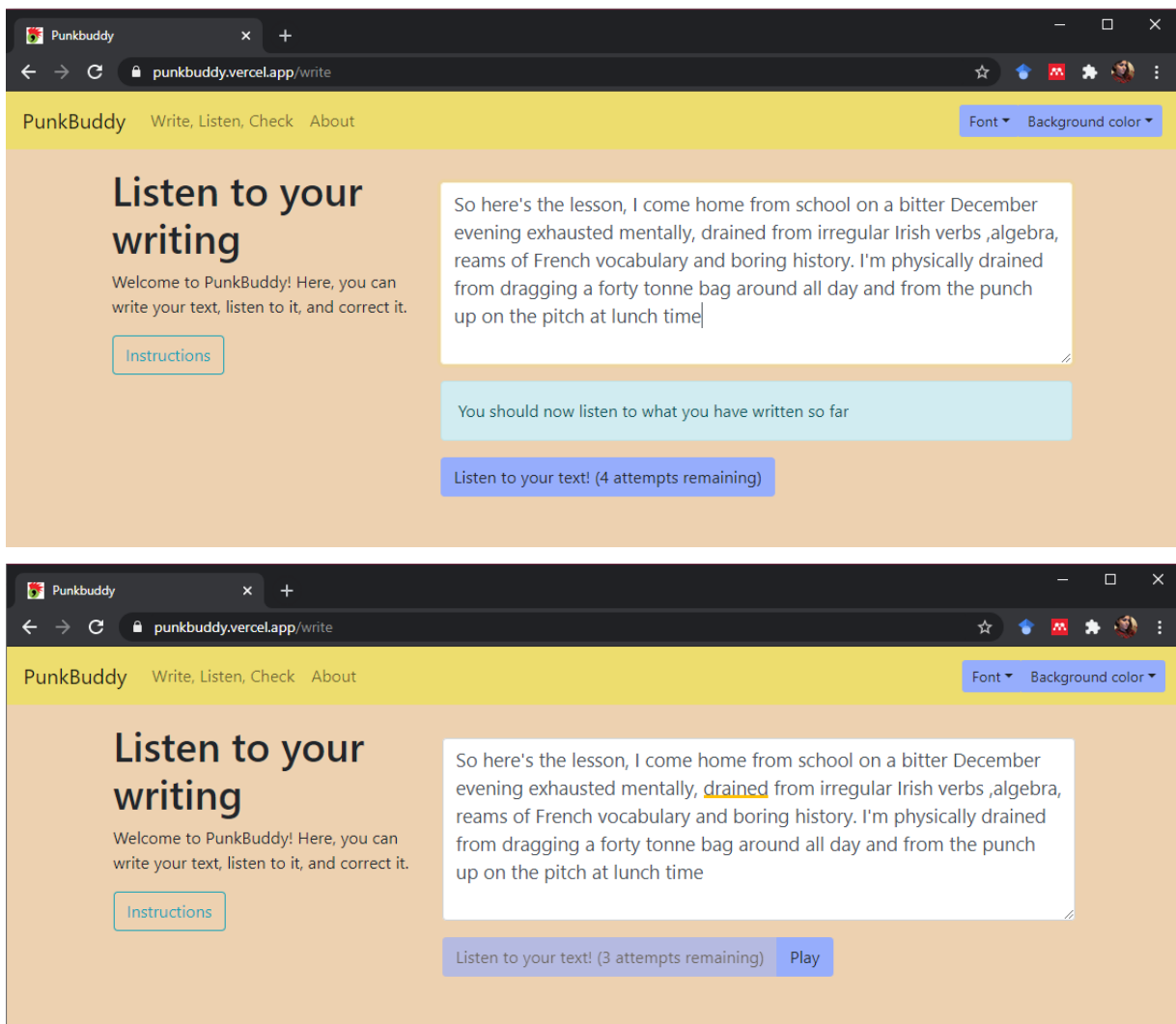
*Instructions Offered by PunkBuddy*



The TTS interface offers a minimum of three attempts and a maximum of five attempts. The number of attempts left is visible at all times. The user can also pause the text as it is being read and then continue listening again. To enhance noticing and readability, the text is underlined as it is being read. Moreover, the user is prompted to listen to their text every 50 words, in order to minimise short term memory effects (see 3.5. and 3.8.). The TTS is powered using the *JavaScript Web Speech API*; if not available, the *Google Cloud Speech Synthesiser* is used as back-up. The initial plan was to use the *Google Cloud Speech Synthesiser* only, which uses neural networks to synthesise speech and is therefore more natural, but most neural network speech synthesisers did not allow customisations, such as underlining text as it is being read to enhance readability.

**Figure 19**

*The PunkBuddy TTS*



### 5.4.2. The Punctuation Correction Interface

Based on the findings in 2.3., the punctuation correction interface suggests the addition of a comma in these cases:

- (a) Before trigger words: but, as, so, though,
- (b) Before and after adverbials and phrases: instead, however, firstly, secondly, finally, ultimately, alternatively, eventually, in my opinion, in conclusion
- (c) After adjectives
- (d) After salutations.

Regarding full stops and sentence segmentation, the word count bar shows the length of each sentence in the form of a progress bar, giving a yellow warning at 15 words and a red warning at 18 words (see 2.3.1. and 2.5.). The comma suggestions are generated by a combination of simple string searching and *Google Cloud's Natural Language API*. The *Natural Language API* was especially used to detect adjectives and salutations. The coding behind *PunkBuddy's* punctuation correction is available on GitHub (PunkBuddy Repository, 2020).

**Figure 20**

*Sentence Length and Punctuation Suggestion in PunkBuddy*

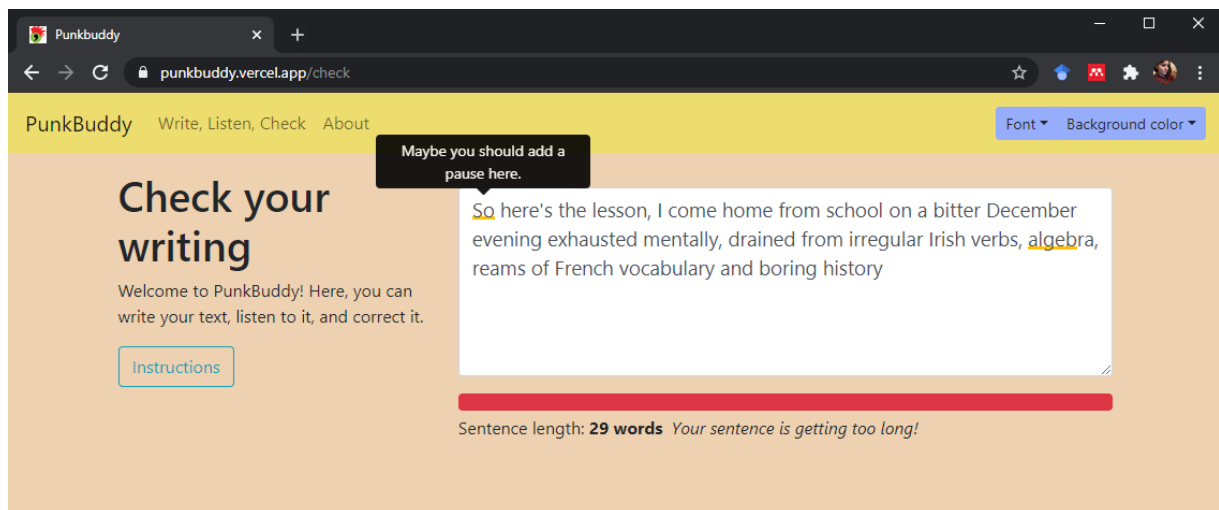
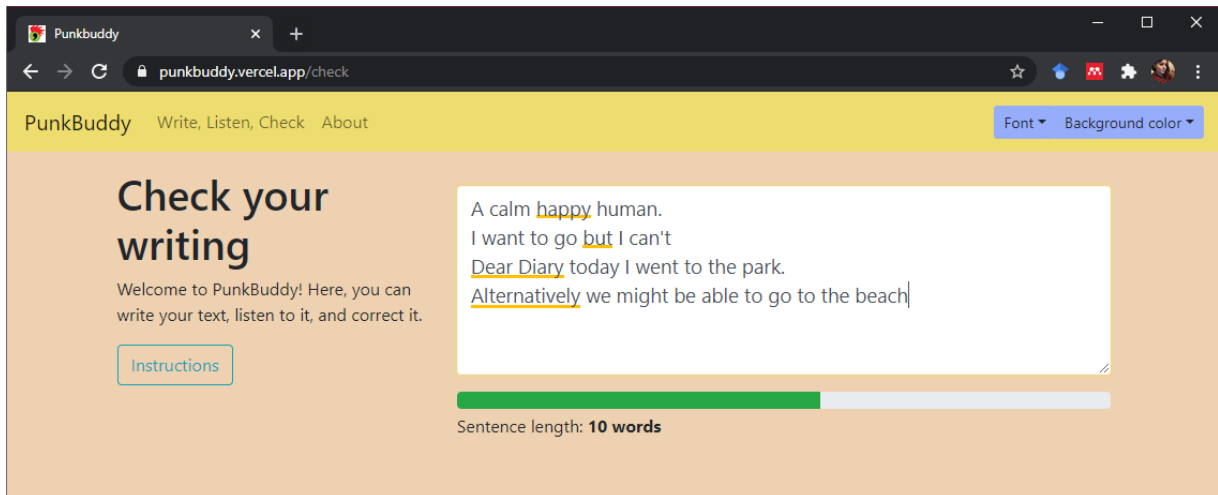


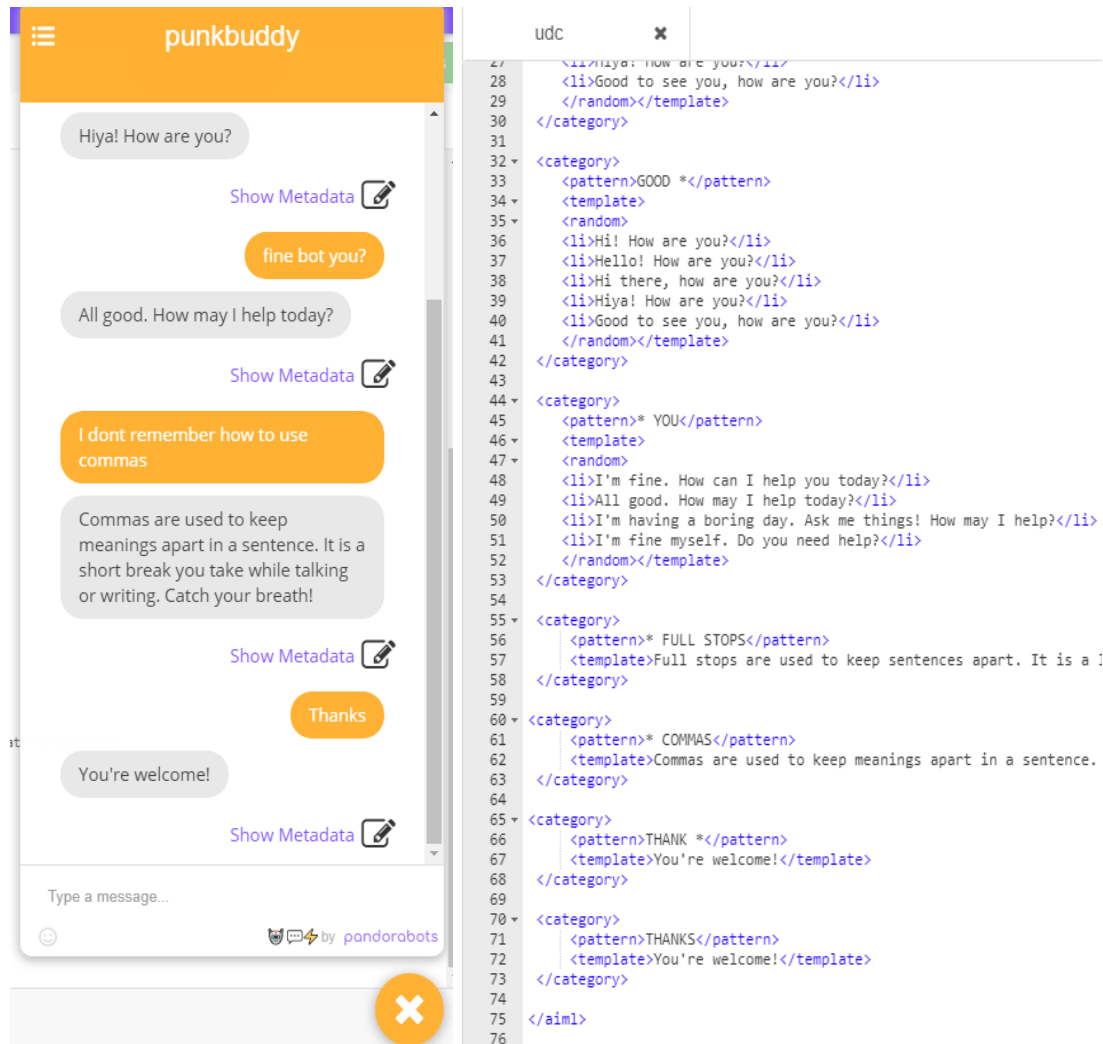
Figure 21

*Comma Suggestions in PunkBuddy***5.4.3. The Chatbot**

The *PunkBuddy* chatbot is at an early stage of development and it is made and deployed on *Pandorabots* using Artificial Intelligence Markup Language (AIML). It has not been integrated in the current *PunkBuddy* website, as monthly payments are required for its deployment on any platform other than the internal bot directory. Regarding its conversational abilities, it offers short, simple-worded explanations on the meaning of punctuation marks, i.e. full stops, commas, and question marks, and can exchange salutations. A sample of a dialogue with the chatbot and part of its code are in the screenshot below.

Figure 22

## The PunkBuddy Chatbot



## 5.5. Evaluation

At its current stage *PunkBuddy* offers limited features and I am summarising the work done and the future development needed by using the desiderata of 4.4. The table is colour-coded to show the aspects of *PunkBuddy* that have been developed to an adequate degree and those that need more work.

**Table 13***Evaluation of PunkBuddy*

Learner Desiderata	Task Desiderata	Teacher Desiderata
Customisability: choice of fonts available and background colours available; no choices of voice in the TTS	Authenticity: some real communicative tasks through the chatbot	Portability: only available as a website, requires an Internet connection; not yet responsive on mobile devices
Explicit instruction: text highlighted when read, trigger words for punctuation highlighted	Scaffolding: some scaffolding by progressing from the TTS interface to the punctuation checking interface; no differentiated difficulty	Flexibility: mostly suitable for individual work
Feedback: meaningful feedback through the chatbot; hints rather than corrections		Ease of use: straightforward instructions and clear interface to facilitate ease of use
Clear interface: hoverable instructions, no added media, few colours and buttons		

Evaluating *PunkBuddy* would require testing it with dyslexic students and their teachers, in order to determine the aspects needing improvement. Especially regarding the TTS interface, it is important to determine whether the auditory feedback received is intelligible (see 3.8.). Testing *PunkBuddy* within the interactive context of a classroom might elicit more favourable reviews (Ní Chiaráin & Ní Chasaide, 2017), but considering that this tool is mostly tailored for autonomous use, it is important to test the TTS in individual student work. This evaluation can be conducted on the basis of the framework proposed in 4.2.; for the evaluation of TTS technologies in particular, see also Grimshaw et al. (2018). Finally, an interesting aspect of evaluation would be to consider what Rosell-Aguilar (2017, p. 255) calls “appsmashing”, i.e. the combination of different apps in autonomous use. For instance, it would be interesting to examine whether dyslexic students would combine *PunkBuddy* with other spellcheckers and readability enhancement tools, or with apps and tools beyond the assistive spectrum.

## 5.6. Conclusion

This chapter has described the characteristics of *PunkBuddy* and the decisions informing its development based on the findings of the previous chapter. All four research questions have contributed to the development of *PunkBuddy*:

- (a) RQ 1.1.: The findings on the use of punctuation have informed the type of feedback provided to users, offering hints and suggestions on commas and sentence length.
- (b) RQ 1.2.: The findings on prosodic processing and dyslexia have informed the design of the TTS interface and the evaluation needed to test its intelligibility for dyslexic students.
- (c) RQ 2.1.: The characteristics of other dyslexia software informed the customisable aspects of the *PunkBuddy* interface and its open-source nature.
- (d) RQ 2.2: The desiderata drawn provide an outline of the current possibilities of *PunkBuddy* and inform the aspects needing further development, such as portability and progress tracking.

Ultimately, this chapter shows how CALL development unfolds following the TATL framework (Ní Chiaráin & Ní Chasaide, 2015) and emphasises the need for a strong theoretical framework in CALL research in order to develop tools for dyslexic students and beyond.

## Chapter 6: Conclusion

### 6.1. Final Remarks

Addressing four research questions regarding the use of punctuation (RQ 1.1.), prosodic processing in dyslexia (RQ 1.2.), and CALL development (2.1. and 2.2.), this dissertation has shown the development of *PunkBuddy*, a CALL tool aiming at assisting dyslexic students with the use of punctuation.

The findings of Chapter 2 (RQ 1.1.) shed light on the individual variations in the use of punctuation, even within teachers of the English language. Furthermore, these findings affect the design of instructional software and assistive technologies, as seen in the development of *PunkBuddy*. Considering the range of acceptable ways to punctuate, the instruction of punctuation should be flexible enough to allow all grammatically correct individual styles.

The findings of Chapter 3 (RQ 2.1.) indicate that prosodic processing of linguistic forms is impaired in dyslexia. However, some studies show that auditory training can be used to improve memory and both implicit and explicit prosody. Moreover, studies in non-dyslexic learners show the positive impact of prosody training on punctuation use. The findings of Chapter 3 include the physiology of prosody and dyslexia, indicating brain areas for future research on prosodic processing in dyslexia. Finally, 3.7. outlines theories of dyslexia and suggests a re-definition of the Phonological Deficit Hypothesis, making it inclusive of recent findings on the cognition of dyslexia.

The findings of Chapter 4 show the characteristics of software for dyslexia (RQ 2.1.) and set a number of desiderata for CALL development for dyslexia (RQ 2.2.). Current software for dyslexia shows some degree of sophistication with automatic suggestions for punctuation, personalised readable environments, and AI-informed tools, such as chatbots and progress-tracking activities. However, there are still aspects that require further development, especially in the accuracy of automatic corrections and the interface design. Providing a guide for evaluation and further research, the desiderata drawn outline a framework of evaluation for *PunkBuddy* and for the development of other CALL tools.

Finally, Chapter 5 shows how all the aforementioned findings are utilised for the development of *PunkBuddy*. The Chapter follows the TATL framework (Ní Chiaráin & Ní Chasaide, 2015) to summarise theories of language acquisition, the needs of the learner group, and the actions prompted by the tool. The Chapter also describes the platforms used for the development and deployment of *PunkBuddy* and the details of the interface design. The code used is referenced and remains available for re-use.



## 6.2. Limitations and Further Research

The main limitation in this study was in the design of the Perception Test, which, due to the COVID-19 pandemic had to be distributed online. The pandemic influenced the sample size, with the distribution of the test being difficult due to the hurdles in communication. Moreover, the findings of the test showed potential for the replication of the study. In a future attempt, the test should also consider other aspects that might influence the individual punctuation styles, such as the age of the participants, the instruction they have received, and the materials they use for teaching. It would also be interesting to consider the prosody of the teachers, i.e. their pauses in speech, and examine if there are any correlations between their choices in speech and writing.

Moreover, future development for *PunkBuddy* should prioritise better punctuation correction. For instance, differentiating between restrictive and non-restrictive relative clauses, determining whether apostrophes are needed in a pronoun, and suggesting comas in tag questions would provide a more accurate punctuation correction interface. Additionally, further development should focus on progress tracking methods and scaffolded tasks. For instance, punctuation corrections can be offered based on the level of the learners and their most frequent errors, while students should also be praised when making improvements. Other aspects to consider include portability, offline use, and further development of the chatbot.

Finally, regarding prosodic processing in dyslexia, *PunkBuddy* can be used to implement prosodic training and test the improvement in punctuation skills. However, a prosodic training programme would need to be carefully designed and implement several activities beyond the use of *PunkBuddy* for punctuation checking. Regarding synthetic speech intelligibility, it is important to test the intelligibility of the *PunkBuddy* TTS and eventually create more intelligible and natural speech synthesisers for educational purposes.

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**Appendix A**  
**Research Ethics Approval**



**Trinity College Dublin**  
Coláiste na Tríonóide, Baile Átha Cliath  
The University of Dublin

06/06/2018

Application                      Academic Year 2017/18

Applicant:                      TT77 Ní Chasaide, Alibhe, Neasa Ní Chiaráin and Emily Barnes

Title of Research:              Speech technology in educational games and platforms for Irish.

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Dear Ailbhe, Neasa and Emily,

Your revised application for ethics approval for the research project above was considered by the Research Ethics Committee, School of Linguistic, Speech and Communication Sciences, Trinity College Dublin, on Tuesday 1<sup>st</sup> May 2018, and has been approved in full. We wish you the very best in your research activities.

Please note that on completion of research projects, applicants should complete the End of Project Report Form and submit one signed hard copy to the School Office as well as an electronic copy ([slscs@tcd.ie](mailto:slscs@tcd.ie)).

Best wishes,

Professor John Saeed

**Chair, Research Ethics Committee**  
**School of Linguistic, Speech and Communication Sciences**



## Appendix B

### Texts Chosen for the Perception Test

“Dear Diary,

Today was a wonderful day. I went to Herbert Park to feed the ducks. We brought a bag of birdseed with us. Mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans, as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call in to Aunt Mary in the nursing home, as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone. I'd like to show Aunt Mary, as she loves Herbert Park. Lately I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening I think that should be enough to complete most of the work. I have to stop writing now, but I will let you know how it all goes tomorrow.”

Kingdom 1, p. 5, 190 words

“[...] I am here to propose the motion that written homework should be banned. Let me begin by outlining my three main reasons for this argument. Firstly, written homework is an unnecessary stress that all students must endure after a long day at school, which takes from our time to unwind in the afternoon and relax. Secondly, there are no proven statistics to say that written homework is of benefit to a student's development, and, finally, this time would be better spent revising, as most exams are memory and information related. Let me start by introducing myself. I am Lucy Garvey and I am a third year student at St Martin's Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health. [...]”

Kingdom 1, p. 51, 151 words

“The story of Mick, the six-week-old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with 'Swimmer Puppy Syndrome'. This condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out. The poor thing could

only lie on his stomach. Thankfully for him, the Mia Foundation in Rochester, New York, took him in. It was this little puppy's lucky day when the foundation, which takes in animals with birth defects that might otherwise be put down, agreed to help him. And so began his journey to recovery. To begin with, they propped him up to take the weight off his chest. They then placed him in a harness to put his legs which were also taped, into the correct resting position. Then he was taken to swim therapy where he was made to swim in a mini-pool to build up the muscles in his legs. The results were almost immediate. After a few days he was sleeping on his side and after only two weeks, he was able to sit up and walk. Granted he walks like a man with 10 pints on him, but it's a miracle that he's walking at all. This little pup may never win any gold medals at the Crufts dog show, but I defy anyone to watch the YouTube video of him stumbling about, delighted with life, and not have a tear in their eye. [...]"

Great Expectations 1, pp. 208-209, 248 words

"So here's the lesson - I come home from school on a bitter December evening, exhausted, mentally drained from irregular Irish verbs, algebra, reams of French vocabulary, and boring history. I'm physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch-time, and I'm absolutely freezing since it lashed rain as I trudged wearily home minus a jacket 'cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy, uncomfortable, horrible, nylon/polyester uniform and quickly throw on my soft, soothing, fleecy PJs and slipper socks. The miserable, perished, grumpy monster dissolves revealing a warm, thawed out, calm, happy human. Oh such bliss! My truly indispensable PJs. My hot water bottles; I have quite a selection you know!"

Great Expectations 1, p. 32, 138 words

"At their new school, meanwhile, they quickly make two firm friends: Yasmeen, who is HIV positive, and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon. Her feelings are reciprocated while Tippi, literally, looks the other way. But an attack of flu leaves the twins in failing health, with separation – however dangerous – the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace, employing a loose but readable form of

blank verse that often takes up only a few lines on the page. She narrates directly and honestly until towards the end when emotions finally burst their banks, drowning further plot developments in torrents of raw feeling. Grace also creates one of those 'bucket lists' of things to do in case she dies, one of which includes climbing a tree."

Kingdom 1, p. 258, 159 words

## **Appendix C**

### **Perception Test Layout**

The survey was exported directly through the *LimeSurvey* platform as a printable document.

#### **Punctuation Perception Test**

Hello, and welcome to this short perception test.

Thank you very much for taking the time to participate amid the COVID-19 Crisis. Your time is greatly appreciated.

The purpose of this test is to examine how punctuation works and observe its spontaneous use. Therefore, there is no right or wrong answer in the test you are taking. Any way you punctuate is acceptable and you are encouraged not to overthink your answers.

Target Group: Native speakers of English training to teach English in Irish Secondary Schools.

Please, do not consult any guides or examples, and refrain from searching things up. It is best to complete this survey with minimum distractions.

The Perception Test should take you approximately 15 minutes.

**Ethics approval has been provided by the Phonetics and Speech Laboratory at the School of Linguistic, Speech and Communication Sciences of Trinity College Dublin.**

This survey contributes towards the dissertation of Charikleia Triantafyllidou for the MPhil in Applied Linguistics. By participating in this survey, you agree for your data and answers to be stored and used for research purposes. If you decide against participating, you can withdraw from the survey at any point. Your data will not be stored unless submitted.

The supervisor for this dissertation is Dr. Neasa Ní Chiaráin.

For any questions and concerns, please send an e-mail to [triantac@tcd.ie](mailto:triantac@tcd.ie).

#### **Student Details**

Charikleia Triantafyllidou

MPhil in Applied Linguistics, School of Linguistic, Speech and Communication Sciences, Trinity College Dublin

Student ID: 19331104

Dissertation Title: "Assistive Technologies for Dyslexia: Punctuation and its Interfaces with Speech"

E-mail: triantac@tcd.ie

### **Supervisor Details**

Dr. Neasa Ní Chiaráin

Ussher Assistant Professor, Trinity College Dublin

E-mail: nichiar@tcd.ie

There are 7 questions in this survey.

### **Participant Information**

This survey will not ask you for any personal details. The following questions test your eligibility as a participant.

**The target group for this test is native speakers of English who are under training or qualified to teach English in Irish Secondary Schools.**

What is your level of English? \*

Choose one of the following answers

Please choose **only one** of the following:

- Native speaker
- Native-like fluency
- Bi-lingual fluent speaker
- Fluent speaker
- Intermediate speaker

Are you qualified to teach English at Irish Secondary Schools? \*

Choose one of the following answers

Please choose **only one** of the following:

**Yes (graduate)**

**I am under training/studying**

**I don't know****Text Punctuation**

In this test, you will be provided with five short completely unpunctuated texts.

You are asked to paste the texts in your answer box, punctuate, and capitalise accordingly.

There is no timer and the process you follow is not monitored. Only your final answer will be saved.

As explained in the description of the survey, your answers are not assessed. All answers are acceptable and there is no right or wrong way of punctuating the texts.

Please paste the text below and add punctuation as needed.

dear diary today was a wonderful day I went to Herbert Park to feed the ducks we brought a bag of birdseed with us mum sat on the bench while I divided out the birdseed among the ducks I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened I think that tomorrow I will call in to Aunt Mary in the nursing home as I haven't seen her in a few weeks Mum took a few photos of me feeding the ducks on her phone Id like to show Aunt Mary as she loves Herbert Park lately I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter if I set aside two hours every evening I think that should be enough to complete most of the work I have to stop writing now but I will let you know how it all goes tomorrow \*

Please write your answer here: []

Please paste the text below and add punctuation as needed.

I am here to propose the motion that written homework should be banned let me begin by outlining my three main reasons for this argument firstly written homework is an unnecessary stress that all students must endure after a long day at school which takes from our time to unwind in the afternoon and relax secondly there are no proven statistics to say that written homework is of benefit to a students development and finally this time would be better spent revising as most exams are memory and information related let me start by introducing myself I am Lucy Garvey and I am a third year student at St Martins Community College I strongly believe that using our time in the

evening to watch television listen to music play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health \*

Please write your answer here: []

Please paste the text below and add punctuation as needed.

the story of Mick the six week old Boston Terrier has been warming the hearts of animal lovers around the globe Mick was born with Swimmer Puppy Syndrome this condition meant that he was unable to walk stand or even sit because all four of his legs were splayed out the poor thing could only lie on his stomach thankfully for him the Mia Foundation in Rochester New York took him in it was this little puppys lucky day when the foundation which takes in animals with birth defects that might otherwise be put down agreed to help him and so began his journey to recovery to begin with they propped him up to take the weight off his chest they then placed him in a harness to put his legs which were also taped into the correct resting position then he was taken to swim therapy where he was made to swim in a mini pool to build up the muscles in his legs the results were almost immediate after a few days he was sleeping on his side and after only two weeks he was able to sit up and walk granted he walks like a man with 10 pints on him but its a miracle that hes walking at all this little pup may never win any gold medals at the Crufts dog show but I defy anyone to watch the YouTube video of him stumbling about delighted with life and not have a tear in their eye \*

Please write your answer here: []

Please paste the text below and add punctuation as needed.

so heres the lesson I come home from school on a bitter December evening exhausted mentally drained from irregular Irish verbs algebra reams of French vocabulary and boring history Im physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch time and Im absolutely freezing since it lashed rain as I trudged wearily home minus a jacket cos it's simply not cool to wear one dumping the forty tonnes in the hall I head upstairs whip off the itchy uncomfortable horrible nylon polyester uniform and quickly throw on my soft soothing fleecy PJs and slipper socks the miserable perished grumpy monster dissolves revealing a warm thawed out calm happy human oh such bliss my truly indispensable PJ my hot water bottles I have quite a selection you know \*

Please write your answer here: []

Please paste the text below and add punctuation as needed.

at their new school meanwhile they quickly make two firm friends Yasmeen who is HIV positive and Jon who lives in squalor after his mother had left him this little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon her feelings are reciprocated while Tippi literally looks the other way but an attack of flu leaves the twins in failing health with separation however dangerous the only alternative to certain death for both Sarah Crossan tells this affecting story through the voice of Grace employing a loose but readable form of blank verse that often takes up only a few lines on the page she narrates directly and honestly until towards the end when emotions finally burst their banks drowning further plot developments in torrents of raw feeling Grace also creates one of those bucket lists of things to do in case she dies one of which includes climbing a tree \*

Please write your answer here: []

Thank you very much for completing the Punctuation Perception Test!

By participating in this survey, you agree for your data and answers to be stored and used for research purposes. If you have changed your mind or have any other queries, please send an e-mail to [triantac@tcd.ie](mailto:triantac@tcd.ie).

#### **Text Sources**

- Text 1: Kingdom 1, p. 5
- Text 2: Kingdom 1, p. 51
- Text 3: Great Expectations 1, p. 208
- Text 4: Great Expectations 1, p. 32
- Text 5: Kingdom, p. 258



**Appendix D**  
**Results of the Perception Test**

**Table 14***Perception Test Answers: R9*

Survey response #1	
Response ID	9
Date submitted	2020-06-09 17:56:48
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	I am under training/studying
<b>Text 1:</b>	
<p>Dear diary, today was a wonderful day. I went to Herbert Park to feed the ducks. We brought a bag of birdseed with us, mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call in to Aunt Mary in the nursing home as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone I'd like to show Aunt Mary, as she loves Herbert Park. Lately I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening I think that should be enough to complete most of the work, I have to stop writing now but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that written homework should be banned. Let me begin by outlining my three main reasons for this argument. Firstly, written homework is an unnecessary stress that all students must endure after a long day at school, which takes from our time to unwind in the afternoon and relax. Secondly, there are no proven statistics to say that written homework is of benefit to a students development. Finally this time would be better spent revising, as most exams are memory and information related. Let me start by introducing myself, I am Lucy Garvey and I am a third year student at St Martins Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick, the six week old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome, this condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out. The poor thing could</p>	

only lie on his stomach. Thankfully for him the Mia Foundation in Rochester, New York took him in. It was this little puppys lucky day when the foundation, which takes in animals with birth defects that might otherwise be put down, agreed to help him. And so began his journey to recovery. To begin with they propped him up to take the weight off his chest, they then placed him in a harness to put his legs which were also taped into the correct resting position. Then he was taken to swim therapy where he was made to swim in a mini pool to build up the muscles in his legs. The results were almost immediate. After a few days he was sleeping on his side and after only two weeks he was able to sit up and walk. Granted he walks like a man with 10 pints on him but its a miracle that hes walking at all! This little pup may never win any gold medals at the Crufts dog show but I defy anyone to watch the YouTube video of him stumbling about delighted with life and not have a tear in their eye.

**Text 4:**

So, heres the lesson. I come home from school on a bitter December evening, exhausted , mentally drained from irregular Irish verbs, algebra, reams of French vocabulary and boring history. Im physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch time. Im absolutely freezing since it lashed rain as I trudged wearily home (minus a jacket cos it's simply not cool to wear one) . Dumping the forty tonnes in the hall I head upstairs ,whip off the itchy uncomfortable, horrible ,nylon polyester uniform and quickly throw on my soft soothing fleecy PJs and slipper socks. The miserable, perished ,grumpy monster dissolves revealing a warm ,thawed out, calm ,happy human. Oh such bliss. My truly indispensable PJ, my hot water bottles. I have quite a selection you know!

**Text 5:**

At their new school meanwhile, they quickly make two firm friends. Yasmeen who is HIV positive and Jon who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon. Her feelings are reciprocated, while Tippi literally looks the other way. But an attack of flu leaves the twins in failing health. With separation ,however dangerous, the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace. Employing a loose but readable form of blank verse, that often takes up only a few lines on the page. She narrates directly and honestly until towards the end, when emotions finally burst their banks, drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things to do in case she dies, one of which includes climbing a tree.

**Table 15***Perception Test Answers: R14*

Survey response #2	
Response ID	14
Date submitted	2020-06-11 11:42:49
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	I am under training/studying
<b>Text 1:</b>	
<p>Dear diary, Today was a wonderful day. I went to Herbert Park to feed the ducks. We brought a bag of birdseed with us, mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call in to Aunt Mary in the nursing home as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone, I'd like to show Aunt Mary as she loves Herbert Park. Lately, I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening, I think that should be enough to complete most of the work. I have to stop writing now but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that written homework should be banned. Let me begin by outlining my three main reasons for this argument: firstly, written homework is an unnecessary stress that all students must endure after a long day at school, which takes from our time to unwind in the afternoon and relax; secondly, there are no proven statistics to say that written homework is of benefit to a students development, and finally, this time would be better spent revising as most exams are memory and information related. Let me start by introducing myself, I am Lucy Garvey and I am a third year student at St Martins Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick, the six week old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome. This condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out, the poor thing could only lie on his stomach. Thankfully for him the Mia Foundation, in Rochester New York, took him in. It was this little puppy's lucky day when the foundation, which takes in animals with birth defects that might otherwise be put down, agreed to help him and so began his journey to recovery. To begin</p>	

with; they propped him up to take the weight off his chest; they then placed him in a harness to put his legs, which were also taped into the correct resting position; then he was taken to swim therapy, where he was made to swim in a mini pool to build up the muscles in his legs. The results were almost immediate. After a few days he was sleeping on his side and after only two weeks he was able to sit up and walk, granted he walks like a man with 10 pints on him but its a miracle that hes walking at all. This little pup may never win any gold medals at the Crufts dog show but I defy anyone to watch the YouTube video of him stumbling about delighted with life and not have a tear in their eye.

**Text 4:**

So here's the lesson. I come home from school on a bitter December evening exhausted, mentally drained from irregular Irish verbs, algebra, reams of French vocabulary, and boring history. I'm physically drained from dragging a forty-tonne bag around all day and from the punch up on the pitch at lunch-time, and I'm absolutely freezing. since it lashed rain as I trudged wearily home, minus a jacket cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy, uncomfortable, horrible, nylon-polyester uniform and quickly throw on my soft, soothing, fleecy PJs, and slipper socks. The miserable, perished, grumpy, monster dissolves revealing a warm, thawed-out, calm, happy human. Oh, such bliss, my truly indispensable PJ, and my hot water bottles. I have quite a selection, you know.

**Text 5:**

At their new school, meanwhile, they quickly make two firm friends: Yasmeen, who is HIV positive, and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon. Her feelings are reciprocated, while Tippi, literally looks the other way. But an attack of flu leaves the twins in failing health with separation, however dangerous, the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace, employing a loose but readable form of blank verse that often takes up only a few lines on the page. She narrates directly and honestly until towards the end when emotions finally burst their banks, drowning further plot developments in torrents of raw feeling. Grace also creates one of those "bucket lists" of things to do in case she dies, one of which includes climbing a tree.

**Table 16***Perception Test Answers: R18*

Survey response #3	
Response ID	18
Date submitted	2020-06-12 12:36:23
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	Yes (graduate)
<b>Text 1:</b>	
<p>Dear Diary, Today was a wonderful day. I went to Herbert Park to feed the ducks,.We brought a bag of birdseed with us. Mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call in to Aunt Mary in the nursing home as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone, I'd like to show Aunt Mary as she loves Herbert Park. Lately, I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening I think that should be enough to complete most of the work. I have to stop writing now but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that written homework should be banned. Let me begin by outlining my three main reasons for this argument; firstly, written homework is an unnecessary stress that all students must endure after a long day at school which takes from our time to unwind in the afternoon and relax; secondly, there are no proven statistics to say that written homework is of benefit to a student's development; and finally, this time would be better spent revising as most exams are memory and information related. Let me start by introducing myself, I am Lucy Garvey and I am a third year student at St Martin's Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick, the six week old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome, this condition meant that he was unable to walk stand or even sit because all four of his legs were splayed out, the poor thing could only lie on his stomach. Thankfully for him, the Mia Foundation in Rochester, New York took him in. It was this little puppy's lucky day when the foundation, which takes in animals with birth defects that might otherwise be put down, agreed to help him and so began his journey to recovery. To</p>	

begin with, they propped him up to take the weight off his chest ,they then placed him in a harness to put his legs which were also taped into the correct resting position then he was taken to swim therapy where he was made to swim in a mini pool to build up the muscles in his legs. The results were almost immediate. After a few days he was sleeping on his side and after only two weeks he was able to sit up and walk, granted he walks like a man with ten pints on him, but its a miracle that he's walking at all. This little pup may never win any gold medals at the Crufts dog show but I defy anyone to watch the YouTube video of him stumbling about delighted with life and not have a tear in their eye.

**Text 4:**

So here's the lesson, I come home from school on a bitter December evening exhausted mentally, drained from irregular Irish verbs ,algebra, reams of French vocabulary and boring history. I'm physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch time and I'm absolutely freezing since it lashed rain. As I trudged wearily home, minus a jacket because it's simply not cool to wear one, dumping the forty tonnes in the hall, I head upstairs, whip off the itchy uncomfortable horrible nylon polyester uniform and quickly throw on my soft soothing fleecy PJs and slipper socks, the miserable perished grumpy monster dissolves revealing a warm thawed out calm happy human. Oh such bliss, my truly indispensable PJ my hot water bottles I have quite a selection you know.

**Text 5:**

At their new school, meanwhile they quickly make two firm friends Yasmeen, who is HIV positive and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon, her feelings are reciprocated while Tippi literally looks the other way. But an attack of flu leaves the twins in failing health, with separation, however, dangerous the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace, employing a loose but readable form of blank verse that often takes up only a few lines on the page. She narrates directly and honestly until towards the end when emotions finally burst their banks drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things to do in case she dies one of which includes climbing a tree.

**Table 17***Perception Test Answers: R26*

Survey response #4	
Response ID	26
Date submitted	2020-07-03 13:57:05
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	Yes (graduate)
<b>Text 1:</b>	
<p>Dear Diary, Today was a wonderful day. I went to Herbert Park to feed the ducks. We brought a bag of birdseed with us mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous about the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call into Aunt Mary, in the nursing home, as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone. I'd like to show Aunt Mary, as she loves Herbert Park. Lately, I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening I think that should be enough to complete most of the work. I have to stop writing now but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that written homework should be banned. Let me begin by outlining my three main reasons for this argument. Firstly written homework is unnecessary stress that all students must endure after a long day at school which takes from our time to unwind in the afternoon and relax. Secondly, there are no proven statistics to say that written homework is of benefit to a students development and finally, this time would be better spent revising as most exams are memory and information related. Let me start by introducing myself I am Lucy Garvey and I am a third-year student at St Martin's Community College I strongly believe that using our time in the evening to watch television, listen to music play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick the six weeks old Boston Terrier has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome. This condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out; the poor thing could only lie on his stomach, thankfully for him, the Mia Foundation in Rochester New York took him in it was this little puppy's lucky day, when the foundation which takes in animals with birth defects, that might otherwise be put down, agreed to help him and so began his journey to recovery .to sit up and</p>	

walk. Granted he walks like a man with 10 pints on him but it is a miracle that hes walking at all. This little pup may never win any gold medals at the Crufts dog show but I defy anyone to watch the YouTube video of him stumbling about delighted with life and not have a tear in their eye.

**Text 4:**

So here's the lesson. I came home from school on a bitter December evening, exhausted mentally, drained from irregular Irish verbs, algebra, reams of French vocabulary and boring history. I'm physically drained from dragging a forty-tonne bag around all day and from the punch up on the pitch at lunchtime and I'm absolutely freezing since it lashed rain as I trudged wearily home minus a jacket cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy uncomfortable horrible nylon polyester uniform and quickly throw on my soft soothing fleecy PJs and slipper socks the miserable perished grumpy monster dissolves revealing a warm thawed out, calm happy human. Oh, such bliss, my truly indispensable PJs and my hot water bottles - I have quite a selection you know.

**Text 5:**

At their new school meanwhile, they quickly make two firm friends, Yasmeen who is HIV positive and Jon who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon, Her feelings are reciprocated, while Tippi literally looks the other way, but an attack of flu leaves the twins in failing health. With separation, however dangerous, the only alternative to certain death for both Sarah Crossan tells this affecting story through the voice of Grace employing a loose but readable form of blank verse that often takes up only a few lines on the page. She narrates directly and honestly, until towards the end when emotions finally burst their banks drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things to do in case she dies, one of which includes climbing a tree.



**Table 18***Perception Test Answers: R29*

Survey response #5	
Response ID	29
Date submitted	2020-07-03 14:58:43
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	Yes (graduate)
<b>Text 1:</b>	
<p>Dear Diary, Today was a wonderful day. I went to Herbert Park to feed the ducks. We brought a bag of birdseed with us. Mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call in to Aunt Mary in the nursing home as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone. I'd like to show Aunt Mary as she loves Herbert Park. Lately, I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter, if I set aside two hours every evening I think that should be enough to complete most of the work. I have to stop writing now but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that written homework should be banned. Let me begin by outlining my three main reasons for this argument. Firstly, written homework is an unnecessary stress that all students must endure after a long day at school which takes from our time to unwind in the afternoon and relax. Secondly, there are no proven statistics to say that written homework is of benefit to a students development and finally this time would be better spent revising, as most exams are memory and information related. Let me start by introducing myself. I am Lucy Garvey and I am a third year student at St. Martin's Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick, the six week old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome. This condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out. The poor thing could only lie on his stomach. Thankfully, for him, the Mia Foundation in Rochester, New York, took him in. It was this little puppy's lucky day when the foundation, which takes in animals with birth defects that might otherwise be put down, agreed to help him and so began his journey to recovery. To</p>	

begin with, they propped him up to take the weight off his chest, they then placed him in a harness to put his legs, which were also taped, into the correct resting position, then he was taken to swim therapy where he was made to swim in a mini pool to build up the muscles in his legs. The results were almost immediate, after a few days he was sleeping on his side and after only two weeks he was able to sit up and walk, granted he walks like a man with 10 pints on him but it's a miracle that he's walking at all. This little pup may never win any gold medals at the Crufts dog show but I defy anyone to watch the YouTube video of him stumbling about, delighted with life, and not have a tear in their eye.

**Text 4:**

So here's the lesson, I come home from school, on a bitter December evening, exhausted, mentally drained from irregular Irish verbs, algebra, reams of French vocabulary and boring history. I'm physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch time and I'm absolutely freezing, since it lashed rain as I trudged wearily home minus a jacket cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy, uncomfortable, horrible, nylon-polyester uniform and quickly throw on my soft soothing fleecy PJs and slipper socks. The miserable perished grumpy monster dissolves revealing a warm, thawed out, calm, happy human. Oh, such bliss! My truly indispensable PJ, my hot water bottles, I have quite a selection, you know!

**Text 5:**

At their new school, meanwhile, they quickly make two firm friends, Yasmeen, who is HIV positive and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon. Her feelings are reciprocated while Tippi literally looks the other way but an attack of flu leaves the twins in failing health, with separation, however dangerous, the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace, employing a loose but readable form of blank verse that often takes up only a few lines on the page. She narrates directly and honestly until towards the end, when emotions finally burst their banks, drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things to do in case she dies, one of which includes climbing a tree.

**Table 19***Perception Test Answers: R33*

Survey response #6	
Response ID	33
Date submitted	2020-07-03 22:36:02
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	Yes (graduate)
<b>Text 1:</b>	
<p>Dear Diary. Today was a wonderful day. I went to Herbert Park to feed the ducks. We brought a bag of birdseed with us. Mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far, to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you, with their beaks, if they feel threatened. I think that, tomorrow, I will call in to Aunt Mary, in the nursing home, as I haven't seen her in a few weeks. Mum took a few photos, of me feeding the ducks, on her phone. Id like to show Aunt Mary as she loves Herbert Park. Lately, I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening, I think that should be enough to complete most of the work. I have to stop writing now but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that 'Written homework should be banned'. Let me begin by outlining my three main reasons for this argument: Firstly, written homework is an unnecessary stress that all students must endure, after a long day at school, which takes from our time to unwind in the afternoon and relax. Secondly, there are no proven statistics to say that written homework is of benefit to a student's development and, finally, this time would be better spent revising as most exams are memory and information-related. Let me start by introducing myself. I am Lucy Garvey and I am a Third Year student at St Martin's Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick, the six-week old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome. This condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out. The poor thing could only lie on his stomach. Thankfully, for him, the Mia Foundation in Rochester, New York took him in. It was this little puppy's lucky day when the foundation, which takes in animals with birth defects that might otherwise be put down, agreed to help him and so began his journey to recovery. To</p>	

begin with, they propped him up to take the weight off his chest. They then placed him in a harness to put his legs, which were also taped, into the correct resting position. Then he was taken to swim therapy, where he was made to swim in a mini pool, to build up the muscles in his legs. The results were almost immediate. After a few days he was sleeping on his side and after only two weeks he was able to sit up and walk. Granted, he walks like a man with 10 pints on him but it's a miracle that he's walking at all. This little pup may never win any gold medals at the Crufts' Dog Show but I defy anyone to watch the YouTube video of him stumbling about, delighted with life, and not have a tear in their eye.

**Text 4:**

So here's the lesson: I come home from school on a bitter, December evening, exhausted, mentally drained from irregular Irish verbs, Algebra, reams of French vocabulary and boring History. I'm physically drained from dragging a forty-tonne bag around all day and from the punch up on the pitch at lunch time and I'm absolutely freezing since it lashed rain as I trudged wearily home, minus a jacket cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy, uncomfortable, horrible, nylon-polyester uniform and quickly throw on my soft, soothing, fleecy PJs and slipper socks. The miserable, perished, grumpy monster dissolves revealing a warm, thawed- out, calm, happy human. Oh, such bliss! My truly indispensable PJ, my hot water bottles; I have quite a selection you know!

**Text 5:**

At their new school, meanwhile, they quickly make two firm friends: Yasmeen, who is HIV positive and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon. Her feelings are reciprocated, while Tippi literally looks the other way. But an attack of flu leaves the twins in failing health with separation, however dangerous, the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace, employing a loose, but readable, form of blank verse that often takes up only a few lines on the page. She narrates directly and honestly until towards the end when emotions finally burst their banks, drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things to do in case she dies; one of which includes climbing a tree.

**Table 20***Perception Test Answers: R34*

Survey response #7	
Response ID	34
Date submitted	2020-07-03 17:49:33
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	Yes (graduate)
<b>Text 1:</b>	
<p>Dear Diary, Today was a wonderful day; I went to Herbert Park to feed the ducks! We brought a bag of birdseed with us. Mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call in to Aunt Mary in the nursing home as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone; I'd like to show Aunt Mary as she loves Herbert Park. Lately, I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening, I think that should be enough to complete most of the work. I have to stop writing now, but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that written homework should be banned! Let me begin by outlining my three main reasons for this argument. Firstly, written homework is an unnecessary stress that all students must endure after a long day at school, which takes from our time to unwind in the afternoon and relax. Secondly there are no proven statistics to say that written homework is of benefit to a student's development, and finally this time would be better spent revising as most exams are memory and information-related. Let me start by introducing myself. I am Lucy Garvey and I am a third year student at St Martin's Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick, the six-week-old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome; this condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out. The poor thing could only lie on his stomach. Thankfully for him, the Mia Foundation in Rochester, New York took him in. It was this little puppy's lucky day when the foundation, which takes in animals with birth defects that might otherwise be put down, agreed to help him and so began his journey to recovery. To</p>	

begin with they propped him up to take the weight off his chest, they then placed him in a harness to put his legs, which were also taped into the correct resting position. Then he was taken to swim therapy where he was made to swim in a mini pool to build up the muscles in his legs. The results were almost immediate. After a few days he was sleeping on his side and after only two weeks he was able to sit up and walk. Granted, he walks like a man with 10 pints on him, but it's a miracle that he's walking at all! This little pup may never win any gold medals at the Crufts dog show but I defy anyone to watch the YouTube video of him stumbling about, delighted with life, and not have a tear in their eye.

**Text 4:**

So, here's the lesson. I come home from school on a bitter December evening, exhausted, mentally drained from irregular Irish verbs, algebra, reams of French vocabulary and boring history. I'm physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch time, and I'm absolutely freezing since it lashed rain as I trudged wearily home minus a jacket, cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy, uncomfortable, horrible, nylon-polyester uniform and quickly throw on my soft, soothing, fleecy PJs and slipper socks. The miserable, perished, grumpy, monster dissolves revealing a warm, thawed-out calm, happy human. Oh, such bliss! My truly indispensable PJ; my hot water bottles! I have quite a selection you know.

**Text 5:**

At their new school meanwhile, they quickly make two firm friends - Yasmeen, who is HIV positive and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon. Her feelings are reciprocated, while Tippi literally looks the other way, but an attack of flu leaves the twins in failing health, with separation, however dangerous, the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace, employing a loose but readable form of blank verse that often takes up only a few lines on the page. She narrates directly and honestly until towards the end when emotions finally burst their banks, drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things-to-do in case she dies, one of which includes climbing a tree.

**Table 21***Perception Test Answers: R37*

Survey response #8	
Response ID	37
Date submitted	2020-07-03 20:52:18
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	Yes (graduate)
<b>Text 1:</b>	
<p>Dear Diary, Today was a wonderful day; I went to Herbert Park to feed the ducks. We brought a bag of birdseed with us. Mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow, I will call in to Aunt Mary in the nursing home as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone. I'd like to show Aunt Mary as she loves Herbert Park. Lately, I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening, I think that should be enough to complete most of the work I have to stop writing now but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that "Written homework should be banned". Let me begin by outlining my three main reasons for this argument. Firstly, written homework is an unnecessary stress that all students must endure after a long day at school which takes from our time to unwind in the afternoon and relax. Secondly, there are no proven statistics to say that written homework is of benefit to a student's development and, finally, this time would be better spent revising as most exams are memory and information related. Let me start by introducing myself; I am Lucy Garvey and I am a third year student at St Martin's Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick, the six week old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome; this condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out. The poor thing could only lie on his stomach. Thankfully for him, the Mia Foundation in Rochester, New York took him in. It was this little puppy's lucky day when the foundation, which takes in animals with birth defects that might otherwise be put down, agreed to help him and so began his journey to recovery. To</p>	

begin with, they propped him up to take the weight off his chest. They then placed him in a harness to put his legs, which were also taped into the correct resting position. Then he was taken to swim therapy where he was made to swim in a mini pool to build up the muscles in his legs. The results were almost immediate. After a few days, he was sleeping on his side and after only two weeks, he was able to sit up and walk. Granted, he walks like a man with 10 pints on him but it's a miracle that he's walking at all. This little pup may never win any gold medals at the Crufts dog show but I defy anyone to watch the YouTube video of him stumbling about delighted with life and not have a tear in his/her eye.

**Text 4:**

So here's the lesson. I come home from school on a bitter December evening exhausted mentally drained from irregular Irish verbs, algebra, reams of French vocabulary and boring history. I'm physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch time and I'm absolutely freezing since it lashed rain as I trudged wearily home minus a jacket cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy, uncomfortable, horrible nylon polyester uniform and quickly throw on my soft soothing fleecy PJs and slipper socks. The miserable, perished, grumpy monster dissolves revealing a warm, thawed out, calm, happy human. Oh, such bliss! My truly indispensable PJ! My hot water bottles! I have quite a selection, you know!

**Text 5:**

At their new school, meanwhile, they quickly make two firm friends: Yasmeen, who is HIV positive and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees and Grace soon falls heavily for Jon. Her feelings are reciprocated while Tippi literally looks the other way but an attack of flu leaves the twins in failing health. With separation, however, dangerous, the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace, employing a loose but readable form of blank verse that often takes up only a few lines on the page. She narrates directly and honestly until, towards the end, when emotions finally burst their banks drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things to do in case she dies, one of which includes climbing a tree.



**Table 22***Perception Test Answers: R40*

Survey response #9	
Response ID	40
Date submitted	2020-07-03 22:41:45
What is your level of English?	Native speaker
Are you qualified to teach English at Irish Secondary Schools?	Yes (graduate)
<b>Text 1:</b>	
<p>Dear diary, Today was a wonderful day. I went to Herbert Park to feed the ducks; we brought a bag of birdseed with us. Mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call in to Aunt Mary in the nursing home, as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone. I'd like to show Aunt Mary as she loves Herbert Park. Lately I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening, I think that should be enough to complete most of the work. I have to stop writing now but I will let you know how it all goes tomorrow.</p>	
<b>Text 2:</b>	
<p>I am here to propose the motion that written homework should be banned. Let me begin by outlining my three main reasons for this argument. Firstly, written homework is an unnecessary stress that all students must endure after a long day at school, which takes from our time to unwind in the afternoon and relax. Secondly, there are no proven statistics to say that written homework is of benefit to a student's development. And finally, this time would be better spent revising as most exams are memory- and information-related. Let me start by introducing myself: I am Lucy Garvey and I am a third year student at St Martin's Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<b>Text 3:</b>	
<p>The story of Mick, the six week old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome. This condition meant that he was unable to walk, stand or even sit because all four of his legs were splayed out. The poor thing could only lie on his stomach. Thankfully for him, the Mia Foundation in Rochester, New York took him in. It was this little puppy's lucky day when the foundation, which takes in animals with birth defects</p>	

that might otherwise be put down, agreed to help him and so began his journey to recovery. To begin with, they propped him up to take the weight off his chest. They then placed him in a harness to put his legs, which were also taped, into the correct resting position. Then he was taken to swim therapy, where he was made to swim in a mini pool to build up the muscles in his legs. The results were almost immediate; after a few days he was sleeping on his side and after only two weeks he was able to sit up and walk. Granted he walks like a man with 10 pints on him, but it's a miracle that he's walking at all. This little pup may never win any gold medals at the Crufts' dog show, but I defy anyone to watch the YouTube video of him stumbling about delighted with life and not have a tear in their eye.

**Text 4:**

So here's the lesson: I come home from school on a bitter December evening, exhausted, mentally drained from irregular Irish verbs, algebra, reams of French vocabulary and boring history. I'm physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch time. And I'm absolutely freezing since it lashed rain as I trudged wearily home minus a jacket, cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy uncomfortable horrible nylon polyester uniform and quickly throw on my soft soothing fleecy PJs and slipper socks. The miserable perished grumpy monster dissolves, revealing a warm thawed out calm happy human. Oh such bliss: my truly indispensable PJs, my hot water bottles... I have quite a selection, you know.

**Text 5:**

At their new school, meanwhile, they quickly make two firm friends: Yasmeen, who is HIV positive, and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees, and Grace soon falls heavily for Jon. Her feelings are reciprocated, while Tippi literally looks the other way. But an attack of flu leaves the twins in failing health. With separation, however dangerous, the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace, employing a loose but readable form of blank verse that often takes up only a few lines on the page. She narrates directly and honestly until towards the end, when emotions finally burst their banks, drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things to do in case she dies, one of which includes climbing a tree.

**Table 23***Perception Test Answers: R48*

Survey response #10	
Response ID	48
Date submitted	2020-07-05 20:42:32
What is your level of English?	Fluent speaker
Are you qualified to teach English at Irish Secondary Schools?	Yes (graduate)
<p>Dear Diary, today was a wonderful day. I went to Herbert Park to feed the ducks. We brought a bag of birdseed with us. Mum sat on the bench while I divided out the birdseed among the ducks. I had to fling a few handfuls of it really far to reach the shy ducks that didn't paddle up to me. I was nervous of the swans as Mum said that they can nip you with their beaks if they feel threatened. I think that tomorrow I will call in to Aunt Mary in the nursing home as I haven't seen her in a few weeks. Mum took a few photos of me feeding the ducks on her phone. I'd like to show Aunt Mary as she loves Herbert Park. Lately I feel as though the time is flying by and I won't get all of my school projects finished in time for Easter. If I set aside two hours every evening I think that should be enough to complete most of the work. I have to stop writing now, but I will let you know how it all goes tomorrow.</p>	
<p>I am here to propose the motion that written homework should be banned. Let me begin by outlining my three main reasons for this argument. Firstly, written homework is an unnecessary stress that all students must endure after a long day at school, which takes from our time to unwind in the afternoon and relax. Secondly, there are no proven statistics to say that written homework is of benefit to a student's development and finally, this time would be better spent revising as most exams are memory and information related. Let me start by introducing myself. I am Lucy Garvey and I am a third year student at St Martin's Community College. I strongly believe that using our time in the evening to watch television, listen to music, play sport or socialise with friends is far more beneficial to the development of our social skills and protection of our mental health.</p>	
<p>The story of Mick, the six week old Boston Terrier, has been warming the hearts of animal lovers around the globe. Mick was born with Swimmer Puppy Syndrome. This condition meant that he was unable to walk, stand or even sit, because all four of his legs were splayed out. The poor thing could only lie on his stomach. Thankfully for him, the Mia Foundation in Rochester New York took him in. It was this little puppy's lucky day when the foundation which takes in animals with birth defects that might otherwise be put down agreed to help him, and so began his journey to recovery. To begin with, they propped him up to take the weight off his chest. They then placed him in a harness to put his legs, which were also taped, into the correct resting position. Then, he was taken to Swim Therapy where he was made to swim in a mini pool to build up the muscles in his legs. The results</p>	

were almost immediate. After a few days he was sleeping on his side, and after only two weeks he was able to sit up and walk. Granted, he walks like a man with 10 pints on him, but it's a miracle that he's walking at all. This little pup may never win any gold medals at the Cruft's Dog Show, but I defy anyone to watch the YouTube video of him stumbling about delighted with life and not have a tear in their eye.

So here's the lesson: I come home from school on a bitter December evening exhausted, mentally drained from irregular Irish verbs, algebra, reams of French vocabulary and boring history. I'm physically drained from dragging a forty tonne bag around all day and from the punch up on the pitch at lunch time, and I'm absolutely freezing since it lashed rain as I trudged wearily home minus a jacket 'cos it's simply not cool to wear one. Dumping the forty tonnes in the hall, I head upstairs, whip off the itchy uncomfortable horrible nylon polyester uniform and quickly throw on my soft, soothing, fleecy PJs and slipper socks. The miserable, perished, grumpy monster dissolves, revealing a warm, thawed out, calm, happy human. Oh such bliss! My truly indispensable PJ, my hot water bottles - I have quite a selection you know.

At their new school, meanwhile, they quickly make two firm friends - Yasmeen, who is HIV positive, and Jon, who lives in squalor after his mother had left him. This little gang of outsiders go on forbidden smoking and drinking sprees, and Grace soon falls heavily for Jon. Her feelings are reciprocated, while Tippi literally looks the other way, but an attack of flu leaves the twins in failing health with separation, however dangerous, the only alternative to certain death for both. Sarah Crossan tells this affecting story through the voice of Grace. Employing a loose but readable form of blank verse, that often takes up only a few lines on the page, she narrates directly and honestly until towards the end when emotions finally burst their banks drowning further plot developments in torrents of raw feeling. Grace also creates one of those bucket lists of things to do in case she dies, one of which includes climbing a tree.

## Appendix E

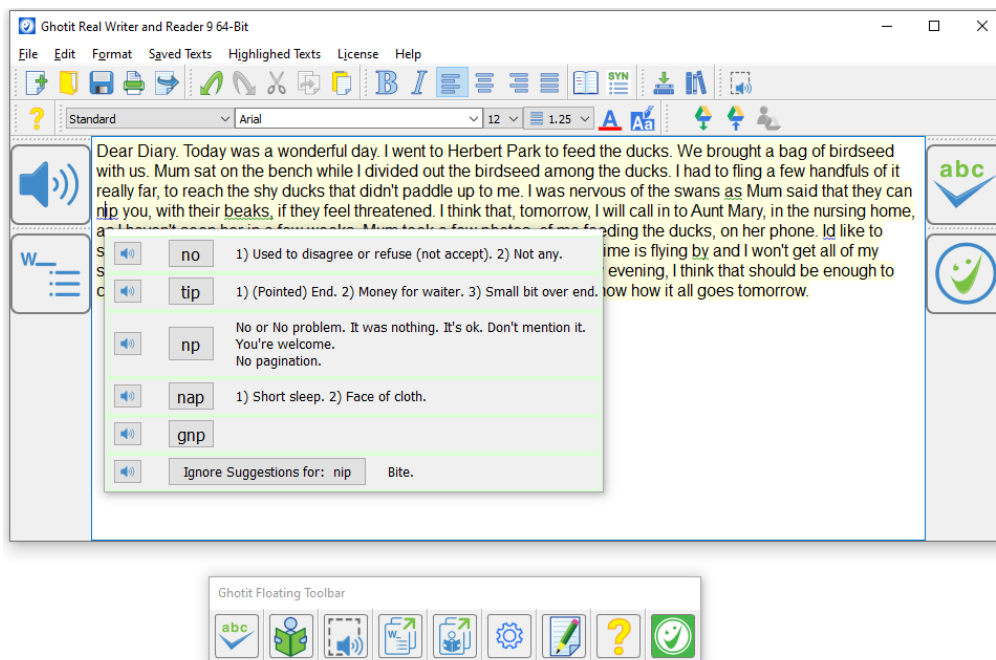
### Dyslexia Software

#### Screenshots from *Ghotit*

R33 from Text 1 of the Perception Test corrected on Ghotit. The software suggests the deletion and addition of some commas, the addition of an apostrophe, and offers definitions and alternative words. The floating toolbar offers extra options and settings.

**Figure 23**

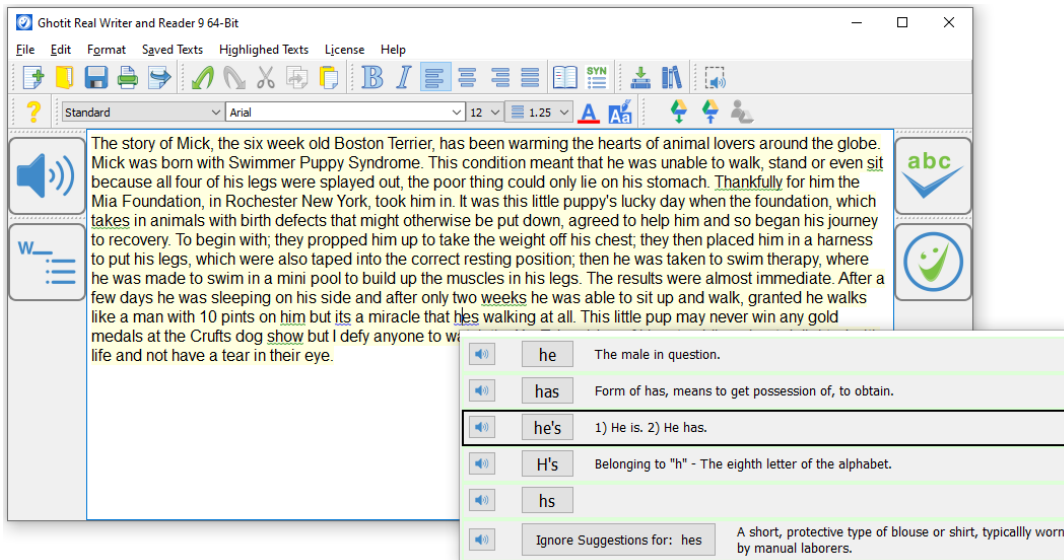
#### *Ghotit Corrections and Definitions*



R14 from Text 3 of the Perception Test corrected on Ghotit. The software suggests the addition of commas and apostrophes.

**Figure 24**

### *Ghotit Corrections*



Colour and TTS options in *Ghotit*.

**Figure 25**

### *Ghotit Colour Options*

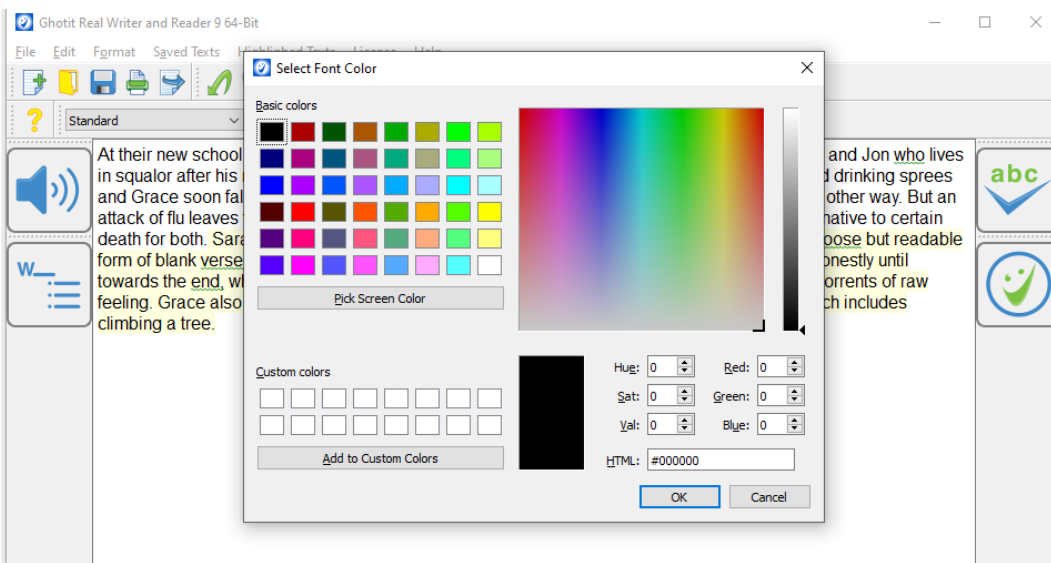


Figure 26

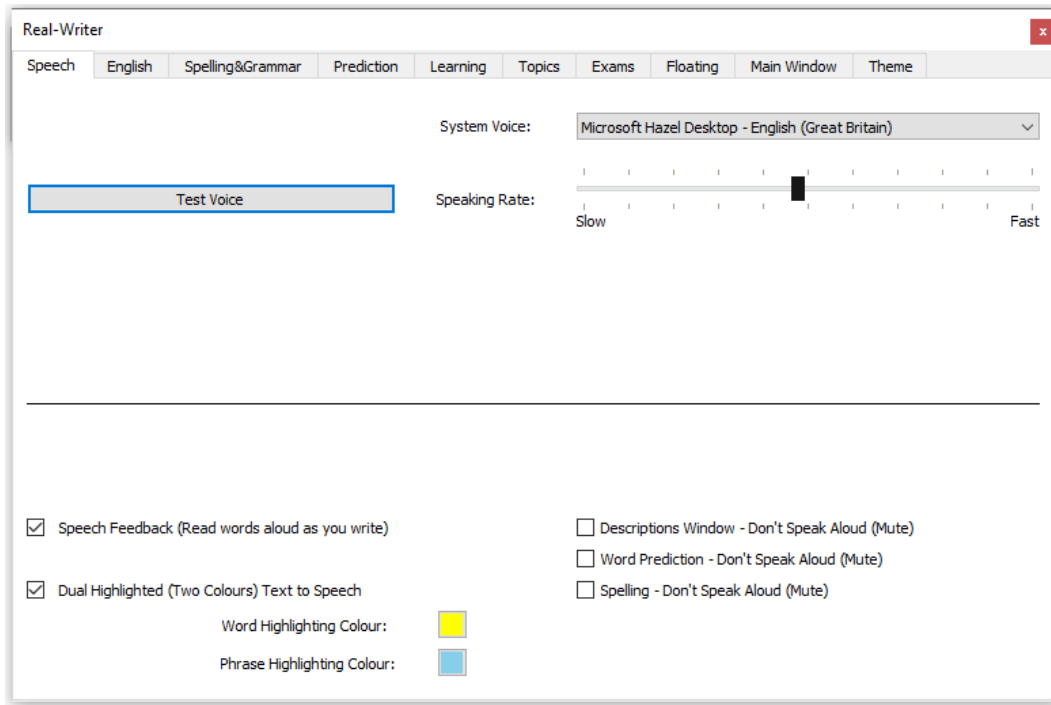
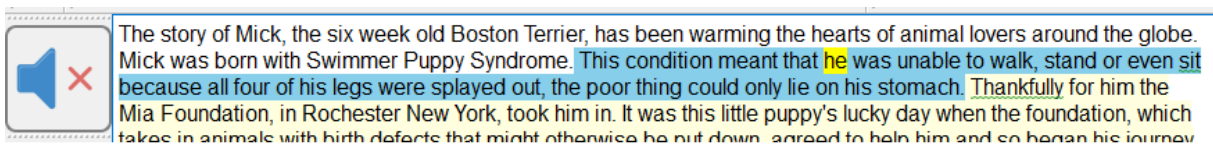
*Ghotit TTS Options*

Figure 27

*Chunking and Highlighting in the Ghotit TTS*

## Screenshots from *Dyslex.ie*

Figure 28

*The Dyslex.ie Questionnaire: Personal Details and Reading Issues*

### First, some questions

If you have the time, take a few minutes to answer these questions so that we can better improve Dyslex.ie for you.

How challenging is your dyslexia?

How does dyslexia affect you?

Are you a student?

What age group do you fit in ?

May we get your email for research purposes?

Question 3.

### Do you see some letters as upside down?

Question 7.

### Do your eyes skip lines when you read?

Question 8.

### Do you often find the text size too small?



**Figure 29***The Dyslex.ie Questionnaire: Font and Colour Preferences*

Question 9.

**Which font do you prefer?**

Penguins eat krill, fish, squid, and other small animals from the ocean, which they catch. They are at home in the ocean. They come up on the land or ice to lay their eggs and raise the chicks. They don't eat there because they live in places where the land has no food for them. In most species the birds all nest together in a huge group, called a rookery. They usually make nests on the ground with rocks or mud.

Choose this

Penguins eat krill, fish, squid, and other small animals from the ocean, which they catch. They are at home in the ocean. They come up on the land or ice to lay their eggs and raise the chicks. They don't eat there because they live in places where the land has no food for them. In most species the birds all nest together in a huge group, called a rookery. They usually make nests on the ground with rocks or mud.

Choose this

Question 10.

**Which color do you prefer?**

Penguins eat krill, fish, squid, and other small animals from the ocean, which they catch. They are at home in the ocean. They come up on the land or ice to lay their eggs and raise the chicks. They don't eat there because they live in places where the land has no food for them. In most species the birds all nest together in a huge group, called a rookery. They usually make nests on the ground with rocks or mud.

Choose this

Penguins eat krill, fish, squid, and other small animals from the ocean, which they catch. They are at home in the ocean. They come up on the land or ice to lay their eggs and raise the chicks. They don't eat there because they live in places where the land has no food for them. In most species the birds all nest together in a huge group, called a rookery. They usually make nests on the ground with rocks or mud.

Choose this

## Screenshots from *Dyslexia.ai*

Figure 30

### *The Dyslexia.ai Registration*

**Dyslexia** Next → **Age** Next →

Please describe yourself

Let us know how old you are!

I have been diagnosed with Dyslexia

I have not been diagnosed with Dyslexia, but need help to improve my reading & spelling

13 years old!

18	Απρ	2006
19	Μαΐ	2007
20	Ιουν	2008

Figure 31

### *The Dyslexia.ai Interface: Instructions, Activities, and the OCR Feature*

To see results, be consistent, and try using the app for 10 to 20 minutes a day, a few days a week! The app adapts to your reading level, becoming more challenging over time.

the

+ 6 XP

The

1 / 10 NEXT

Results

Words Sentences  Paragraphs

Currently, Dyslexie is only available as a browser extension. It cannot work with text processors or online shared documents, such as Google Docs and, therefore, it cannot be used to proof-read texts. Cross-platform compatibility requires more development, so this feature might be added in the future. Regarding research, the Dyslexie website states that "the software features have been informed by best practice and guided by an ongoing review of international peer-reviewed research and primary research in