



Inner and outer voices: L2 readers' experiences of silent reading, reading aloud and reading-while-listening

Ellen Mok

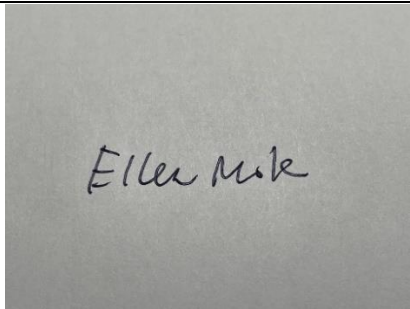
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Content Page

Abstract	7
List of Abbreviations	8
List of Tables	8
1. Introduction	9
2. Literature Review	11
2.1 <i>Reading as an interactive process</i>	11
2.1.1 Overview of reading and its processes.....	11
2.1.2 The interactive compensatory model.....	11
2.2 <i>Working memory and Cognitive load</i>	12
2.2.1 Working memory	12
2.2.2 Cognitive load theory	13
2.3 <i>Role of phonology in reading</i>	14
2.3.1 Phonological loop as a fundamental mechanism	14
2.3.2 Role in word recognition	15
2.3.3 Prosody.....	17
2.4 <i>Reading silently, reading aloud, reading-while-listening</i>	18
2.4.1 Reading silently (RS) and inner speech.....	18
2.4.2 Reading aloud (RA)	20
2.4.3 Reading-while-listening (RWL)	21
2.5 <i>Summary</i>	23
2.6 <i>Research Questions</i>	24
3. Methods	25
3.1. <i>Design</i>	25
3.2. <i>Participants</i>	25
3.3. <i>Materials and measures</i>	26
3.3.1. Reading materials.....	26
3.3.2 Audio recording.....	27
3.3.3 Self-reported ratings.....	27
3.3.4 Oral reading descriptors.....	27
3.4. <i>Pilots for materials and interviews</i>	27

3.5. Procedures.....	28
3.6. Data analysis	29
3.6.1 Comprehension scores.....	29
3.6.2 Oral reading.....	29
3.6.3 Coding	29
3.7. Ethics.....	30
4. Findings.....	32
4.1 Research Questions 1 & 2.....	32
4.2 Research Question 3.....	34
4.3 Research Question 4.....	36
4.3.1 Research Question 4a.....	36
4.3.2 Research Questions 4b & c.....	39
5. Discussion	47
5.1 Difficulties in decoding during RA hampered comprehension	47
5.2 Interplay of inner voice, working memory, and dual-route word recognition during RS.....	49
5.3 RWL: an aid for decoding, or a source of interference due to split attention?.....	52
6. Conclusion	56
6.1 Limitations	56
6.2 Concluding remarks and implications for teaching and learning	56
Reference list	58
Appendices	69
Appendix A Language Background Questionnaire	69
Appendix B Summary of the linguistic profiles of reading materials.....	71
Appendix C Reading texts, questions and marking schemes	72
Appendix D Oral reading rating descriptors	81
Appendix E Interview questions	82
Appendix F A sample of interview transcripts	84
Appendix G Codes Table	90
Appendix H Ethics approval	97

Appendix I Participant information sheet and consent form98

Appendix J Oral reading summary102

Abstract

This qualitative study, which adopts an exploratory, case-study approach, aims to explore L2 learners' reading comprehension and their experiences in three reading conditions – reading silently (RS), reading aloud (RA), and reading-while-listening (RWL). It also aims to investigate the role of phonology in L2 reading through these different conditions. Five international students studying in a UK university participated in reading sessions and follow-up interviews. Their comprehension results in all three reading conditions, oral reading in RA, and perceived affordances and challenges for each of these conditions were analysed. Results indicate very different individual patterns among participants in both their comprehension and perceptions. While some performed best in RWL and liked it most, others found it the most difficult condition to read. There are also similarities. They all reported hearing an inner voice in RS. Their comprehension generally suffered in RA, and they experienced difficulties in phonological decoding to a different extent in this condition. Implications for these similarities and differences were discussed. These suggest that individual differences in L2 decoding skills and reading pace are likely the causes for their different experiences, and reveal a significant role of phonology in all three reading conditions.

List of Abbreviations

ESL/EFL: English as a Second Language/English as a Foreign Language

L1: First language

L2: Second language

LTM: Long-term memory

ORF: Oral reading fluency

RA: Reading aloud

RS: Reading silently

RWL: Reading-while-listening

WM: Working memory

Wpm: Word per minute

List of Tables

Table 1 Summary of participants' comprehension scores and perceptions of reading in each condition (p.32)

Table 2 Oral reading performance (p.34)

Table 3 Frequency level of words which are commonly mispronounced or repeated (p.34)

1. Introduction

Reading ability has been considered essential for academic success (Grabe & Stoller, 2020). Reading is thought to be one of the best ways for second language learners to acquire input to develop L2 proficiency (Day & Bamford, 1998; Krashen, 1995). However, unlike L1 readers, many L2 readers learn to read at almost the same time as they learn the oral language. Therefore, they have much less L2 linguistic knowledge such as vocabulary and grammar to draw on when they read. They also have much less exposure to print in L2 than L1 students. These, among other reasons, often cause difficulties in L2 reading (Jiang et al., 2020). The problems may persist even when their levels of proficiency and education increase. According to Segalowitz (1986), even for highly skilled or fluent bilinguals who can use L2 vocabulary and grammar accurately and rapidly, they are generally less skilled when reading in a second language. This will affect their work efficiency and put them at a disadvantage at work or study, compared with their L1 counterparts.

This can be a particularly serious challenge for university students, who often need to read a large number of academic papers. According to a large-scale survey in the United States, on average university departments expect students to complete 38 – 85 pages of reading per week in the first course of their selected major (Anderson, 2015). Understanding academic texts was ranked as the second most difficult study skill by international students in a Canadian university. Although they did not usually have problems understanding the content, they often mentioned that they read slowly and found it difficult to cope with the high reading demand (Cheng et al., 2004). Asian EFL university students were also found to read English texts slowly or very slowly compared with their native speaker peers, and even slower than L1 8th grade students (Jackson et al., 1999). ESL postgraduate students in Australian universities reported that academic vocabulary and discipline-specific terminology were sources of difficulties which slow down their reading (Burke & Wyatt-Smith, 1996; Phakiti & Li, 2011). If students read slowly or laboriously in English, their studies in their major subjects could be affected.

There seems to be little guidance on reading for these L2 tertiary students. In my own observations and experience, it is often assumed that reading means reading silently. However, other modes of reading are possible. Reading-while-listening has recently attracted attention in L2 research as a way to facilitate reading (Chang & Millett, 2015; Singh & Alexander, 2022; Woodall, 2010). With the advance of technology, a lot of texts are now read online. Faculties also often expect their students to read digitally (Anderson, 2015). E-book readers, internet browsers, or mobile devices often include the audio or text-to-speech function, enabling readers to read and listen at the same time. Going back in time, there was a long period when reading aloud was the norm (Pearson & Goodin,

2010). Today it is still a rather common classroom practice adopted by teachers (Machado & Luchini, 2018). However, academic papers often contain technical vocabulary, proper nouns, and other low-frequency words and these may pose difficulties to readers, not only when reading aloud but also when reading silently. While silent reading does not involve sound, it is nonetheless a common phenomenon that readers project an inner voice during reading (Perrone-Bertolotti et al., 2014). They mentally hear what they read.

These three reading conditions, reading silently, reading aloud, reading-while-listening, differ in how phonology is manifested, whether it is overtly present or absent, and whether it is self-generated (i.e., by the reader her or himself) or provided externally. Self-generated phonology may not have good quality in terms of either accuracy or fluency. It is unclear the extent to which it is necessary or helpful for comprehension.

Literature indicates that phonology plays a significant role in reading and is related to reading difficulties in L2. L2 readers' slower reading rate could be in part attributed to their weaker phonological skills (Segalowitz, 1986). Even for advanced ESL students studying graduate programmes, phonological processing skills contribute importantly to their English reading comprehension (Nassaji & Geva, 1999). Holm and Dodd (1996) found that Hong Kong university students have weak phonological awareness and had difficulty analysing nonwords. It is suggested that they may encounter difficulties with unfamiliar words during reading when they transit to universities which adopt English as the medium of instruction.

As such, it will be useful to investigate L2 learners' comprehension of written text in three modalities, reading silently, reading aloud, and reading-while-listening. It will also be interesting to explore the role of phonology in these different conditions and its impact on comprehension. It is hoped that this study will shed light on the relative effectiveness of different reading modes that L2 readers can use to facilitate their comprehension.

2. Literature Review

2.1 Reading as an interactive process

2.1.1 Overview of reading and its processes

Reading comprehension “occurs when the reader extracts and integrates various information from the text and combines it with what is already known” (Koda, 2005, p.4). Reading processes are commonly described as lower-level or higher-level. Lower-level processes are text-based. A central process is recognising words, which occurs when visual input of the word activates orthographic, phonological, semantic and syntactic information of entries in the lexicon. Its constituent processes include making use of orthographic information such as letters or word shape, and phonological information i.e. knowledge about the structure of sound in one’s language (Nassaji, 2014). Another example is syntactic parsing, which refers to how one accesses meaning by extracting syntactic information such as grammatical categories of words and word ordering (Grabe, 2009). Higher-level processes involve integrating text-based information and reader-based knowledge to arrive at an overall understanding (Nassaji, 2014). Readers bring their own interpretation to the mental representation of the text message (Snowling & Hulme, 2005), informed by their background knowledge, experiences, and associated inferences. While developing their interpretation, additional higher-level processes are performed by the reader, such as evaluating whether comprehension is successful, applying reading strategies to assist or restore comprehension (Grabe, 2009).

Top-down, bottom-up, and interactive models of reading are some fundamental models to capture these many processes in comprehension. According to bottom-up models, readers decode the text letter by letter, word by word, then sentence by sentence (Gough, 1972). In contrast, top-down models depict that readers start with a set of expectations of the text meaning in mind, and they sample words through the text to predict and confirm their expectations (Goodman, 1967). It has been widely accepted that reading is an interactive process, during which both top-down and bottom-up processes are involved, and there is interaction between the two (Rumelhart, 2022).

2.1.2 The interactive compensatory model

Stanovich (1980) proposes that all reading processes support each other interactively in a sense that when one process is slowed down, other processes or knowledge sources will be drawn upon more heavily to compensate the less effective one so that comprehension can continue. This is based on the interactive model of reading, and that several knowledge sources can be used simultaneously in reading (Rumelhart, 2022). A process at any level, higher or lower, can compensate for a less effective one at another level.

Two types of contextual processes are identified by Stanovich (1980). The first one is the comprehension processes which facilitate knowledge structure construction when reading a text, such as relating new information to existing information. The second type involves using the context to facilitate ongoing word recognition while reading. Both take cognitive capacity. Since lower-level word recognition process in poorer readers is slow, higher-level contextual prediction is used to aid the process. However, this comes with a cost. Drawing on context requires attentional resources. The same resources could have been used for the more important comprehension, knowledge construction process. Since less cognitive capacity is available, their comprehension is affected, even though this process assists their word recognition. Fluent readers, on the other hand, do not rely on contextual clues for word recognition, and consequently have more cognitive resources for comprehension.

Stanovich's theory highlights the importance of automaticity. According to LaBerge and Samuels (1974), reading is a complex skill which requires coordination of multiple processes within a short time frame. Attention capacity in the memory system will be overloaded if these processes all need attention. Our brain can only direct attention to one thing at a time; however, if a subskill has become automatic, it can process without attention, and we can process many tasks simultaneously as long as no more than one draws attention. Both theories posit that when lower-level processes such as word recognition becomes automatic, cognitive capacity can be freed up for higher-level comprehension processes.

2.2 Working memory and Cognitive load

2.2.1 Working memory

Working memory (WM) refers to the temporary storage system that maintains, manipulates, and processes information during real-time complex cognitive activities (Mitchell et al., 2019). According to Baddeley's model, WM comprises three main components (Baddeley & Hitch, 1974; Baddeley & Logie, 1999). The phonological loop temporarily stores speech-based information and prevents the information from decaying by rehearsing it. More about its role in reading will be discussed in Section 3. The visual-spatial sketchpad serves a similar function for information of visual or spatial nature. These two sub-systems are supervised by the central executive, which regulates information flow in and out of these systems, and between them and long-term memory. Both the phonological loop and visual-spatial sketchpad are limited in capacity, and the central executive controls and allocates attentional resources between them, focusing and switching attention as needed.

WM supports the various sub-component reading processes outlined in Section 1.1. (Grabe & Stoller, 2020). The cognitive processes of reading are performed simultaneously. While readers hold information and build a text representation, they continue to take in and decode new information and integrate such information to the existing representation (Harrington & Sawyer, 1992). Different components fight for attentional resources in WM. When the processing demand of a task is too high or there is overload, some information in the system will be lost. The efficiency of WM is crucial for successful reading. Harrington and Sawyer (1992) found that among a group of advanced ESL learners in a Japanese university, those who had larger WM capacity also scored higher in the Reading section of the TOEFL test. In Linck et al.'s (2014) meta-analysis, subset of data covering 2203 participants from 46 samples of L2 studies indicate a positive correlation between WM and second language proficiency outcomes and processing (comprehension and/or production) outcomes.

2.2.2 Cognitive load theory

Cognitive load theory (Sweller, 1988, 2004) focuses on the relationships between working memory (WM) and long-term memory (LTM), the effects of such relationships on learning, and the implications for designing instructional materials. It presumes that a learner solves a problem by randomly generating a proposal and testing its effectiveness. WM determines what problem-solving move to be taken. It also takes previous knowledge stored in LTM during the process. After processing, effective moves and elements of information will be combined into the existing knowledge and retained in LTM for future use (Paas & Sweller, 2021).

The theory is partly based on Baddeley and Hitch's (1974) multicomponent working memory theory in that there are separate components for processing visual and auditory input and WM is limited in capacity. It is also partly based on Paivio's (1990) dual-coding theory, which posits that information is encoded and stored in two sub-systems, one for verbal information, the other for non-verbal. Activation of one system stimulates the other. If information is coded in both systems, memory for information can be optimised. This is also called the modality effect (Castro-Alonso & Sweller, 2021), and cognitive load theory proponents encourage dual-mode presentations of learning materials, e.g. supplementing graphic information with audio rather than written texts.

Two types of cognitive load are distinguished (Paas & Sweller, 2021). Intrinsic cognitive load refers to the inherent complexity of the learning material. The load is high when there is a high degree of interaction between elements, e.g. word orders of English. All the words and the relationships between them have to be considered in WM simultaneously (Tindall-Ford et al., 1997). Extraneous cognitive load is caused by inappropriate design of instructional material, which creates unnecessary interacting elements and therefore cognitive activities which are irrelevant to the learning goal.

Instructional materials should be designed in a way to reduce extraneous cognitive load so that limited WM capacity can be freed up for intrinsic cognitive load.

A type of adverse effect caused by inappropriate design is redundancy. Redundant information is any extra information not needed for learning. Redundancy may result when “the same information is presented simultaneously in different forms such as spoken and written form” (Kalyuga & Sweller, 2021, p.212). If the same written text is presented concurrently in both visual and auditory formats, learners may need to coordinate the two sources of information and build connections between them. This consumes WM resources. This redundancy effect is also related to the split-attention effect (Tindall-Ford et al., 1997), when learners need to attend to and mentally integrate multiple sources of information before arriving at the meaning. However, it is also suggested that the redundancy effect can be reversed with learners of less expertise. Information which is redundant for high-proficiency learners may be helpful for weaker learners.

2.3 Role of phonology in reading

2.3.1 Phonological loop as a fundamental mechanism

Phonology plays an essential role in reading comprehension. According to (Grabe, 2009), “all language information used in working memory is stored and rehearsed phonologically” (P.34). The phonological loop in WM has two sub-components (Baddeley, 2003). The phonological store holds information in the form of phonological codes, which fades within seconds. The articulatory rehearsal mechanism refreshes the decaying representations to preserve them in the store. This rehearsal can be subvocal or overt vocalisation. Baddeley et al. (1998) suggest that written input will be translated to phonological form through a recoding process, which will be fed into the phonological store through subvocalization. The loop holds recently read material long enough for various cognitive processes which run parallel during reading to achieve successful comprehension. There is a maximum amount of information the loop can deal with at any one time and a maximum length of how long it can hold information.

Using the articulatory suppression technique, which prevents participants from rehearsing subvocally by asking them to repeat counting from 1 – 6, or saying the word ‘the’, while reading long, complex sentences, Baddeley et al. (1981) found that participants’ ability to detect wrong words or errors in word order was severely affected under such condition. In a similar condition, subjects in Kleiman’s (1975) experiment were much more likely to accept as semantically acceptable sentences with problematic subject/object or lexical category, like “Pizzas have been eating Jerry”.

Rayner et al. (2011) maintain that a major function of such subvocalization, or “inner speech” during comprehension is to aid higher-level comprehension processes by providing phonological codes which facilitate the storage of words and word order information in WM. Such information is held as a reader is taking in new words, so that words can be chunked together as meaningful units while a reader continues to read and conducts other tasks such as figuring out the syntactic structure of a sentence.

Durable phonological representations enhance WM’s efficiency, and in turn facilitates the multiple cognitive tasks driven by WM (Hamada & Koda, 2008). Studies have shown that nonword repetition scores (a measure of phonological loop capacity) strongly predict performance in L2 English language learning in children (Cheung, 1996; Service, 1992). Walter (2008) argues that readers’ unreliable phonological representations of reading material lead to comprehension difficulties. This is because the weaker phonological forms may be lost in the loop even more quickly, and consequently, coherent mental representations are more difficult to build. In Walter’s study, two groups of adolescent ESL learners whose native language was French - one group stronger readers in English comprehension, another group poorer - were asked to recall lists of word sequences. Some lists are dissimilar-sounding English words (e.g. *cheese, job, yes*). Others share similar sounds (e.g. *mine, met, might*). The weaker comprehension group performed much worse than the good comprehension group in the similar-sounding sequences. Results suggest that the phonological representations of these poorer readers were weaker than the strong readers. Poor readers may have more difficulties in distinguishing minimal pairs.

2.3.2 Role in word recognition

The dual-route theories of word identification e.g. (Coltheart, 2005; Coltheart et al., 2001; Forster & Chambers, 1973) have been widely accepted as a reading model for how humans derive pronunciation and meaning from print (Frost, 1998). According to Coltheart’s (2005) Dual-Route Cascaded model, which uses a computer programme to simulate human cognition, there are two major routes readers used. In the lexical route, readers access a word’s entry from visual input directly from the mental lexicon which stores letter patterns and phonological forms, where there are direct connections between the two. In the non-lexical (or phonological) route, our brain, on recognising the letters in a word, parses the letter strings into graphemes (a letter or letter string representing a single phoneme) (Berndt et al., 1987), and converts them to sequences of phonemes (minimal sound unit which can contrast word meaning) (Katamba, 1989) using correspondence rules. Phonological sequences are then activated and assembled, and the word is recognised. This

process is also commonly referred to as phonological recoding by researchers (Taft & van Graan, 1998; Ziegler & Jacobs, 1995).

These two routes are used in parallel and supplementary to each other. It is suggested that the lexical route is essential for reading irregular words, e.g. *yacht*, which do not follow grapheme-phoneme correspondence rules. The non-lexical route is needed for words read the first time (Baron, 1977), and non-words, which are not stored in the mental lexicon (Coltheart, 2005). The relative importance of the lexical computation and phonological processing is a much-debated issue in literature. The lexical route is also called the direct route, since it bypasses the step of mapping graphemes to phonemes. It is therefore considered to be faster than the indirect, non-lexical route (Lukatela & Turvey, 1998; Morris & Folk, 2000), and to be the dominant route, especially for high-frequency words, and for skilled readers (Colombo, 2000; Paap & Noel, 1991).

Frost (1998) proposed a strong phonological theory of word recognition, which states that pre-lexical (before a word is identified) conversion of letters into phonemes or syllables is a mandatory, default mechanism which cannot be bypassed. A number of experiments using different paradigms support the claim that phonological computation inevitably occurs as part of or alongside meaning access among skilled adult L1 readers e.g. (Lesch & Pollatsek, 1993; Lukatela & Turvey, 1994; Morris & Folk, 2000). For example, Ziegler and Jacobs (1995) asked their subjects to search a target letter, e.g. “i”, after briefly presenting a pseudoword e.g. BRANE. More false alarm errors were detected following BRANE than the control BRATE. This suggests that the orthographic structure of BRANE was phonologically recoded automatically. Such phonological representation activated the lexical entry of the homophone BRAIN. The recoding process seemed to occur in an early stage (prelexical), thus interfering with lexical decisions. In Van Orden’s (1987) semantic decision task, participants more often wrongly categorised e.g. ROWS, as a type of flower, than ROBS. ROWS is a homophone of Rose, while ROBS is just orthographically similar.

There are also studies which suggest phonological mediation may not be a prerequisite e.g. (Taft & van Graan, 1998). Nevertheless, Coltheart et al. (2001) argue that any output generated from their dual-route model is always a result of input both from the lexical and non-lexical routes. Both routes run simultaneously and contribute to phonemic activation and word recognition. While diverging in opinions in various aspects, Coltheart (2001, p.234) agrees with Frost (1998) that phonological computation always plays a role – “Exactly as Frost (1998) said, phonology is always partly assembled (non-lexical) and always partly lexical”. These underlie the importance of phonological decoding in reading successfully. Efficient generation of phonological representations is needed for fast lexical access.

This is especially the case for ESL learners, since English is considered an orthographically 'deep' language. Orthographic depth refers to the degree of transparency with respect to symbol-sound correspondence (Frost, 2005). For example, Finnish and Spanish are considered very shallow languages because there is a highly consistent, generally one-to-one relationship between letter and phoneme. Readers can sound out the word by looking at it easily. English, however, contains many irregularities and inconsistencies in its grapheme to phoneme mappings. For example, the pronunciation of the *ch* strings in *chef* and *yacht* cannot be obtained by applying the 'rule' which usually governs the pronunciation of *ch* (as in words like *chum*, *cheese* and *church*). *Moth* and *Both* share the same letter string 'oth' but its pronunciation is different in the two words (Frost, 2005). These will potentially make phonological decoding more difficult.

2.3.3 Prosody

Another area in which phonology may play a role in reading is prosody, which refers to appropriate expression and phrasing of spoken speech (Rasinski & Hoffman, 2003). Oral language includes prosodic features which are not available in written texts, such as stress, intonation, duration and pausing (Dowhower, 1991; Schreiber, 1991; Taguchi et al., 2016). These features assist one to parse a sentence into units and construct meaning. For example, the rise and fall of intonation indicates syntactic boundaries and phrasal organisation. Content words, but not function words, are usually stressed. A speaker will need to determine the syntactic roles of words in a sentence in order to read with appropriate intonation. Speakers will also emphasise new or important information by speaking in a higher pitch and louder voice. In addition, a speaker can express their intentions and emotions through the use of prosody (Taguchi et al., 2016). All these mean that prosody conveys more than speech sound and adds to meaning.

Experimental evidence indicates that prosody in oral language helps a listener resolve ambiguity in sentences e.g. (Beach, 1991). Schreiber (1991) have discussed how when L1 English children were asked to repeat a phrasal unit of a sentence, e.g. a subject noun phrase, their performance was severely affected when the sentence was presented in unnatural prosodic breaks. This indicates the importance of prosody in their language processing. Written texts do not contain prosodic features. Readers can only rely on punctuation for segmenting sentences into chunks. However, it has been suggested that even when readers read silently, they may create prosodic information and mentally hear it through their inner speech (Fodor, 1998; Rayner et al., 2011). The phenomenon of inner speech will be discussed further in Section 4.

As reviewed previously, phonological representations are stored and retained in working memory to support cognitive processes during reading comprehension, such as chunking of words. Prosody, as

an inherent feature of phonological representations, are compatible with the phonological codes in Baddeley's working memory model. It follows that prosody in reading may bolster working memory and therefore comprehension, through providing additional information which helps syntactic and semantic analysis in the phonological store (Koriat et al., 2002).

2.4 Reading silently, reading aloud, reading-while-listening

2.4.1 Reading silently (RS) and inner speech

Silent reading, or "just plain reading" (Hiebert & Reutzel, 2014, p.16), is probably the most common reading practice and is often seen as a natural reading behaviour (Alshumaimeri, 2011). It has been commonly adopted in both L1 and L2 settings to encourage extensive reading. For example, in a Sustained Silent Reading programme, all students and teachers read silently in a fixed period of time during the school day (Allington, 1977). Studies usually report that students who practised this had higher reading achievement scores than their counterparts who received traditional class input e.g. (Cho & Hey-Jung, 2004). However, relative effectiveness of silent reading over oral reading as a reading mode is not established (Hiebert & Reutzel, 2014).

It should be noted that reading silently may not be quite so silent after all. Inner speech, which refers to "the silent production of words in one's mind" (p.221), is a common phenomenon among readers (Perrone-Bertolotti et al., 2014). Inner speech is generally thought to be the sound codes used in the phonological loop in the working memory model for retaining and rehearsing materials (de Guerrero, 2018). According to Rayner et al. (2011), there are two forms of inner speech: subvocalization, which is the articulatory processes, and phonological coding, the mental representations of speech which give people the experience of hearing voices. Subvocalization and phonological coding are not necessarily the same. While one can possibly vocalise one thing with the mouth and mentally hear something else, subvocalization is the main source of phonological coding.

Studies have shown that readers "read aloud" in their mind even during silent reading. Using stimuli with the same orthographic length but different phonetic length (e.g. swipe/swine with short/long vowels), Abramson and Goldinger (1997) found that university students' response time increased with the word's phonetic length. The phenomenon is not only seen in reading individual words. Readers with Northern and Southern English accents (e.g. 'glass' spoken with shorter duration in the North) were found to exhibit eye movements which reflect their regional accent when silently reading limericks (Filik & Barber, 2011). Errors are observed in inner speech as well. Dell and Repka (1992) reported that college students made similar types of slips of the "tongue" when reciting

tongue twisters silently and practising them aloud. The tongue twister effect during silent reading is believed to be a result of the interference arising from the overlapping sound codes automatically generated. In Alexander and Nygaard's (2008) experiment, participants listened to two speakers, one of whom spoke faster, the other more slowly. Then they were asked to read two texts, which were written by the fast and slow speakers respectively. In both reading silently and aloud, the participants spent longer time on reading the text written by the slow speaker than the fast one. Results suggest that readers access the prosodic information of the authors, the speech rate, in their mind even during silent reading.

Views about the nature of inner speech are not conclusive. While the above studies suggest that inner speech closely resembles overt speech, some researchers believe that inner voice may manifest as a more abstract, impoverished form of normal speech. Oppenheim and Dell (2008) argue that inner speech lacks phonological detail, based on their experiment results which reveal that when reducing the phonological similarity in tongue twisters, fewer errors were made in reading aloud, but little difference was seen in silent reading. There is also a question of whether one hears all words in the mind. It has been suggested that inner speech is faster than overt speech (Anderson, 1982) and that phonological representations of voice may not be needed when reading easier materials (Alexander & Nygaard, 2008).

Very few studies have explored the role of inner speech in reading L2 texts, especially in terms of decoding and the subvocal rehearsal mechanism (de Guerrero, 2018). Kato (2009) found that their subjects, 64 Japanese ESL university students consisting of a higher reading proficiency group and a less proficient group, experienced a significant decline in performing a sentence processing task in the articulatory suppression condition, compared with normal silent reading. The effect was stronger among the less proficient group, indicating that proficient readers may rely less on covert phonological processes in working memory when comprehending in English. However, as the authors pointed out, the fact that the performance of the proficient group was also affected, although to a lesser extent, implies a marked contribution of phonological processing, even among the advanced L2 readers. By measuring tensions in the lower jaw, an early study by Sokolov (1972) reveals that L2 readers' inner speech tended to reduce when reading easier texts, while it expanded when processing difficult texts.

If ESL learners encounter speech errors/decoding difficulties when reading in their inner speech, their reading comprehension could be negatively affected. It is unclear how much inner speech L2 readers may experience during reading, and the extent to which they may have difficulties when encountering unfamiliar words.

2.4.2 Reading aloud (RA)

Reading aloud is also called oral reading. It can be described as a learning activity where teachers read aloud a text for students e.g. (Amer, 1997). Reading aloud has also been used by teachers as a kind of supported reading (Grabe, 2009), for example, choral or paired reading, students' reading aloud after their teacher. It is often used as an instructional technique to improve L2 students' pronunciation, other speaking features such as stress and intonation, and oral fluency (Gibson, 2008). It is also used to develop L2 students' reading fluency or general reading ability, often through re-reading the same text several times (Grabe & Stoller, 2020), and some ESL teachers have reported benefits for students' comprehension after they were encouraged to read aloud passages repeatedly after a period of time (Jeon, 2011; Yu, 2015). However, in this dissertation, reading aloud refers to the learner reading out a text for their own comprehension, rather than for any specific language-learning purpose (Gabrielatos, 2002).

It is unclear whether reading aloud is a more effective method than reading silently for comprehension, if it is not used as repeated reading practice. Some L1 studies found similar levels of comprehension between silent reading and oral reading among children (Holmes & Allison, 1986) and college students (Holmes, 1985). Alshumaimeri (2011) is one of the very few L2 researchers who investigated the same issue. His study involved Saudi EFL 145 10th grade students. All participants read expository passages in both reading aloud and silent reading conditions. Comprehension test scores reveal that students had significantly higher comprehension when reading aloud than silently. Participants reported that they preferred oral reading since it helped them concentrate, and also memorise the text and new words.

However, a major factor that seems to determine whether students can comprehend L2 texts successfully when reading aloud is their oral reading fluency (ORF). Reading fluency is defined as the "level of reading competence at which textual material can be effortlessly, smoothly, and automatically understood" (Schreiber, 1980, p.177), while ORF is the ability of an individual to translate text into spoken words with accuracy, speed, and appropriate expression (Fuchs et al., 2001; Grabe, 2009). The development of oral reading fluency is dependent on word recognition and phonemic decoding skills. With fluency, readers can attend to the meaning of the text without the need to spare attentional resources on recognising words. A line of research has explored the relationship between oral reading fluency and reading comprehension, and found positive correlations between ORF and English L2 comprehension, among intermediate-level L1 Arabic and Hebrew university students (Saiegh-Haddad, 2003), intermediate-level L1 Chinese adult learners of English (Jiang et al., 2012), junior secondary students with Malay and Chinese L1 (Pey et al., 2014),

and Korean L1 primary school students (Kim, 2004). While these studies show consistent results and provide a strong line of evidence, there may be some limitations. Studies of Jiang et al. (2012) and Pey et al. (2014) measured comprehension and oral reading separately. This means when participants read aloud, they were not required to understand what they read at the same time. While the rationale of ORF is that when readers decode fluently they can attend to meaning without expending resources on the former, it is possible that L2 readers decode without comprehension (Lems, 2003). In that sense, measuring readers' online understanding of the text while they are reading aloud may be a better option.

During reading aloud, phonology is generated by the learners themselves. While it seems to be a popular practice for developing L2 students' pronunciation and reading fluency, the fact that they may not generate phonology accurately and fluently might affect the comprehension process.

2.4.3 Reading-while-listening (RWL)

Reading-while-listening, which refers to "reading while simultaneously listening to an oral rendition of the text" (Tragant Mestres, 2018, p.820), is also commonly called "audio-assisted reading" (Chang & Millett, 2015), or "dual modality on comprehension" (Rogowsky et al., 2016). Different methods for rendering the listening part have been used, e.g. a teacher reading the text aloud (Amer, 1997), tapes (Taguchi, 1997), and audio books (Alsamadani, 2017). Like reading aloud, reading-while-listening is considered a type of assisted reading and has long been adopted by L1 teachers, and recently by L2 teachers in extensive reading programmes and repeated reading practice. Facilitative effects have been found on L2 reading rate, listening comprehension, and vocabulary knowledge e.g. (Chang, 2009; Gorsuch & Taguchi, 2010; Webb & Chang, 2012).

Regarding reading comprehension, research results are far from conclusive. Here, for reasons of space, I will only review those studies which included a silent reading comparison group, with a purpose primarily on learning reading in L2 rather than using it as the medium to learn other content, and will only focus on relevant findings comparing reading silently (RS) and reading-while-listening (RWL).

Askildson's (2011) study involved 77 English L1 college students taking a beginner L2 French course. Two sets of 5 vocabulary items, which were covered in the course previously, were incorporated into the text for Reading 1 and texts for Readings 2-5 respectively. These 5 texts were each composed of a different short paragraph. Readings 1 and 5 were the pre- and post-tests respectively. After reading, students completed short-answer comprehension questions, each corresponding to one of the words in sets 1 or 2. To answer correctly, students needed to understand both the respective

item and the paragraph as a whole. Readings 2 - 4 were the treatment. While the RS group read silently, the RWL group read with a concurrent audio recording read by a native French speaker. Statistically significant gains in reading comprehension as indicated in the pre- and post-tests were found in the RWL group compared with RS group. The strength of this experiment lies in its clever design, where the author isolated the decoding of individual words as a measure to explore the phonological training effect by RWL on comprehension, with the target words repeatedly presented in Readings 2-4 during the treatment. The results indicate the beneficial effects of RWL through its assistance in decoding words.

In contrast, Diao and Sweller (2007) reported detrimental effects from RWL on both word decoding and text comprehension. 60 Chinese L1 ESL college students participated in two reading sessions, reading a different expository text in each. The RWL group had significantly weaker comprehension than RS group as measured by a free recall task. Participants also completed a vocabulary test on 10 words central to the meaning of the passage before and after each session. The RWL group showed significantly worse vocabulary scores than the RS group after reading the text. Since the RWL group reported higher subjective mental load ratings, the authors believed they experienced interference, and the negative effect was attributed to the redundancy effect in cognitive load theory. However, while the authors posited that students' listening rate lagged behind their reading rate, they did not explain what kind of interference students experienced and how it was like. Yang et al. (2022) point out that unmatched audio pace in Diao and Sweller (2007) could cause poor audio-visual correspondence, and in turn poorer comprehension. However, readers' actual experience in this regard is unclear and remains to be explored.

Other studies investigated the effect of RWL with participants from different age groups, L2 proficiency levels, L1 backgrounds, using different text types (narrative or expository) and outcome measures have reported mixed results. For example, Higher comprehension under RWL over RS was found amongst ESL primary students in Cairo, with RWL delivered by the teacher reading the story aloud to students who read silently along (Amer, 1997). Similarly, Woodall (2010) reported that beginner-level ESL university students in Puerto Rico, who read a children's novel in a RWL condition, performed significantly better than those in RS on all eight weekly comprehension quizzes.

However, Luchini et al., (2016) reported that RWL yielded poorer recall of ideas from a textbook passage (about 500 words) than did RS among L1 Spanish ESL learners in secondary school. Using the same material and experimental procedures, Machado and Luchini (2018) replicated the study with two groups of students with different levels of English proficiency. The same results were obtained.

Within both higher- and lower-proficiency groups, RS sub-groups performed significantly better than RWL. A limitation of these two studies is that no information about the audio pace or who recorded the audio was provided, but the quality of the audio could have made a difference. Pellicer-Sánchez et al. (2018) found no significant differences between conditions in child ESL learners in Spain as well as advanced L2 learners studying in a UK university, who read half a story in a RS condition and the other half in a RWL condition, using a counterbalanced design. The text they used is rather long, about 2000 words for the adult learners. It is unclear whether participants could refer to the story when attempting the questions. If they could not, a memory effect could have affected the results.

Several longitudinal studies (Chang & Millett, 2015; Kim, 2021; Tragant Mestres et al., 2019) have investigated whether there is a reading comprehension gain from RWL over RS, measuring students' reading comprehension levels pre- and post-treatment. Results reported are mixed.

Different reasons have been attributed to these mixed findings. Among those who reported positive effects from RWL, the most often mentioned reasons are that it promoted higher concentration and helped readers group words meaningfully. On the contrary, those researchers who observed negative effects suggested that it led to interferences and increased cognitive load. Research in this area is predominantly quantitative in nature, with a few studies using questionnaires to collect students' feedback. More qualitative research may be needed to explore these potential causes in greater detail. This is one of the goals of the current study.

2.5 Summary

Reading comprehension is an interactive process where insufficiencies in lower-level processes will affect higher-level processes, since resources in WM is limited. WM can be overloaded if it attends to many tasks simultaneously, and instructional design should avoid this. Phonology underlies the fundamental mechanism in the storage and rehearsal of verbal information in WM, and also plays a significant role in word recognition. Prosody in phonology conveys more than speech sound and adds to meaning in oral reading. Therefore, reliable, high-quality phonological codes are significant for effective reading. Phonology is manifested in different ways in reading silently (RS), reading aloud (RA), and reading-while-listening (RWL). There is little research regarding inner speech, and effectiveness of reading aloud on comprehension in L2 reading context. Research results on RWL during L2 reading are very mixed.

This study therefore aims to investigate L2 readers' comprehension and their experiences in the above three conditions, and explore the role of phonology in L2 reading, through the lens of inner

and outer voices in these different conditions. As far as I am aware, this is the first qualitative study which explores these issues.

2.6 Research Questions

- 1 Are there any differences between the three modalities (RS, RA, RWL) in terms of the readers' comprehension?
- 2 Are there any differences between the three modalities (RS, RA, RWL) in terms of the readers' perceived ease of comprehension?
- 3 In the RA condition, to what extent do students read the texts aloud (a) accurately, (b) fluently and (c) with correct intonation?
- 4a What are reader's experiences of the three modalities (RS, RA, RWL)?
- 4b What do readers perceive to be the key affordances of each modality, in terms of comprehension?
- 4c What do readers perceive to be the key challenges of each modality, in terms of comprehension?

3. Methods

3.1. Design

This study adopts an exploratory, case-study approach. The experiences of several individual readers were explored in detail using a range of data. Their comprehension in the different conditions were measured, their views of the reading conditions were collected through interviews, and their phonological output when reading aloud was evaluated. The case study design with multiple data-collection methods enables in-depth understanding when a single perspective may not be able to provide a full explanation of the research topic (Ritchie et al., 2014).

3.2. Participants

The group of interest in this study is L2 English learners studying in university. Originally, purposive sampling (Mason, 2002) was adopted to obtain participants with contrasting L1 writing system backgrounds, since these learners might show different phonological processing behaviours during L2 reading (Koda, 2005), and this may enable deeper exploration of the research topic. However, since this did not appear to be a particularly significant factor as revealed in data analysis, it is not pursued further in this dissertation.

Recruitment was done through a combination of in-person and snowballing approach, and advertisement through WhatsApp groups. A total of seven main participants were recruited. A language background questionnaire (Appendix A) was adapted from Lim and Godfroid (2015) to collect information about the background and learning history of their first language, L2 English, and any additional languages. At the time of data collection, they were all international students in a major UK university, studying a range of graduate programmes from different departments. Their first languages were Cantonese, Hindi, Japanese, Korean, Mandarin, Spanish, and Tamil respectively. Their overall IELTS scores reported were between 7.5 and 8.5. IELTS scores for two participants were unavailable. However, their courses required them to reach a minimum overall score of 7.5 in IELTS or equivalent. Therefore they are all considered advanced ESL readers. A similar pool of people was recruited as pilot participants in the process.

Two participants were excluded from the data analysis phase, due to practical concern with limited time and space permitted. One participant was the Hindi-speaking Indian who reported having dyslexia. Readers with learning difficulties are not the primary group of interest in the current study. The other participant was the Cantonese speaker. The decision was made originally because of an attempt to maintain L1 diversity among participants. Cantonese is a dialect of Chinese, so the Mandarin-speaking participant who may represent a wider population was selected.

3.3. Materials and measures

3.3.1 Reading materials

To make the investigation ecologically valid and resemble learners' usual L2 reading activities, I aimed to use general academic texts in the study. IELTS, which is a standardised test of English proficiency for non-native speakers (IELTS, n.d.), was considered suitable for use after pilots (see below). Since I did not have access to actual IELTS test papers, I searched for IELTS practice tasks online or from books. They were developed by the British Council, IDP, or the Cambridge Assessment Team, the three co-owners of the test.

Efforts were made to select suitable texts of equal difficulty, using three criteria. First, to minimise effects of background knowledge, I chose a common topic, general science, for the three texts. Second, preferences were given to texts which contain some words which may be difficult for L2 learners to pronounce, in order to investigate the potential effect of phonological decoding challenges in reading. Third, I attempted to ensure similarity in terms of the texts' linguistic level. I used the Lexical Tutor (Cobb, n.d.) to check the vocabulary profiles (distribution of frequency levels) of potential texts. Readability, which refers to how easy a text is for readers to understand (Li, 2018), was considered. Flesch Reading Ease Formula is one of the most popular readability formulas and has been used in analysing IELTS texts e.g. (Li, 2018). Several researchers in RWL studies have also used Flesch-Kincaid Grade Level e.g. (Ari & Calandra, 2022; Nakashima et al., 2018). I therefore used these two formulas for analysing and screening potential texts. I screened more than 100 articles to select the best three for the purposes of this research.

Three IELTS practice task passages (British Council, n.d.; Cambridge Assessment, 2021; IDP IELTS India, n.d.) entitled *Plant Thermometer*, *Origins of Birds*, and *Time Travel*, were used in the RS, RA, and RWL conditions respectively. The original texts were edited down to about 640 words in length. Flesch Reading Ease scores of the texts are between 45.6 and 47.8. See Appendix B for a summary of the linguistic profiles of the texts. To ensure that participants' experiences and comprehension best reflect a particular reading condition, they were asked not to re-read the texts when answering the questions. (If they re-read, most likely it will be done silently.) This, however, increases the effect of memory. To minimise this, central questions about main ideas were used (Alderson, 2000). There are 8 questions for each article, including 7 multiple-choice questions (1 mark each) and one extended-answer question (2 marks). Multiple-choice questions are the most common question type used in reading tests, and also in IELTS (Alderson, 2000). The extended-answer questions test readers' understanding of the main phenomenon/mechanism explained in the text. Questions and answers were adapted from the original IELTS practice task by an English teacher in a Hong Kong

university. She is a native English speaker with many years of experience in teaching and developing assessments. She was advised not to include questions testing details or understanding of individual vocabulary items, but only those about understanding of the main ideas. See Appendix C for the three texts, the questions and marking schemes.

3.3.2 Audio recording

An audio file for the text *Time Travel* was recorded at a comfortable speed by a male native English speaker of British English who is a university professor. The length of the recording was 4 minutes 51 seconds. The speech rate is 132 words per minute.

3.3.3 Self-reported ratings

Participants were asked to give self-ratings on a 0-100% scale for the percentage of each text that they understood, the level of difficulty they experienced when reading, and the level of prior familiarity with the topic for each of the three texts.

3.3.4 Oral reading descriptors

To evaluate participants' oral reading, I developed a set of descriptors based on Suzuki (2017), whose participants were college intermediate-level ESL students. I combined 'speaking rate' and 'number of pauses' into one category, labelled 'Fluency and Pace'; and 'stressed and unstressed syllables' and 'intonation' into a single category of 'stress and intonation'. Suzuki's scale does not have a category for accuracy, so I added this, partly based on the relevant parts in the speaking assessment guidelines of a university entrance examination in Hong Kong (The Hong Kong Examinations and Assessments Authority, n.d.). Descriptors for each rating were further refined, since participants in this study are advanced, not intermediate English learners. Adjustments were also made to replace any descriptors using the term 'native-like' as a reference point, since English both as a native and second language are part of world Englishes and it is difficult to use 'native-like' to evaluate one's spoken English (Kirkpatrick, 2007). See Appendix D for the finalised scale.

3.4. Pilots for materials and interviews

The initial candidates for reading material were three excerpts from Bill Bryson's *A Short History of Nearly Everything* (Bryson, 2004), previously used in a study comparing L1 college students' reading in RS and RWL conditions (Varao Sousa et al., 2013). Whilst this general science book written by a popular author appeared suitable, and had accompanying comprehension questions available for use in my study, piloting with two participants showed that they found the texts very demanding

and unpleasant. These two participants were then invited to read an IELTS text and rate the level of difficulty. Their responses indicated that IELTS texts are much more suitable. Following this, I tried out IELTS texts and questions with another pilot participant. It was found that since participants were asked to complete the questions without re-reading the text, the task, while suitable, was more challenging than a usual IELTS test. Therefore, I decided to further edit down the text length. Another round of pilot with four pilot participants was conducted after the materials were finalised. Complete procedures, from reading to interviewing were tried out. The process was smooth overall and participants were able to give many relevant comments. Adjustments to comprehension questions, interview questions and order of questions were made.

3.5 Procedures

Each main participant completed online reading sessions individually with me on Microsoft Teams. Participants had an option to do it in one 2-hour session (with a break) or two one-hour sessions. They were asked to read three articles, each in a different reading condition, in the following sequence: (1) reading silently; (2) reading the text aloud; (3) reading while listening to an audio recording. No time limit was set for reading in the RS or RA conditions. The time each participant spent on reading was noted down. This was done by recording the starting time and ending time as shown on Microsoft Teams and as self-reported by the participant. Since during RWL the audio was played concurrently, the reading time was the same as the audio length, i.e. 4 minutes 51 seconds. After reading each text, participants were asked to rate how much they thought they had understood and the perceived difficulty of the reading. Then they completed the comprehension task. Participants were reminded not to refer back to the text when doing the questions (They were told about this at the beginning of the session). There was no time limit for the questions. Participants then completed a semi-structured, stimulated recall interview with me. The same procedures were repeated for each reading condition.

Stimulated recall is deemed a suitable means for understanding participants' thought processes and their impressions about a reading experience, and the reading passage can be used as the stimulus (Gass & Mackey, 2000). Following the reading and comprehension tasks, participants were asked to view the passage and share their screen with me while recalling their experiences. Similar delayed retrospective recall procedures were also used by Paribakht and Wesche (1999). Interview questions (See Appendix E) were developed with an aim to explore what helped or hindered their comprehension in each of the modalities, any challenges they experienced and what effects, if any, they thought phonology had on their reading in the different conditions. For example, they were

asked to refer to the text and comment on any words which they struggled to read, and what they did or thought when they saw those words. Interview guidelines suggested by Friedman (2012), such as avoiding yes/no or leading questions, were followed. During interviews, I also observed participants' reading behaviours during RA and asked follow-up questions as appropriate: for example, 'I noticed you hesitated here. Do you remember why?'. The oral reading by participants in the RA condition, and the interviews in all three conditions, were audio-recorded.

3.6. Data analysis

3.6.1 Comprehension scores

Comprehension tasks for all participants were marked by me using the marking scheme (Appendix C). Its development process and appropriateness have been explained in Section 3.1.

3.6.2 Oral reading

Participants' reading aloud clips were analysed. Any pronunciation errors, and places where they seemed to have difficulties were noted down. I also analysed the words that participants usually had difficulties with using the Lexical Tutor (Cobb, n.d.). I used the oral reading descriptors (as explained in Section 3.4) to give each participant component scores and an overall score. In order to check reliability of the scoring, an experienced English teacher from a university in Hong Kong double-marked the clips. She was advised that a foreign accent should not be penalized. Our scores were reasonably closely aligned: inter-rater agreement was 73%. The final score for each participant was calculated as an average of the two raters' marks¹.

3.6.3 Coding

All interviews were fully transcribed. Scripts automatically produced on Microsoft Teams were downloaded. They were then checked carefully several times and errors generated by the computer were corrected. See Appendix F for a sample of the transcripts. They were then imported into Nvivo (Release 1.6.1) for coding. Principles of coding were guided by Ritchie et al. (2014), who broadly adopt a form of thematic analysis, which refers to the identifying and interpreting of patterns and meanings from data (Braun & Clarke, 2006). An initial thematic framework was constructed based on a combination of deductive and inductive approaches (Ellis & Barkhuizen, 2005). It was first developed by considering the research questions and topics in interview questions

¹ The second marker was unsure and gave one participant two scores for 'pace and fluency' (2/3) and 'stress and intonation' (2/3), because the participant re-read many parts of the text after the first reading. Since there is no half score in the scale, I took the score that was same as mine when calculating scores and inter-rater agreement.

(Affordances/Challenges; Dealing with words with unsure pronunciation; Inner Voice), and then an additional theme which emerged from the data was added (Reading strategies). Sub-themes under each main category were developed inductively.

Coding was conducted in an iterative manner (Dörnyei, 2007). Codes were reflected on, recoded, split or combined, and restructured over several rounds into themes and sub-themes. The size of the chunks that were coded ranged from a single phrase to several paragraphs (Baralt, 2012).

Simultaneous coding, when the same datum is coded to more than one code, was used when deemed necessary (Saldaña, 2021). To enhance reliability, a coding protocol was drawn up, with a definition and an example for each code (Révész, 2012). I considered: the situation in which the concept/behaviour occurred; its characteristics; and how it is different from, and may be related to, other codes (Baralt, 2012).

An experienced university English teacher was invited to second-code 5% of the data. We read and discussed the coding protocol together in a meeting. He then coded the data independently. As suggested by Révész (2012), to increase representativeness, the subset of data was selected so that it covers both easy and difficult coding decisions, data from all three reading conditions, and codes from all main categories. Inter-coder agreement was 77%. Differences were identified, discussed and resolved. It was found that a sub-category "Use of reading strategies" under "Affordances/challenges" (participants perceived being able/unable to use strategies helped/hindered their reading), is similar to one main category "Reading strategies" (participants mentioned they used strategies, but did not describe them as something helped/hindered). Considering that this can be ambiguous and reading strategies is not a focus of this study, I removed "Reading strategies" after second coding. The finalised coding protocol, with 73 codes (including parent codes), is attached in Appendix G.

Since this study involves three reading conditions, both cross-sectional and non-cross-sectional data organisation strategies (Ritchie et al., 2014) were employed to conduct analysis across reading conditions, and between and within cases. After the themes and sub-themes were finalised, each reference was coded to either Reading Silently, Reading Aloud, or Reading-while-listening to enable matrix analysis in Nvivo. The aim was to eventually seek explanations accounting for the patterns arising from the data.

3.7 Ethics

This study has received ethics approval from the Department of Education's Research Ethics Committee at the University of Oxford (See Appendix H). Informed consent was gathered from all participants prior to the reading and interview sessions. For details, refer to the participant

information sheet and consent form in Appendix I. A £20 Amazon voucher was provided for the main participants in recompense for the time and effort they provided in participating in the research. Each participant was assigned a pseudonym and all data were pseudonymized. To further protect their identity, their gender was masked. The pseudonym/pronoun used may or may not represent their real gender. Their ages and first languages are reported as a group but not individually in this dissertation.

Ethics consideration has also been made concerning the choice of reading materials. As mentioned, the pilot with *A Short History of Nearly Everything* (Bryson, 2004) received very negative feedback from both participants. Considering that research should not put any unreasonable demands on participants, and they should not be left with negative feelings about participation (Lewis & Graham, 2007), I decided not to push ahead with it.

4. Findings

To address the Research Questions, I will present the overall findings from all participants, and also additional findings from individual participants by case, aiming to highlight any similarities or differences between them.

I will first introduce the five participants:

Participants are all advanced ESL learners studying a range of graduate programmes in a major UK university. Their ages ranged from 20 to 40. Their first languages are Japanese, Korean, Mandarin, Spanish, and Tamil.

Alex started learning English at 4, and has spent about 9 years living abroad in English-speaking countries. In addition to English, he has also learnt Chinese for 1 year.

Ben started learning English at 12, and has spent 4 years living abroad in an English-speaking country. He has learned Japanese for a year.

Carson started learning English at about 5. Since then he used both English and his L1 at home. He has spent 10 months living abroad in an English-speaking country. He has learned German for 2 years.

Daisy started learning English at 5, and only used L1 at home. She has spent 7 years living in an English-speaking country. She has learned Italian for a few months.

Emma started learning English at 13, and has spent 4 years abroad in an English-speaking country. She has learned French for 4 years.

4.1 Research Questions 1 & 2

1 Are there any differences between the three modalities (RS, RA, RWL) in terms of the readers' comprehension?

2 Are there any differences between the three modalities (RS, RA, RWL) in terms of the readers' perceived ease of comprehension?

As shown in Table 1, there are differences between the three modalities (RS, RA, RWL) in terms of the readers' comprehension. The mean average comprehension scores for all 5 participants for the 3 reading conditions are 5.8 for RS, 4.4 for RA, 6.8 for RWL respectively. There are very different

individual patterns among participants. Some scored the best in RS, others in RWL, while the marks for RA are usually the lowest. Marks are the closest to one another (lowest = 6, highest = 8) in RWL, while in RS marks are the furthest away (lowest = 2, highest = 8).

There are also differences between the three modalities in terms of the readers' perceived ease of comprehension. Participants' perceptions regarding the reading conditions they found easiest and hardest vary greatly from one another. Two participants found RWL the easiest condition, two found RS easiest, and one found RA easiest. In terms of the condition they found hardest, three said RA and two said RWL. Participants either chose RWL or RA as the condition they enjoyed most.

Table 1 Summary of participants' comprehension scores and perceptions of reading in each condition

Participant	Reading time (RS/RA) <i>(Remark: Length of audio used in RWL is 4:51)</i>	Comprehension score (Full mark = 9)			Perceived % of comprehension of the text	Perceived topic knowledge of the text	Perceived ease of comprehension of reading condition
		RS (Plant thermometer)	RA (Origins of Birds)	RWL (Time travel)			
Alex	6:08/5:20	8	6	6	RS: 80% RA: 40% RWL: 70%	RS: 0% RA: 0% RWL: 20-30%	Easiest: RS Hardest: RA Enjoy most: RWL
Ben	9:34/11:00	2	4	7	RS: 70% RA: 90% RWL: 70%	RS: 0% RA: 0% RWL: 60%	Easiest: RA Hardest: RWL Enjoy most: RA
Carson	5:28/5:04	8	4	8	RS: 80% RA: 90% RWL: 90%	RS: 30% RA: 95% RWL: 70-80%	Easiest: RWL Hardest: RA Enjoy most: RWL
Daisy	4:48/6:48	6	5	6	RS: 80% RA: 75% RWL: 70%	RS: 20% RA: 40% RWL: 50-60%	Easiest: RS Hardest: RWL Enjoy most: RA
Emma	5:25/6:33	5	3	7	RS: 60% RA: 70% RWL: 75%	RS: 1-5% RA: 10-15% RWL: 50-60%	Easiest: RWL Hardest: RA Enjoy most: RWL
Average comprehension score per condition		5.8	4.4	6.8			

Looking at cases individually:

Alex scored highest in RS (=8), while marks for RA and RWL are the same (=6). The conditions he perceived as easiest/hardest were generally in line with his actual comprehension scores. He enjoyed RWL most.

Ben's score in RS (=2) is the lowest among the 3 conditions. He found RA easiest and liked it most, and reported understanding 90% of the text in this condition. However, his score in RA is 4 only. In contrast, while he found RWL hardest, he scored best (=7) in this condition. He spent significantly longer time on reading in RS and RA compared with the other participants.

Carson found reading in RWL easiest, and enjoyed it most. His score (=8) in this condition is as high as that in RS. He reported reading in RA was hardest, and his score in RA (4) is also the lowest. However, he reported understanding 90% of the text. He explained that he was very familiar with the topic of the text (95%).

Daisy's scores in the three conditions are similar - 6, 5, 6 for RS, RA, and RWL respectively. She perceived reading in RS easiest but enjoyed RA most. She found RWL the most difficult condition.

Emma scored highest in RWL (=7). She perceived reading in RWL easiest and enjoyed it most. She scored lowest in RA (=3) and perceived it the hardest condition. Her mark in RS is 5.

4.2 Research Question 3

In the RA condition, to what extent do students read the texts aloud (a) accurately, (b) fluently and (c) with correct intonation?

As indicated in Table 2, there was considerable variation in the quality of participants' oral reading. From my observations, often when participants saw a less familiar word, they were able to pronounce it correctly, after some repetitions or self-corrections; however, this affected their fluency and pace. Table 3 shows the words which participants most frequently had difficulties with: these are words which at least 2 participants mispronounced, repeated, or hesitated over when reading. As can be seen from the table, very often, these are low-frequency words; some are people's names or specialised words.

Sometimes, participants repeated groups of words or phrases, or slowed down when reading them. This happened in different places in the text, but below are two sentences, both from Paragraph E, which they more commonly had problems with:

But the dino-bird supporters contend that an unknown dinosaurian bird-ancestor could have been tree-dwelling, or that birds evolved flight from the ground up by chasing and leaping after insects.

Their reasoning is that flight is most likely to have started from a tree-climbing ancestor, yet all the proposed dinosaurian ancestors were ground-dwellers.

Table 2 Oral reading performance

Participant	Reading time (RA)	Accuracy /5	Fluency and pace /5	Stress and intonation /5	Average mark /5
Alex	5:20	5	4.5	4.5	4.7
Ben	11:00	2.5	2	3	2.5
Carson	5:04	5	5	5	5
Daisy	6:48	4	3.5	4	3.8
Emma	6:33	3	3	3	3

Remarks: Marks were given based on the descriptors (See Appendix D) with a 5-point scale. Average mark of 3 components is shown in the last column.

Table 3 Frequency level of words which are commonly mispronounced or repeated

Word	Frequency level
Distinctly	K-3
Dwelling	K-4
Novelties	K-6
Palaeontologist	K-8
Pheasant	K-8
Quail	K-8
Entomologist	K-10
Ornithologist	K-10
Tibia	K-12
Theropod	K-17
Cladistics	K-25
Archaeopteryx	Off list
Danish	
Dinosaurian	
Furcula	
Unidentified	
Anklebone	System breaks each word into two words and so no result
Collarbone	
Fedeccia	These are people's names
Gerhard Heilmann	
Willi Hennig	

Remarks: Frequency level was obtained using the Lexical Tutor (Cobb, n.d.).

Below is a summary of participants' oral reading presented by case, based on Table 2 and my observations. Both Alex and Carson are excellent in all three oral reading components. Their reading was expressive, with very good stress and intonation. Their pronunciation was highly accurate, even for unusual words like "Archaeopteryx". There were very occasional repetitions or self-corrections.

Daisy and Emma read aloud the text moderately well. The time they spent on reading was longer than Alex and Carson, reflecting the more frequent hesitations/repetitions they made during reading. Daisy's pronunciation was clear and accurate in general, with a couple of mistakes when pronouncing less common words. Emma sometimes mispronounced vowel/consonant sounds, e.g. /sh/ pronounced as /s/ in "relationship", and tended to either miss or add a syllable when pronouncing multi-syllable words, e.g. "palaeontologist" as 'pa.la.on.to.list'.

Ben's oral reading was comparatively weaker. He spent significantly longer time on reading. This was partly because he made rather frequent hesitations/repetitions/self-corrections. Another reason was that after reading the text once, he returned to the beginning and jumped to different parts to re-read. He is the only participant who did this. There were many pronunciation mistakes. He mispronounced a word as another a number of times, e.g. "distinctly" as "distinguish". He also mispronounced certain consonant and vowel sounds, e.g. /eɪ/ as /e/ in "maintain". He tended to speak with a flat tone, but stress and intonation patterns were usually correct.

See Appendix J for more details and examples of participants' pronunciation problems.

4.3 Research Question 4

To address Research Questions 4 (a), (b), and (c), data from the interviews will be reported. Participant's quotations are reported in *italic font*. The code (or part of the code) labels are indicated by " ". For the complete coding scheme, refer to Appendix G.

4.3.1 Research Question 4a

4a *What are reader's experiences of the three modalities (RS, RA, RWL)?*

(i) Inner voice

All participants reported that they heard an inner voice when reading silently. Four believed it was their own voice speaking. One did not know whose voice it was. All recalled hearing it when they tried to remember a new word. They listed different examples, but all reported that they heard themselves 'saying' the word *Phytochromes* because it is new to them. E.g.

I heard a voice in my mind when I was trying to remember the name of the molecules, basically Phytochromes. Uh, it was easier for me to remember what they were called, when I heard the voice playing in my head. (Carson)

Because it's something that I haven't really heard before, and I had to read it to myself in order to kind of hear it... But after I confirmed the pronunciation to myself, well, for example, I just said to myself

like phytochromes phytochrome, OK, Phytochromes....So I think, knowing the pronunciation, but well, I thought that was the pronunciation... Anyway, the moment I kind of like confirmed to myself the pronunciation, I think it made the reading a bit more easier. (Alex)

They also heard it when they read some important or difficult ideas, often through re-reading. E.g.

It [inner voice] was, either key concepts, or me going through an idea that I didn't quite grasp at the first time that I read it. (Daisy)

Any difficulties in understanding the meaning of the sentence, I kind of ... try to read again was with voice in my head. (Emma)

Two participants, Emma and Ben, mentioned when they were not sure if they know a word or not, they 'said' it to themselves to try to recall its meaning. E.g.

I did... sometimes when I try to pronounce you know,... like I may know that word actually, but you know like I just confirmed, oh I don't know this word. (Emma)

Like when I just look at this word, I did not pronounce it. I did not know its meaning. Or I just forgot it. But I tried to pronounce it in my head, like sermometer, sermometer [thermometer], all of a sudden I got this meaning. (Ben)

One participant mentioned hearing their inner voice reading the L1 pronunciation of a word:

Sometimes like Japanese pronunciation comes in. ... it's sort of direct translation or direct use of English language in Japanese, but in the Japanese pronunciation, for example, like thermometer, maybe pronounced in Japanese sa-mo-men-ta.

(Remarks: Katakana in Japanese is used for foreign loan words, but its representation of the foreign sounds is often not faithful because Japanese has a simple sound system (Taylor & Taylor, 2014).

All participants reported that they heard the voice some of the time only. Some participants described the situation when they did not hear an inner voice. Daisy mentioned that when she has already learned a word, e.g. *Phytochromes*, she did not read it with inner voice when seeing it again. Alex mentioned that he did not recall hearing the inner voice when he was not trying to understand something. The example given was the word *scalpels*:

I didn't even try to read it (with inner voice in his mind)... I didn't even try to understand what the meaning of the word was. It's something like professional. I kind of like regarded it as that. (Alex)

However, Alex and Daisy also mentioned later in the interviews that they believed the voice was there all the time during reading. E.g.

I'll try to think what I did. I think I've heard everything. (Alex)

Ben explained that he did not read out the text word by word when reading something easy:

I think it (whether the inner voice was there all the time) actually depends on the extent to which the text is difficult to me. Like, as for the easier part.... I would not like reading "an international team of scientists". I read it as a like more complicated phrase. Like, this is a part, then led by the University of Cambridge as another part. (Ben)

Two participants, Ben and Daisy, recalled they also heard an inner voice during RWL. E.g.

I'll read it to myself without speaking, right. I'll be, like, "researchers from the European organization", but all of it is going in my mind. I'm not speaking any words. (Daisy)

Participants did not explain why they heard it, but they mentioned their inner voice and the audio voice were not at the same pace. E.g.

Even when the video [audio] was playing, I still got a voice in my head like reading, you know, like got different paces. (Ben)

(ii) Dealing with words with unsure pronunciation

Participants were asked whether there were any words which they were unsure how to pronounce when reading during RS and RA, and any words that the audio pronounced differently to the way they would have pronounced them during RWL; and if yes, what they did or thought. Participants dealt with words of whose pronunciations they were unsure differently in the three conditions. First, they reported many more instances of strategies or behaviours dealing with pronunciations of words during RS and RA, and almost none in RWL. In both RS and RA, what they did most often fell into the category of "check if the word is important or whether it will impede understanding". E.g.

It seems like a very important word. In this text. (Alex)

In RA, some participants mentioned that they tried to decode the words by breaking down a word into smaller parts, or by relating it to words with similar spelling or pronunciation. E.g.

I broke it down like fee, and then fee-sant (pheasant). So it reminds me a lot of "peasant"? So I use like this fee, because I know PH is an F sound. (Daisy)

In RS they reported doing the same, but fewer instances. One participant, Alex, also mentioned he looked at the word “as a kind of image” in RS. E.g.

I don't have to, stay long on those two words, but I can just jump I can just look at it as the kind of image. (Alex)

The impact of words with challenging pronunciation also seems to be different in the different reading conditions. In all three conditions, participants often reported that being unsure about the pronunciation of a word, or the audio’s pronunciation being different from their own, had “little or no impact on comprehension”. Indeed, during RWL, all codes belong to this category, broadly speaking. E.g.

I was glad to hear how it was pronounced, but I didn't really think anything more about it. (Daisy)

During RS and RA, participants also mentioned (albeit less frequently) that words with challenging pronunciation did not affect their comprehension. E.g.

It didn't impact my comprehension. I just thought, well, that's a funny name. (Alex)

In RS, they also reported that the word “slowed down reading”. One participant, Ben, seemed to have “difficulty in recognising the word” of whose pronunciation they were unsure:

Like I don't know, it's pronounced as ser-mo-meter [thermometer] or what, cause like there's another pronunciation in my mind, like in my head, but it's kind of different from that. I will like, spontaneously pronounce it as “ser-rom-meter”. But, when I look at this word, I will pronounce it “ser-more-meter”... I haven't read or heard this word for a very long time. Like, at first sight, the memory about this word wasn't woke up in my head. (Ben)

In RA they mentioned “distraction”, “slow down reading”, and that they pronounced words “without understanding or missing out content”. E.g.

While I was looking at these names, I ended up speculating about how to pronounce them, and that might have distracted me a little bit. (Carson)

For example, the word cladistics. I just, try to pronounce it without necessarily remembering what it meant. (Daisy)

4.3.2 Research Questions 4b & c

4b What do readers perceive to be the key affordances of each modality, in terms of comprehension?

4c What do readers perceive to be the key challenges of each modality, in terms of comprehension?

Participants' perceptions of key affordances and challenges of each modality in terms of comprehension were grouped into four main categories, "attention and effort", "audio pace", "use of reading strategies", and "word recognition or decoding". See Appendix G for these categories and the sub-categories. Readers' perceptions vary greatly, and the same category can be perceived by some as affordances in a certain reading condition, but as challenges by others, or as affordances in another reading condition. Due to this diversity, in the following I will first report participants' perceptions by case. I will then draw a summary across cases by reading condition.

Alex

Alex found reading in RS the easiest, because of "use of reading strategies" - he could adjust reading pace and re-read. E.g.:

Pace myself, if that's the right word,... like I can go back and read the paragraph again and then I kind of like grasp the information most accurately.

In addition, he reported "increased attention" during RS as he could *focus more on the message*.

He mentioned a disadvantage of RS is that he "cannot sound out words". He recalled instances that he had to resist himself from reading out loud. E.g.:

I had to suppress myself from reading it out loud... you know, like the Phytochromes? ... I have to kind of imagine myself, hearing my voice in Phytochromes, so that was a kind of suppression for me, and inhibition? ... That was I think that would be the hard part.

Although he read aloud the text very well (mark=4.7), he found RA the hardest for comprehension and could not think of a benefit. The challenge was that part of his attention was diverted to pronunciation of words instead of understanding the content. E.g.:

Because reading out loud made me kind of focus on like, saying the word properly....I couldn't focus more on the contents of the text.

He enjoyed RWL the most, although his perceptions were half-half. He liked it because he *didn't have to stop to confirm the pronunciation of some words*. He mentioned *confirm the pronunciation* a couple of times during the interview, sometimes when he recalled hearing inner voice when encountering a new word during RS. See his quotation in 4a) above.

Another affordance reported is that he felt some words become more *explicit* because of the pronunciation of the audio:

So if it's a difficult and unfamiliar word,... you have to really focus on the word, in order to remember it, and recognize it, in future texts, right? But because he read Rene Barjavel like in a French way....that the person in this text was very,... It's very, very explicit to me.

However, he also reported several challenges related to “attention spilt because of reading and listening at the same time”, “audio pace too fast or too slow”, and “cannot re-read”. He recalled several instances when he tried to re-read but couldn't, or he re-read *regardless of the audio* and consequently his reading and listening were not at the same places. E.g.:

To grasp the text, I have to go back to the paragraph again and read it again. But then the audio is going on, so I couldn't do that. So in that sense, it could be a bit fast, if I could not pause.

It's kind of something that I'm familiar with. So I could kind of like skim read and then Oh I know what this means... So I just read it fast, and then I just went back to (Paragraph) D ... and then read it again, while the audio was like slowly reading line three and four.

Ben

Like Alex, Ben believed what facilitated reading in RS was that he was able to adjust reading pace and re-read. When asked what made it harder he reported a problem related to “word recognition or decoding” which seems to only challenge him but not other participants. E.g.:

When I come across some new words, with different pronunciations or just the same word, I would try to go back to the place where, like Pe-to-chromes (Phytochromes) was talked for the first time, to check whether they are the same word, because I can easily forget the pronunciation of the word.

He also described some strategies he used to decode the word:

Like every time I come across the same word, I may pronounce it in different ways... For example, like you can just look at it and use some intuition, to read it as like pe-to-chromes. Or when I saw it for the second time, I can guess the pronunciation from its, how it's spelled, like PHY. I can guess the pronunciation from like some similar words like Physics. I may call it fe-to-chromes, instead of pe-to-chromes. So like every time I can have different ways to pronounce the same word.

During the interview, when he tried to say the word *Phytochromes*, he also came up with different pronunciations – “*fittle-chromes*”, “*photo-chromes*”, “*fee-pe-ter-chromes*”.

He described a similar situation with the word “thermometer”. See his quotation in 4a) above.

Despite some difficulties observed in his oral reading (mark=2.5), he found reading in RA the easiest and liked it most. He felt that it helped him “stay focused”. E.g.:

It keeps me focused on understanding the text, like I would not easily get lost or think about other things when I have to stick to the task of speaking.

However, he also mentioned his attention was split and “get lost” during reading aloud. E.g.:

My attention is more diverted to the task of speaking instead of understanding.

When you come across some long sentences, ... you get lost in the process.

He found RWL the hardest, although his score in RWL is the highest among the three conditions. Like Alex, he experienced attention split arising from the different paces between his reading and the audio and his attempts to re-read. A special phenomenon is that his inner voice was also there along with the audio and he had to stop his voice. E.g.:

When it comes to the complicated part... you just think it's [audio] too fast. It does not allow you enough time to process this new information...sometimes you get lost.

When my inner voice goes faster than the video [audio], I will ask my inner voice to stop here and listen to the video, and when I miss some part or like of the video, for example, I did not catch up with the video, I will like use my inner voice to replay the part that I missed.

So I think these two voices are in conflict with each other. I don't know which one to listen to.

He believed what helped him during RWL was that he adjusted his strategy and focused on main ideas:

In the beginning, I use a similar strategy that I use in the previous two scenarios, like I rely more on the pronunciation, but when the listening comes in, ... it's too difficult... So I focused more on understanding the passage, or the paragraph on the whole.... instead of like focus more on details so that I can keep pace with it.

Carson

Carson found reading in RWL the easiest, because there was “no need to decode or confirm pronunciation”, and “less effort” was needed for reading. These are perhaps best represented in the following comment:

Like here I could sort of just relax and take it in. I didn't feel like I was really trying to remember things actively... it reduced the pressure on myself to understand everything, like when I'm reading on my own, I'm trying to understand what was in the text and focusing a lot on that. When I was reading and listening at the same time, it was, like, I think I mentioned in the first experiment that I felt a voice in my head reading out some of the words... So in the third experiment..., the voice in my head was like somebody else was making the voice,... so I could, for example, while reading I could ignore a few words, I'm not look at them in too much detail, because I knew that the voice would read them.

He also liked the audio pace:

The pace at which the reading was happening was perfect. It gave me enough time to digest what was being discussed.

He found RA the hardest, despite his excellent oral reading (mark=5). He reported attention split and more effort needed because of thinking about how to pronounce words and where to take pauses.

E.g.:

Since I was paying so much attention to my own voice, pronouncing things correctly, and figuring out what each word sounded like, I was actually spending less attention, less focus on the meaning of what I was reading.

I hadn't taken enough pauses. And I felt quite conscious of how I'm pronouncing each word.

He mentioned he had to *spend more mental energy on pronunciation* and because of that *knowledge sort of slipped away*.

What he felt to be affordance was that he parsed sentences into clauses during RA:

Like if I read it without breaking it into clauses, it may have been harder for me to remember anything at all. But the fact that I broke it into clause has made it easier for me to package the information.

His perceived affordances and challenges of RS are all related to “use of reading strategies”. He considered being able to skim and re-read as advantages. E.g.:

I was able to, first passed through the entire thing. I read it very quickly and tried to make sense of, like the flow of the piece. Then I could skip to different parts of it, and reread sections that I didn't understand, ... it felt more flexible in my mind because I could jump from piece to piece.

He also felt it was “harder to visualise” or picture the content in RS.

Daisy

Daisy expressed a strong preference for reading in RA. She felt “less effort” was needed to achieve understanding. E.g.:

At least in English, I do tend to read out loud more because, I feel that way I understand things easily. Or easier. When I'm reading silently I do find myself having to reread the same thing a couple of times, in order to again have that understanding, and if I'm reading out loud, it takes fewer attempts to get there.

Unlike others, she did not complain much about distraction during RA, although she also mentioned she “get lost” when reading long sentences. The perceived challenge for RA is that she could not re-read (in this study):

I couldn't go over the same parts, one or two times, if I hadn't understood it. Because I'm only reading it once.

She perceived reading in RS the easiest. Like other participants, she believed what helped was that she was able to use some strategies as needed. However, a challenge is that she “cannot sound out words”:

I was like, oh no, I need to read this silently. Haha, so I've been just continued silently.

She found RWL the hardest. She often found the audio too slow, and reported a number of instances when she needed to make some effort to make sure her reading and listening were in sync. A behaviour she often mentioned was re-reading, either because she wanted to go over something again, or she had nothing left to do. E.g.:

If he was going slower than I, I would want to take advantage of the extra time, and read something again. But then, sometimes I found that while I was rereading it, he would already, you know, be past that section or that sentence. And then I had to catch up.

Other times because he was just so slow. I was like, OK, let me reread this again while he's still doing that.

She also mentioned examples when she felt part of her attention was diverted to the audio's pronunciation of words. E.g.:

When he's given the pronunciation in French, sometimes I spent too much time being trying to remember how he pronounced things, it's like enjoying the way he pronounced it.

Emma

Emma found reading in RWL the easiest. She commented that *it helps my understanding of the text.*

Very well. Nothing like I can read it myself.

She found RWL helped her “stay focused”, and it required “less effort to understand”. E.g.:

Maybe the audio works as a pacemaker as well... help me to concentrate.

It was just easy to follow you know like being sort of passive, do you understand? And then reading in silence or like yourself, needs more, sort of, concentration.

Just follow the voice and then you know like go with the text... like easy to listen and read at the same time, and then I think it is much easier for me to understand the meaning of the text and sentence.

She felt that the audio pace was *the right speed to understand*. She also mentioned she did not need to worry about pronouncing words. E.g.:

I don't need to be stuck in the unfamiliar words, to which I don't know about, you know the pronunciation. That's I think part of the reason why it feels easy.

While she also described similar challenges of RWL reported by others, that is being unable to use certain reading strategies, she added that it was not an issue for her in reading the text in this study.

She made little comments on RS but she appreciated that she was able to read speedily in this condition.

She found RA the hardest. She experienced similar challenges like other participants in terms of attention split and word decoding. E.g.:

In the debating part, there's several different sort of like reasons and standpoints, so I may need it to like you know structure my thoughts, but when I'm reading loud, it's a little bit you know like difficult to, like to think, and then read, together.

There's some of the words and vocabularies. And I kind of stuck with pronunciation... my attention is, it was more on the pronunciation and then not really understanding the text.

Summary

RS

The most frequent affordances mentioned by the highest number of participants are related to “use of reading strategies”. The sub-categories are “able to adjust pace” and “able to re-read”. All 5 participants commented that they were able to read with flexibility like speeding up, slowing down, or skimming through different parts of the text, and re-read more difficult parts as needed.

Regarding challenges, the trend is less obvious, but three participants reported codes related to “word recognition or decoding”. Two participants wanted to sound out words during reading, but realised that they should not, since they were supposed to read silently. One found it difficult to identify words when they were unsure of the pronunciations.

RA

Opinions concerning affordances are quite divided. Two participants could not think of any. Two mentioned codes about “attention and effort”. They either felt that it helped them to stay focused, or less effort was needed to achieve understanding.

However, the common challenges experienced by participants are also about “attention and effort”. Participants, to a different extent, reported their attention was split because of difficulties in reading aloud the text and thinking about what it means at the same time, or they “get lost” at some points during reading aloud. Their comments are often related to Paragraph E of the text, which involves debates about whether birds were evolved from dinosaurs. Participants referred to it as the “logic part” or “long sentences” in the interviews.

RWL

Perceptions about RWL are the most diverse among the 3 conditions. There is no major affordance or challenge shared among participants. Concerning affordances, three participants felt that there was “no need to decode or confirm pronunciation”. Two felt the “audio pace is just right”. Two felt that “less effort” was needed for reading.

However, three participants experienced “attention split or overload because of reading and listening at the same time” rather frequently, and felt that the “audio pace is too fast or slow”. It seems that their reading and listening were sometimes not at the same places. They also found it a challenge when they were unable to use strategies like adjusting pace or re-reading during RWL.

5. Discussion

There does not seem to be consistent patterns in terms of participants' reading performances across the different reading conditions. Also, their perceptions and experiences reported are wide-ranging and vary from each other considerably. This section will focus on the major similarities and differences observed in the three reading conditions, and the role of phonology in reading as suggested in these conditions.

5.1 Difficulties in decoding during RA hampered comprehension

Participants' average mark in RA is the lowest among 3 conditions. This is the case even for Carson, who reported being very familiar with the topic. Some of them like Daisy had to spend much longer time on reading in RA than in RS. All these results seem to suggest their reading comprehension was negatively affected during RA. This is also supported by participants' perceptions. They often reported that it was difficult to think and read aloud at the same time. Part of their attention was diverted to figuring out how to sound out words, where to take pauses and so on, and taken away from understanding the text. This seems to suggest at least some level of competition for cognitive resources in working memory (WM) during reading, as predicted by the automaticity theory (LaBerge & Samuels, 1974) and interactive compensatory model (Stanovich, 1980). As participants' lower-level reading processes draw on more attentional resources in WM, which are limited in capacity (Baddeley & Hitch, 1974), to decode individual words and parse sentences, it is likely that fewer resources would then be available for participants' higher-level comprehension processes (LaBerge & Samuels, 1974), or resources were drawn from higher-level processes to compensate for lower-level ones (Stanovich, 1980). It is probably why participants found it more effortful to understand what they were reading. Some participants reported feeling "knowledge slipped away" or "got lost" at some points during RA. This could be explained as a result of their WM being overloaded when both lower and higher-level processes required attention, and some information in the system was thus lost (Baddeley, 2003).

Further evidence for increased cognitive load due to resources paid to pronunciation can be seen from participants' reports of some strategies to decode, e.g. breaking down a word into pieces to guess its pronunciation. They felt distracted, or their reading slowed down, or they could pronounce without understanding when encountering words with challenging pronunciations. These are in line with their actual oral reading performance. Some participants made a number of pronunciation mistakes, self-corrections, hesitations, repetitions when reading aloud. The problem is particularly serious in Paragraph E, which involves major debates of a theory, and long, complex sentences. This probably means a higher level of intrinsic cognitive load (Paas & Sweller, 2021), as the material is

inherently more complex, and word orders in a complex sentence have to be considered in WM simultaneously (Tindall-Ford et al., 1997). When intrinsic load of the material is already high, the competition for attentional resources in WM seems to be even more intense when readers experienced difficulty in phonological decoding.

It has been argued that fluent readers need to convert print to sound automatically and accurately, so as to allow effective reading (Kuhn & Stahl, 2003). Although participants in the current study are all advanced ESL students and have a similar level of overall English proficiency, the quality of their oral reading, at least in this study, varied rather widely (scores ranging from 2.5 to 5). Furthermore, regardless of how well they actually read aloud, they nonetheless expressed some level of distraction in oral reading. It does not seem to be an effortless task. Carson, for example, who read aloud with excellent scores, suffered an obvious drop of comprehension in RA. Even advanced learners, when reading academic texts which typically contain low-frequency words such as technical vocabulary (Fang, 2012), may still encounter decoding difficulties. As was seen in Table 3, the commonly mispronounced words (or words they struggled with) are generally low-frequency words. Some may be unknown to the readers. It appears that these words impose strain on the participants, particularly those who might be weaker in phonological decoding, such as Ben, who for example made some minimal pair mistakes e.g. /eɪ/ versus /e/.

Results from this study seems to be very different from those of Alshumaimeri (2011), where beginner-level ESL students showed higher comprehension scores in RA than RS. However, it is unclear what instructions were given to their participants and whether they read aloud the text, or parts of the text, more than once. Results could have been very different when RA is coupled with re-reading (Grabe & Stoller, 2020). In the present study, a limitation is that participants were not instructed as to whether repeated reading was allowed during RA. Participants usually assumed that they could only read aloud the text once, while Ben re-read various parts of the text. It should be noted that both Ben and Daisy preferred RA. Daisy felt she could understand more in RA but her concern was that she could not re-read under this study's condition. Ben is the only participant whose mark in RA is higher than RS. He felt RA helped concentration because he had to "stick to the task". However, when asked why he repeated certain parts, like others, said that his attention was paid to reading aloud instead of understanding, so he had to start over again. Therefore, there is still a sense of competition within limited working memory resources.

Previous studies have demonstrated positive correlations between oral reading fluency and English L2 comprehension (Jiang et al., 2012; Kim, 2004; Pey et al., 2014; Saiegh-Haddad, 2003). However, in this study, it does not seem that fluent readers scored higher on the comprehension test, and nor

did the least fluent oral reader score the lowest. One reason could be because the participants in the cited studies were beginner or intermediate-level ESL students, unlike the advanced learners in this study. Jenkins and Jewell (1993) found a diminishing correlation between oral reading fluency and comprehension among L1 primary school students as their grade levels increased. They explained that, as children's decoding skills develop, world knowledge and language comprehension start to exert a greater influence on reading test performance. It is possible that these other factors played a stronger role in reading among the advanced learners in the present study.

5.2 Interplay of inner voice, working memory, and dual-route word recognition during RS

The findings of this study add to our understanding of the role of inner speech when reading silently in L2. All participants reported they heard an inner voice. This is consistent with the research in L1 indicating that inner voice is a common phenomenon (Huey, 1908; Perrone-Bertolotti et al., 2014). All recalled hearing it when they were reading new words, in particular "Phytochromes". This seems to be compatible with Coltheart's (2005) dual-route model of word recognition. Since Phytochromes is likely to be a new word for participants, it has to be read with the non-lexical route (Baron, 1977). It appears this inner pronouncing of the word gave rise to the phonological codes in one's mind, which according to Rayner et al. (2011), resulted in the experience of inner hearing of sounds. In addition, participants recalled saying the word to themselves more than once to remember it. This indicates a subvocal rehearsal process as suggested in Baddeley's (2003) WM model. Through subvocalization, which in turn became the source of inner voice (Rayner et al., 2011), the word in print was converted into acoustic form and was retained in the phonological store for processing. It seems that participants in the present study tried to sound out and rehearse the word in their mind to enhance its sound representation and lengthen its stay in the loop, assisting them to process and retain this new word in working memory. This also seems to be in line with the notion that the phonological loop's major function is to help learn new words, but not remembering familiar words (Baddeley et al., 1998; Papagno & Vallar, 1992).

Most participants also reported hearing an inner voice when re-reading difficult sentences or important ideas, in addition to individual words. This again suggests the importance of subvocalization in supporting reading processes in the phonological loop. A possible interpretation is that sound codes are particularly important in bolstering the functioning of WM when reading complex ideas, since the earlier part of the sentence would need to be there when one continues to take in new information in the later part (Rayner et al., 2011), and all words and their relationship need to be considered simultaneously (Tindall-Ford et al., 1997) in WM so that they can be chunked into meaningful phrases. This probably also explains why two of the participants, Alex and Daisy, felt

that a challenge during RS was that they wanted to, but could not sound words out. It could be because subconsciously they wanted a more explicit voice to help them read a more challenging text like the one used in the present study.

Two participants, Ben and Emma, also seemed to use inner voice to help them recall word meanings, although the attempts may or may not be successful. Upon “pronouncing” a word to themselves, they either realised that they knew the word, or “confirmed” that they did not. In addition to “Phytochromes”, both cited “thermometer” as an example. Ben mentioned he “haven’t read or heard this word for a very long time”. He also reported trying to break down the word into shorter chunks to pronounce it inwardly. This suggests the use of non-lexical route in reading low-frequency words (Coltheart, 2005; Paap & Noel, 1991). “Thermometer” is a relatively infrequent word (K-8) (Cobb, n.d.). Participants probably did not recognise the word on sight, and thus the non-lexical route was required. Their inner pronunciation gave rise to an inner voice during reading. When the word was successfully decoded, the sound was retrieved, and so was the word meaning. When a word was not in one’s lexical memory, no lexical entry was retrieved even after decoding, and the word was still not recognised.

All participants reported hearing the inner voice some of the time only during reading, although two participants mentioned they heard it all the time later in the interview. Participants seemed to be conscious of it more vividly in some situations than others. The examples they recalled are mainly related to difficult words or parts in the text. Ben mentioned an example of abbreviated form of inner voice, when he did not seem to read out every word fully in easier parts. These findings are in line with other studies which reported that participants experiencing more prominent inner voice when reading difficult texts e.g. (Sokolov, 1972). Alexander and Nygaard (2008), and Ehrich (2006) have explained this using the dual-route theory. This explanation seems to fit the findings of the present study as well. As discussed above, participants seemed to have used the non-lexical route when reading new and low-frequency words. It follows that they might not have used this route at other times, resulting in not hearing the inner voice. It is likely that they used a combination of lexical and non-lexical routes in parallel and in supplementary to each other, as suggested by the dual-route theorists (Coltheart et al., 2001). Access to phonological information could be optional in RS (Treiman et al., 1983). When reading familiar words, the lexical route dominates. These words could have been recognised by the participants before they were fully decoded, leading to no or weak inner voice.

Another factor related to incomplete inner voice is readers’ use of strategies. A common affordance in RS reported by participants is that they were able to adjust reading pace or re-read as needed. As

discussed, when participants re-read new words or difficult concepts, they were likely to hear an inner voice in the rehearsal process. It could also be possible that when they were skimming through easier parts, their inner voice was less involved. This could be in turn related to the use of the lexical route for reading on sight. This direct route enabled them to read quickly (Morris & Folk, 2000). Even when something is difficult, readers may not put effort into decoding it. Most participants mentioned they would decide whether a word is important for understanding. If not, they usually would not worry about how to pronounce it, even though the word might be new to them. They may just “view the word as an image”. Taken together, inner voice seems to be a flexible mechanism sometimes, working partly at the discretion of the readers’ use of strategies.

This probably explains why difficulties in decoding did not seem to hamper participants’ comprehension during RS as much as RA, as reflected in the comprehension scores. In addition to a perhaps more dominant lexical route when reading high-frequency words, participants sometimes did not seem to attempt to decode a word with challenging pronunciation (or at least, attempt to decode it accurately) in the RS condition, when they found that the word is not important for comprehension. Viewed together, the task of words decoding may not consume the same level of attentional effort required for RA, and as such participants did not complain about attentional split because of that. Nevertheless, they still reported some negative effects when dealing with words with difficult pronunciation, i.e. slowing down. This is again consistent with the view that the decoding process competes for cognitive resources.

However, it seems that the extent to which decoding difficulties affect word recognition differs among participants. Ben seems to have experienced more difficulties in recognising a word when he was not sure of its pronunciation, e.g. *Phytochromes*, *thermometer*. He reported this as a challenge during RS. Both “Phytochromes” and “thermometer” are key words in the passage. It is not simply that Ben pronounced the words incorrectly. The problem seemed to be that he could not get a consistent pronunciation for these words, and consequently had difficulties recognising them. Both the inaccurate, and unsure pronunciations suggest a weaker grapheme-phoneme correspondence knowledge. This could result in the activation of more than one phonological representation for one orthographic pattern (Unsworth & Pexman, 2003). Ben’s decoding of “Phytochromes” as “fittle/peto/photo-chromes” seems to be a case in point. This also illustrates how English as an opaque language can create confusions for learners (Frost, 2005). “Phy” in “Phytochromes” and “Physics” share the same letter string but are pronounced differently (“faɪ” vs “fɪ”). It appears that although Ben attempted to learn or recall words during reading with his inner voice, it sometimes did not produce reliable phonological representations. This, as Walter (2008) argues, will lead to more information loss in the phonological loop, and thus comprehension difficulties. This does not

seem to be an equally serious problem for other participants, who did not report challenges related to this area during RS. It should be noted that despite spending the longest time on reading, Ben's mark in RS (2) was lower than his marks in the other conditions, and was lowest among all participants in RS. It is likely that one reason for this weaker performance was weaknesses in his decoding/word recognition skills.

5.3 RWL: an aid for decoding, or a source of interference due to split attention?

Participants' perceptions were the most diverse for RWL. While Carson and Emma liked it the best, Ben and Daisy found it the most difficult. Alex held a more neutral view. What further complicated the picture is that participants' actual comprehension scores in this mode were sometimes very different from their perceived level of comprehension. A closer look at the data revealed some interactions among the four themes from the codes: attention and effort; audio pace; use of reading strategies; and word recognition or decoding.

While one participant, Daisy, reported that part of her attention was diverted to the audio's pronunciation of words, which might be different from the way she imagined the pronunciations during RWL, this did not seem to be a widespread problem. Participants reported almost no strategies to deal with the different pronunciations, and felt that such differences had little or no impact on their reading. The main complaint from Alex, Ben, and Daisy was split attention due to reading and listening at the same time. From their description, what they shared is that they often found the audio either too fast or too slow, and attempted to use some reading strategies to read at their own pace, irrespective of the ongoing audio. When they felt that the audio was too fast and there was not enough time for them to understand the text, they returned to earlier parts to re-read. Sometimes, however, when they found the audio too slow, or they did not need to attend to some details, they read ahead of it. Due to this mismatch, from time to time their reading and listening were not at the same places, and they experienced some difficulties trying to attend to both of them, or attend to one only and not to be distracted by the other. However, since they needed to keep pace with the audio or they would lose the text, they constantly adjusted their reading pace to realign with the audio. All these implied an increased level of mental effort, which could be detrimental to their comprehension. These results seem to support the notion of cognitive load theory (Paas & Sweller, 2021; Sweller, 2004), which states that simultaneous presentation of spoken and written formats of information is redundant. It creates extraneous cognitive load, as learners need to coordinate the two sources (Kalyuga & Sweller, 2021). Their attention will be split between the sources, consuming WM capacity which could be used on learning otherwise.

These perceptions from Alex, Ben, and Daisy are partly in line with those of Diao and Sweller (2007), Luchini et al. (2016), and Machado and Luchini (2018), who found ESL students' reading comprehension in RWL worse than RS, and attributed this to a redundancy effect. It should be noted, though, in the current study, only Alex's comprehension dropped in RWL compared with RS; Daisy's score remained the same, while Ben's score was actually higher. These participants nonetheless all experienced the "interference of concurrent spoken presentation" speculated by Diao and Sweller (2007, p.84). The current study provides qualitative data to further explain what kind of interference readers may experience. The main source of split-attention seems to be a mismatch of the audio pace and the reader's own pace. This corroborates Yang et al.'s (2022) suggestion that this mismatch could cause visual attention loss during reading and possibly cognitive load. Participant's experience indicates that the direction can be both ways – learners can read faster, or slower than the audio, and because of that, their reading and listening are sometimes not in sync. This problem is exacerbated when readers attempt to employ strategies to re-read or skim during reading. It is well-established that good readers are characterised by effective use of reading strategies (Anderson, 1991; Chamot, 2005). They monitor their comprehension and make adjustments in response to comprehension difficulties (Grabe, 2009). In this sense, the inflexibility imposed by the audio could interfere with learners' reading process. All this could overload WM, which coordinates the limited attentional resources required for both lower-level processes (i.e. the split decoding processes between audio and written input), and higher-level processes (i.e. monitoring comprehension and applying reading strategies).

Another related source of interference is readers' inner voice. Ben reported that he still heard the inner voice even during RWL, and he "don't know which one to listen to" because the "two voices are in conflict with each other". Ben apparently experienced serious attention split. Considering Ben spent 9 minutes 34 seconds on reading in RS, while the audio length is 4 minutes 51 seconds, it is no surprise he found the audio too fast. As discussed, although the inner voice during RS may not always be there, it may be more prominent when reading something new or difficult (Alexander & Nygaard, 2008). When there is an 'outer voice', however, in the form of the audio recording, the reader's own reading voice could be disrupted, especially when the outer and inner voices are not synchronized. Ben needed to "ask my inner voice to stop". It seems the generation of inner voice may be automatic for some people, and as such some effort was needed to stop it to keep only one voice at a time.

In contrast, Carson and Emma were positive about RWL, finding it a great help for comprehension. They felt more relaxed but also more focused. Emma's mark in RWL is the highest among the 3 conditions, while Carson's mark is as high as that in RS. Researchers who reported increased

comprehension performance from reading in RWL over RS e.g. (Amer, 1997; Askildson, 2011; Chang & Millett, 2015; Woodall, 2010) believe that one way in which RWL facilitates reading is by assisting learners' decoding process. Findings from this study support this notion. Emma believed RWL helped because she "don't need to be stuck in unfamiliar words". She felt "stuck" with pronunciations of some words in RA. Her oral reading (score=3) reflected a number of hesitations, repetitions, mispronunciations. Carson, by contrast, did not worry about pronunciation and had the best oral reading score (5). Nonetheless, he felt that during RWL he "could ignore a few words" and did not "look at them in too much detail", because "somebody else was making the voice". Alex, despite holding a mixed opinion about RWL, and also had excellent oral reading, felt he did not have to "stop to confirm the pronunciation" and some words became "more explicit" and easier to recognise with the concurrent audio. All these probably indicate that the audio aids readers' phonological decoding by providing concrete pronunciations of words, which is likely to contribute to the non-lexical route of word recognition, and strengthen any phonological representations in WM. Considering (a) that all participants reported challenges in thinking and reading aloud at the same time, (b) their mispronunciations or hesitations during RA, and (c) their use of inner voice to assist them to read during RS, it seems highly likely that the audio can bolster one's comprehension by releasing attentional capacity taken by decoding. This may also be why Carson and Emma felt they could concentrate better and read with less effort during RWL.

In view of the above, the concurrent audio during RWL does not seem to be "redundant" and "additional information not required for learning", as suggested by Kalyuga and Sweller (2021, p.212). The findings of the current study suggest that their notion that written/spoken text redundancy is "especially evident in learning a second or foreign language" (p.217) may need to be reconsidered. Proponents of Cognitive Load Theory believe that since a great deal of WM resources from language learners are needed for decoding text in one modality, let alone two, little resources will be left for building connections between audio and visual input (Diao & Sweller, 2007; Kalyuga & Sweller, 2021; Machado & Luchini, 2018). Findings from the present study indicate that the opposite may be true, at least for some high-proficiency L2 learners. It is precisely because WM resources are required for decoding written text, accurate, reliable phonology – as generated by an audio recording – could provide support for second language readers. Although Kalyuga and Sweller (2021) maintain that redundancy can be reversed for less expert learners, they believe this is limited to learners who have difficulties learning from written text, e.g. dyslexia. This view seems to overlook the important role of phonology in reading and the potential challenges in L2 decoding. As this study reveals, even advanced ESL students could have various kinds of difficulties in decoding and symbol-sound mapping, especially when reading academic texts.

Moreover, readers do not necessarily need to expend effort to coordinate audio and visual input. Pace is at the heart of the problem. In RS, all participants felt that a helpful feature of this condition was that it enabled them to use strategies, e.g. speeding up, re-reading. In essence, this means reading flexibly at their own pace as needed. In RWL, if the audio pace is not right for the reader, as in the cases of Alex, Ben, and Daisy, they will tend to read at their own pace, causing the mismatch in pace described above. The audio's beneficial effect of helping learners to decode cannot then be realised, since what learners are reading does not match with the audio. By contrast, when the audio pace matches the reader's, things fall into place. Carson and Emma found the pace perfect for their understanding. They spent very similar time on RS (5 minutes 28 seconds and 5 minutes 25 seconds respectively). Considering participants might have re-read occasionally during RS, their reading pace could be the best match for the audio (4 minutes 51 seconds). They did not report any interference from the audio or failed attempts of using strategies during RWL, even though both of them also regarded being able to adjust reading pace as an affordance of RS.

Audio pace is one reason which may explain why RWL studies yielded such inconsistent results. 76 words per minute (wpm) used in Diao and Sweller's (2007) study, as observed by Yang et al. (2022), is probably too slow for their college-level participants. In contrast, 234.97 wpm in Ari and Calandra (2022) is probably too fast. Both studies reported negative RWL effects on comprehension. The rate of the recordings used by Chang and Millett (2015) was between 82 – 111 wpm, which seemed to work well for the secondary school participants. However, as seen in the present study, which used a pace of 132 wpm, even among a group of learners whose L2 English proficiency is comparable, there are great individual differences in one's reading speed. The same pace may not fit all.

Considering the relationships between the four themes and the five participants, it seems that the effectiveness of RWL is a balance between the benefits it brings for decoding versus the interference arising from a mismatch between the audio input and the participants' own pace of reading. This balance, in turn, will depend on the learners' individual differences – in particular, their decoding skills and reading speed, which can vary greatly even amongst advanced-level ESL students.

6. Conclusion

6.1 Limitations

There are several limitations in this study. First, while piloting did not throw this up as an issue, clearer instructions could have been given to participants regarding how to read during the RA condition, e.g. whether re-reading is allowed, or they could do whatever they would normally. This could have affected their oral reading quality, as well as their comprehension during RA.

While efforts have been made to prepare passages of similar linguistic difficulties and topic area to be used in the three reading conditions, participants nonetheless reported different levels of background knowledge about the texts. While one participant reported knowing much more about the RA text – about evolution of birds from dinosaurs, others reported more knowledge about time travel, the RWL text. This could have affected their comprehension in the respective reading conditions.

Participants shared a lot of their perceptions and experiences during the interviews. However, due to limited space and timeframe, only the information directly relevant to the Research Questions is coded and analysed. It would be interesting to analyse other information as well, such as their experiences in learning English at school, and their use of reading strategies in different reading conditions in the current study.

6.2 Concluding remarks and implications for teaching and learning

Phonology is important for reading comprehension among this group of advanced ESL students. Participants' inner voice was often in use when reading new words or demanding texts, suggesting the essential role of phonology in supporting WM and word identification during reading. While their perceptions varied widely, interestingly they shared one thing in common: they wanted an outer voice to be there during reading, either produced by themselves, or provided by others; they felt that the outer voices helped them to concentrate or enhanced understanding. Ben and Daisy expressed a preference for RA, while Carson and Emma liked RWL. Alex enjoyed RWL most and wanted to sound out words during RS. However, when they needed to expend effort to produce their own voice, especially when encountering difficulties in phonological decoding, attentional capacity in WM could have been consumed, which to some extent affected their comprehension. An outer voice such as an audio recording could facilitate comprehension. However, when the pace of the audio did not match with the reader's own pace, the external voice might hinder rather than help.

There might be no single formula which fits all learners. However, RWL seems to be able to promote comprehension, provided that learners can have some control over reading pace. Auto-text-to-speech could be useful for students, in that digital audio playback often allows the speed to be varied, which might allow people to tailor the pace of RWL to suit their own particular needs. Any extensive reading programmes could be more beneficial if students can read at their own pace and adjust speech rate of the audio. Considering that some learners (such as Ben and Emma in this study) may have more difficulties in decoding; take longer time and/or understand less if they read themselves compared to RWL, some students are probably better off RWL.

As for classroom instructions, due to individual differences in reading pace, if teachers read aloud, they should be aware that it may be the right pace for some students but not for others. Before teachers ask students to read, either silently or aloud, they could pre-teach the pronunciations of technical terms, since students often have difficulties in pronouncing those words, as seen in the oral reading in this study.

Finally, perhaps rather than strictly adhering to a given reading 'condition', learners can adopt a more flexible/hybrid approach. For example, they can read silently most of the time with some reading aloud being used strategically to support word recognition or working memory as needed. They can also choose to read silently sometimes and read with an audio sometimes. Reading silently, reading aloud, and reading-while-listening could be used interchangeably and flexibly.

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Appendix A - Language Background Questionnaire

- 1) Gender: F M Other Prefer not to say
 - 2) Age : 20 – 30 30 – 40 40 – 50 over 50
 - 3) Mother tongue (First language): _____
 - 4) (a) Other language spoken at home as a child: _____
(b) Did you use both first and the other language more or less equally at home, or did you use one language more than the other? Please give as much detail as you can: _____
 - 5) What is your dominant language? (the language that you are most comfortable in and use the most. You can write more than one if you think you have more than one dominant language)

 - 6) At what age did you start learning English? (If you started at birth, write 0)

 - 7) (approximately) Length of residence/study abroad in the English-speaking countries (including previous education, if applicable)? _____
 - 8) How did you learn English? (E.g. at school/home etc.)

 - 9) Have you learned (or studied) any foreign languages other than English? Yes No
If yes, please specify for each language: 1) which language, 2) how long you have learned it for, and 3) in what context(s)

- [Example] I have learned French for 3 years as a part of my coursework in high school.
I have learned German for 2 years because my family moved to Germany during that time.*
- 10) On a scale of 1-10, ten being the highest (native speaker level), what do you believe your level of English is now? _____

Based on what factors are you calculating this number?

11) English Proficiency Test Scores (if you remember)

Test: _____ (e.g., TOEFL, IELTS)

Total score: _____

Reading score: _____

12) When you read in English, how do you usually read?

Read silently read aloud A mixture of silently / aloud

Read with an audio Other: _____

Appendix B - Summary of the linguistic profiles of reading materials

Text	No. of words	Flesch Reading Ease score	Flesch-Kincaid Grade Level	Frequency level (cumulated %)	Examples of words which may be difficult to decode
Plant Thermometer	636	46.1 (difficult to read)	12.6 (college level)	K-1: 72.8 K-2: 81.3 K-3: 93.9 K-4: 95.0 K-5: 96.1 K-6: 97.2 K-7: nil K-8: 98.0	Photoreceptor Phytochromes Arabidopsis Scalpels Culminations
Origins of Birds	646	47.8 (difficult to read)	11.8 (12 th grade)	K-1: 78.0 K-2: 85.3 K-3: 90.5 K-4: 93.5 K-5: 95.9 K-6: 96.6 K-7: 96.9 K-8: 97.9	Entomologist Cladistics Palaeontologist Pheasant Archaeopteryx
Time Travel	641	45.6 (difficult to read)	12.5 (college level)	K-1: 77.8 K-2: 85.2 K-3: 91.7 K-4: 93.5 K-5: 95.2 K-6: 95.7 K-7: 96.3 K-8: 97.8	Neutrinos Progeny Apocalypse Heresy Le Voyageur

Remarks:

(1) Readability is checked using <https://readabilityformulas.com/freetests/six-readability-formulas.php>

(2) For “Origins of Birds”, Flesch-Kincaid Grade Level found is 12.4 during screening, when the original length of the text with 866 words was used for checking purpose.

(3) For lexical profiles, the first 98% coverage is reported in the table.

Appendix C – Reading texts, questions and marking schemes

Article 1

Plant thermometer

- A** An international team of scientists led by the University of Cambridge has discovered that a “thermometer” molecule in plants enables them to develop according to seasonal temperature changes. Researchers have revealed that molecules called phytochromes – used by plants to detect light during the day – actually change their function in darkness to become cellular temperature gauges that measure the heat of the night.
- B** The new findings, published in the journal *Science*, show that phytochromes control genetic switches in response to temperature as well as light to dictate plant development.
- C** At night, these molecules change states, and the pace at which they change is “directly proportional to temperature”, say scientists, who compare phytochromes to mercury in a thermometer. The warmer it is, the faster the molecular change – stimulating plant growth.
- D** Farmers and gardeners have known for hundreds of years how responsive plants are to temperature: warm winters cause many trees and flowers to bud early, something humans have long used to predict weather and harvest times for the coming year. The latest research pinpoints for the first time a molecular mechanism in plants that reacts to temperature – often triggering the buds of spring we long to see at the end of winter.
- E** With weather and temperatures set to become ever more unpredictable due to climate change, researchers say the discovery that this light-sensing molecule also functions as the internal thermometer in plant cells could help us breed tougher crops. “It is estimated that agricultural yields will need to double by 2050, but climate change is a major threat to achieving this. Key crops such as wheat and rice are sensitive to high temperatures. Thermal stress reduces crop yields by around 10% for every one degree increase in temperature,” says lead researcher Dr Philip Wigge from Cambridge’s Sainsbury Laboratory. “Discovering the molecules that allow plants to sense temperature has the potential to accelerate the breeding of crops resilient to thermal stress and climate change.”
- F** In their active state, phytochrome molecules bind themselves to DNA to restrict plant growth. During the day, sunlight activates the molecules, slowing down growth. If a plant finds itself in shade, phytochromes are quickly inactivated – enabling it to grow faster to find sunlight again. This is how plants compete to escape each other’s shade. “Light-driven changes to phytochrome activity occur very fast, in less than a second,” says Wigge.
- G** At night, however, it’s a different story. Instead of a rapid deactivation following sundown, the molecules gradually change from their active to inactive state. This is called “dark reversion”. “Just as mercury rises in a thermometer, the rate at which phytochromes revert to their inactive state during the night is a direct measure of temperature,” says Wigge.
- H** “The lower the temperature, the slower the rate at which phytochromes revert to inactivity, so the molecules spend more time in their active, growth-suppressing state. This is why plants are slower to grow in winter. Warm temperatures accelerate dark reversion, so that phytochrome thermo-sensing evolved at a later stage, and co-opted the biological network already used for light-based growth during the downtime of night.

I The new findings are the culminations of twelve years of research involving scientists from Germany, Argentina and the US, as well as the Cambridge team. The work was done in a model system, using a mustard plant called Arabidopsis, but Wigge says the phytochrome genes necessary for temperature sensing are found in crop plants as well. "Recent advances in plant genetics now mean that scientists are able to rapidly identify the genes controlling these processes in crop plants, and even alter their activity using precise molecular "scalpels", adds Wigge. "Cambridge is uniquely well-positioned to do this kind of research as we have outstanding collaborators nearby who work on more applied aspects of plant biology, and can help us transfer this new knowledge into the field."

Questions and answers for Plant Thermometer

Answer the questions below. (1 mark each for the MCQs)

1. Scientists have discovered that phytochromes have two functions.

True/False/Not Given

2. Plant sensitivity to high temperatures can
 - a) increase crop yield.
 - b) decrease crop yield.
 - c) affect climate change.
 - d) ensure farmers can increase income.

3. Phytochromes change their state at the same speed day and night.

True/False/Not Given

4. In the past, humans were not able to predict the weather or when to harvest their crops.

True/False/Not Given

5. The lower the temperature, the slower the rate at which phytochromes change from their active to inactive state.

True/False/Not Given

6. Phytochromes evolved to be thermo-sensing after they had evolved to be light-driven.

True/False/Not Given

7. The Cambridge scientists' discovery of the 'thermometer molecule' caused surprise among other scientists.

True/False/Not Given

8. How do plants compete to escape each other's shade? Can you explain in your own words?

In their active state, phytochrome molecules bind themselves to DNA to restrict plant growth. (1 mark) During the day, sunlight activates the molecules, slowing down growth. (1 mark) If a plant finds itself in shade, phytochromes are quickly inactivated – enabling it to grow faster to find sunlight again. (1 mark) (any 2 out of 3)

Article 2

The origin of birds

A The science of evolutionary relationships has undergone a major change in recent decades. It used to be the case that all the features of organisms were important in working out their family tree. But following the work of German entomologist Willi Hennig, many evolutionary scientists now believe that the only features which carry any useful information are the evolutionary “novelties” shared between organisms. Mice, lizards and fish, for example, all have backbones – so the feature “backbone” tells us nothing about their evolutionary relationship. But the feature “four legs” is useful because it’s an evolutionary novelty – a characteristic shared only between the lizard and the mouse. This would suggest that the lizard and mouse are more closely related to each other than either is to the fish. This revolutionary approach is called cladistics, and it has been central to the idea that birds evolved from dinosaurs.

B The “birds are dinosaurs” theory was first developed by English palaeontologist Thomas Huxley (1825-1895). According to some accounts, one evening Huxley went to dinner still thinking about a mystery dinosaur bone in his lab. He knew he was dealing with the lower leg bone (tibia) of a meat-eating, two-legged dinosaur belonging to the classification known as theropods, but attached to the tibia was an unidentified extra bone. On the menu that evening was quail, a small bird similar to a pheasant, and Huxley noticed the same strange bone, attached to the quail tibia on his plate. He later realised that it was in fact the bird’s anklebone. More importantly, Huxley concluded that its forms in both dinosaur and bird skeletons were so similar that they must be closely related.

C Huxley’s idea fell out of favour for fifty years following the 1916 publication of *The Origin of Birds* by the Danish doctor Gerhard Heilmann. During this time, Heilmann’s theory was widely accepted. Heilmann had noted that two-legged, meat-eating dinosaurs lacked collarbones. In later evolutionary stages these bones fuse together to form the distinctive ‘Y’-shaped bone in a bird’s neck, known as the furcula. Heilmann proposed the notion that such a feature could not be lost and then re-evolve at a later date, so dinosaurs could not be the ancestors of birds.

D Then, in the late 1960s, John Ostrom from Yale University in the USA, noted 22 features in the skeletons of meat-eating dinosaurs that were also found in birds and nowhere else. This reset the thinking on bird ancestry and once again Huxley’s ideas caught the attention of the scientific community. But what of Heilmann’s missing bones? It turns out that not only did many dinosaurs have collarbones, these were also fused together into a furcula. Unfortunately for Heilmann, the fossil evidence was somewhat lacking in his day.

E US ornithologist Alan Feduccia and palaeontologist Larry Martin are two vocal opponents of the dinosaur theory. They contend that birds evolved from some unknown reptile at a time long before dinosaurs. Their reasoning is that flight is most likely to have started from a tree-climbing ancestor, yet all the proposed dinosaurian ancestors were ground-dwellers. But the dino-bird supporters contend that an unknown dinosaurian bird-ancestor could have been tree-dwelling, or that birds evolved flight from the ground up by chasing and leaping after insects. Most of Feduccia and Martin’s case against the ‘birds-are-dinosaurs’ hypothesis is based on differences between birds and dinosaurs. Supporters of cladistics, however, maintain that differences between organisms do not matter, as it is the similarities between them that count. Evolution dictates that organisms will change through time, so it is only the features which persist that carry useful information about their origins.

F Most people on either side of the debate do accept, however, that the ancient winged creature known as Archaeopteryx is an ancestor of today's birds. This is in spite of the fact that its form is distinctly non-bird-like, with a long bony tail, and teeth instead of a beak.

Comprehension Questions for The Origin of Birds

Answer the questions below. (1 mark each for the MCQs)

1. Cladistics means that scientists

- a) examine biological features of different species to identify similarities between them.
- b) examine biological features of different species to identify differences between them.
- c) examine biological features within a species to confirm ancestry.
- d) (a) and (b) above

2. Cladistics has developed as a scientific approach in recent decades.

True/False/Not Given

3. Thomas Huxley developed his "birds are dinosaurs" theory after comparing a dinosaur leg bone to a chicken leg bone.

True/False/Not Given

4. Dr Heilmann received the Nobel prize for Biology after he challenged Huxley's theory in 1916.

True/False/Not Given

5. What gave Heilmann an 'advantage' in challenging Huxley's theory?

- a) A lack of dinosaur skeletons at that time.
- b) A lack of palaeontologists to check his research.
- c) A lack of money to investigate Huxley's theory in the 19th century.
- d) (b) and (c) above

6. Current opponents of the "birds are dinosaurs" theory argue that because dinosaurs didn't live in trees, they cannot be the ancestors of birds.

True/False/Not Given

7. Both the proponents and opponents of “birds are dinosaurs” agree that the Archaeopteryx is an ancestor of today’s birds because it looks like a bird.

True/False/Not Given

8. According to the Danish doctor Gerhard Heilmann, the writer of *The Origin of Birds*, why couldn’t dinosaurs be the ancestors of birds?

Answer: Dinosaurs lacked collarbones (1 mark). In later evolutionary stages these bones fuse together to form the distinctive ‘Y’-shaped bone in a bird’s neck, known as the furcula (1 mark). Heilmann proposed the notion that such a feature could not be lost and then re-evolve at a later date, so dinosaurs could not be the ancestors of birds (1 mark). (any 2 of the 3 points)

Article 3

Time travel

A Time travel took a small step away from science fiction and toward science recently when physicists discovered that sub-atomic particles known as neutrinos – progeny of the sun’s radioactive debris – can exceed the speed of light. The unassuming particle – it is electrically neutral, small but with a “non-zero mass” and able to penetrate the human form undetected – is on its way to becoming a rock star of the scientific world.

B Researchers from the European Organisation for Nuclear Research (CERN) in Geneva sent the neutrinos hurtling through an underground corridor toward their colleagues at the Oscillation Project with Emulsion-Tracing Apparatus (OPERA) team 730 kilometres away in Gran Sasso, Italy. The neutrinos arrived promptly – so promptly, in fact, that they triggered what scientists are calling the unthinkable – that everything they have learnt, known or taught stemming from the last one hundred years of the physics discipline may need to be reconsidered.

C The issue at stake is a tiny segment of time – precisely sixty nanoseconds (which is sixty billionths of a second). This is how much faster than the speed of light the neutrinos managed to go in their underground travels and at a consistent rate. Even allowing for a margin of error of ten billionths of a second, this stands as proof that it is possible to race against light and win.

D So is time travel just around the corner? The prospect has certainly been wrenched much closer to the realm of possibility now that a major physical hurdle – the speed of light – has been cleared. If particles can travel faster than light, in theory travelling back in time is possible. How anyone harnesses that to some kind of helpful end is far beyond the scope of any modern technologies, however, and will be left to future generations to explore.

E Certainly, any prospective time travellers may have to overcome more physical and logical hurdles than merely overtaking the speed of light. One such problem, posited by René Barjavel in his 1943 text *Le Voyageur Imprudent* is the so-called grandfather paradox. Barjavel theorised that, if it were possible to go back in time, a time traveller could potentially kill his own grandfather. If this were to happen, however, the time traveller himself would not be born, which is already known to be true. In other words, there is a paradox in circumventing an already known future; time travel is able to facilitate past actions that mean time travel itself cannot occur.

F A further possibility is that of parallel universes. Popularised by Bryce Seligman DeWitt in the 1960s (from the seminal formulation of Hugh Everett), the many-worlds interpretation holds that an alternative pathway for every conceivable occurrence actually exists. If we were to send someone back in time, we might therefore expect never to see him again – any alterations would divert that person down a new historical trajectory.

G A final hypothesis, one of unidentified provenance, reroutes itself quite efficiently around the grandfather paradox. Non-existence theory suggests exactly that – a person would quite simply never exist if they altered their ancestry in ways that obstructed their own birth. They would still exist in person upon returning to the present, but any chain reactions associated with their actions would not be registered. Their “historical identity” would be gone.

H So, will humans one day step across the same boundary that the neutrinos have? World-renowned astrophysicist Stephen Hawking believes that once spaceships can exceed the speed of light, humans could feasibly travel millions of years into the future in order to repopulate earth in the event of a forthcoming apocalypse. This is because, as the spaceships accelerate into the future, time would slow down around them.

I Hawking is therefore reserved yet optimistic. "Time travel was once considered scientific heresy, and I used to avoid talking about it for fear of being labelled a crank. These days I'm not so cautious."

Comprehension Questions for Time Travel

Answer the questions below. (1 mark each for the MCQs)

1. It is unclear where neutrinos come from.

True/False/Not Given

2. The scientists at CERN in Geneva made the discovery about neutrinos by passing them through humans in an experiment.

True/False/Not Given

3. The experiment could soon lead to some practical uses for time travel.

True/False/Not Given

4. The theory of relativity has often been called into question unsuccessfully.

True/False/Not Given

5. Why is the Grandfather Paradox called a paradox?

- a) If we can travel back in time, we can't change anything, so time travel is pointless.
- b) If we travel back in time, we might meet our grandfathers and change their lives and this is unethical.

c) If we travel back in time and kill our grandfathers, we are changing history and time travel would not be possible as we wouldn't exist.

d) If we travel back in time, we can make positive changes to history and the world now would be unrecognizable.

6. According to the many-worlds interpretation, each possible event has an alternative pathway, so a time traveller changing the past would simply end up in a different branch of history than the one he left.

True/False/Not Given

7. Stephen Hawking has stated that

A. Human time travel is theoretically possible, but is unlikely to ever actually occur.

B. Human time travel might be possible, but only moving backward in time.

C. Human time travel might be possible, but only moving forward in time.

D. All time travel is impossible.

8. What does non-existence theory suggest? Can you explain in your words?

Answers: a person would quite simply never exist if they altered their ancestry in ways that obstructed their own birth (1 mark). They would still exist in person upon returning to the present, but any chain reactions associated with their actions would not be registered. (1 mark) Their "historical identity" would be gone. (1 mark) (any 2 of the 3 points)

Appendix D - Oral reading rating descriptors

Score	Fluency and Pace	Stress and intonation	Accuracy
5	Speaks very fluently and at appropriately fast pace throughout, with almost no repetitions/self-corrections/hesitations	Stresses in a sentence are nearly always produced, with content words distinctively more prominent; highly appropriate pitch movement which exhibits the rhythmic aspect of oral language is maintained throughout the text	Pronounces all sounds/sound clusters and words accurately and clearly, may have negligible errors
4	Speaks fluently and at appropriately fast pace throughout most of the text, with few repetitions/self-corrections/hesitations	Stresses in a sentence are often produced, with content words reasonably more prominent; appropriate pitch movement is maintained most of the time	Pronounces almost all sounds/sound clusters and words accurately and clearly, with few errors in less common words
3	Speaks generally fluently, but demonstrates at times some repetitions/ self-corrections/hesitations which may appear in a larger part of the text; pace might be sometimes inappropriate/a mixture of fast and slow pace	Stresses in a sentence are sometimes produced, with content words moderately more prominent; a moderate amount of pitch movement, may show some inappropriate/incorrect patterns	Pronounces most sounds/sound clusters and words accurately and clearly, with some errors in less common words and/or common words
2	Tends to speak rather dysfluently and moderately slowly, with a number of hesitations/ repetitions/self-corrections in various parts of the text	Stresses in a sentence are infrequently produced, with content words only slightly more prominent; tend to read in a flat tone with inadequate pitch movement, inappropriate/ incorrect patterns	Some inaccurate or unclear pronunciation of sounds/sound clusters and words, with a number of errors in both less common and common words
1	Speaks dysfluently and slowly/ laboriously, with frequent hesitations/repetitions/self-corrections	Content words are usually not distinguished from function words; read in a flat tone with little pitch movement	Many sounds/sound clusters/words are pronounced inaccurately or unclearly, a high number of errors in both less common and common words

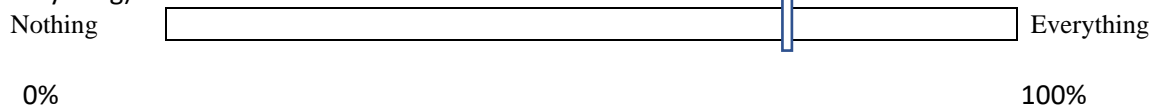
Appendix E – interview questions

Remarks: “Interview questions Part 1” were asked after participants read the text but before doing the comprehension questions, while “Interview questions Part 2” were asked after they finished the comprehension task. Many questions are similar for all 3 reading conditions. Those which are specific to the particular reading conditions are highlighted in blue.

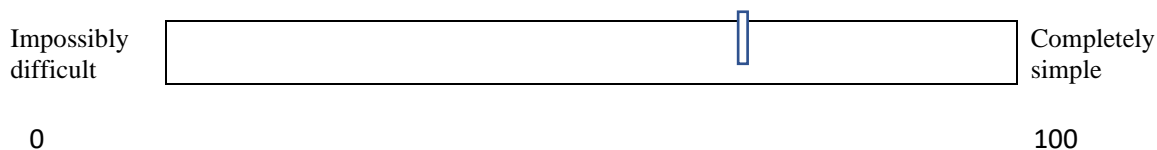
Interview Part 1: self-rating

For all reading conditions: reading silently, reading aloud, reading-while-listening

How much of this text do you think you understood? (0 – 100%, 100% means understand everything)



How easy or difficult was it to understand? (0 – 100, 100 being easiest)



Interview Part 2

Remarks: during this part participants were asked to view the passage again and recall their experiences.

Reading condition 1: reading silently

- Did you hear any voice in your mind when reading?
 - (If yes) what kind of voice did you hear? Whose voice was it?
- Did you "hear" all the words? Or only some of them?
- Were there any words that you were unsure how to pronounce when reading this text?
 - (If yes) Which ones?
 - (If yes) What did you do when you saw those words?
 - (If yes) What impact, if any, did these words have on your comprehension?
- Which parts of the text did you find easy? Why was it easy for you? (look back at their self-rating if needed – is that why you gave x% for your understanding?)
- Which parts of the text did you find difficult? Why was it difficult for you?
- How did you feel when reading silently? What (if anything) made it easier to understand the text, what made it harder?
- How familiar were you previously with the topic of this text? (0 – 100%, 100% means you are extremely familiar with the topic).

- Is there anything else you would like to tell me about your experience of reading that text?

Reading condition 2: reading aloud

- Were there any words that you were unsure how to pronounce when reading this text?
 - (If yes) Which ones?
 - (If yes) What did you do (or think) when you saw those words?
 - (If yes) What impact, if any, did these words have on your comprehension?
- *[If there are other 'problem' words not mentioned above] You paused reading/hesitated here [indicate where in the text]. Why did you do that?*
- Which parts of the text did you find easy? Why was it easy for you?
- Which parts of the text did you find difficult? Why was it difficult for you?
- How did you feel when reading aloud? What (if anything) made it easier to understand the text, what made it harder?
- How familiar were you previously with the topic of this text? (0 – 100%, 100% means you are extremely familiar with the topic).
- Is there anything else you would like to tell me about your experience of reading that text?

Reading condition 3: reading-while-listening

- *Were there any words that the audio pronounced differently to the way you would have pronounced them?*
 - (If yes) What if anything did you do or think when this happened?
 - (If yes) *Can you remember how you pronounced the words and how the audio pronounced them?*
- *Was the pace of the audio too slow, about right or too fast? Can you explain your answer?*
- Which parts of the text did you find easy? Why was it easy for you?
- Which parts of the text did you find difficult? Why was it difficult for you?
- How did you feel when reading while listening to an audio? What (if anything) made it easier to understand the text, what made it harder?
- How familiar were you previously with the topic of this text? (0 – 100%, 100% means you are extremely familiar with the topic).
- Is there anything else you would like to tell me about your experience of reading that text?

Final interview questions (after completing all three reading conditions)

I have asked you to do three types of reading: silent reading, reading aloud and reading while listening. Now I would like you to try to compare the three types of reading.

- Which condition, if any, made it easiest / hardest to understand the text? Why do you think this?
- Which condition, if any, did you enjoy the most? Why?
- Do you have any other reflections on the three different reading conditions?

Appendix F - A sample of interview transcripts

Read silently condition

0:14:14.140 --> 0:14:28.910

Interviewer

Yes, yes, OK great excellent, yeah, thank you. And now my first question is, so I invite you to read silently and did you hear any voice in your mind when reading?

0:14:31.180 --> 0:14:32.450

Participant

Sometimes yes.

0:14:32.930 --> 0:14:41.290

Interviewer

Sometimes yes, OK good and then now I would like to ask what kind of voice did you hear, whose voice is it?

0:14:42.690 --> 0:15:0.920

Participant

so when I stuck you know like when I was stuck in and it was new words like "for-the-clones" (phytochromes) or you know like any sort of difficult with any difficulties in understanding the meaning of the sentence, I kind of may know like.

0:15:1.0 --> 0:15:6.510

Participant

Umm try to read again was with voice in my head.

0:15:7.410 --> 0:15:30.460

Interviewer

Umm so you mean that when you come across some words like phytochromes or when you find that you have difficulty in understanding the meaning of some parts. You kind of read the sentence again in your head and you heard some voice then. Is that am I correct?

0:15:31.610 --> 0:15:44.920

Participant

yeah, yeah, it's not I'm not. I'm not reading it in loud. But at the same time, it's yeah. I just kind of try to sort of you know pronounce in my head you know sometimes.

0:15:44.210 --> 0:15:50.840

Interviewer

I got it, I got it. So it's not really reading out loud, but you remember that you kind of.

0:15:55.430 --> 0:15:56.570

Participant

Hmm right.

0:15:51.680 --> 0:16:6.890

Interviewer

Read that part like pronounce it in in your head right. I see so I wonder what whose voice was it as it was, it like your voice or or did you not remember that or yeah, just wondering?

0:16:7.770 --> 0:16:9.390

Participant

Just my voice I think.

0:16:9.250 --> 0:16:22.890

Interviewer

Umm got it, so in that case so are you, saying that you did not like hear all the words so you kind of or did you hear all the words or just some of them, because you mentioned sometimes?

0:16:29.230 --> 0:16:29.590

Interviewer

Umm.

0:16:24.140 --> 0:16:34.120

Participant

Uh some, like like yeah, you know like as I said, You know like some unknown words or like new vocabularies or something.

0:16:33.530 --> 0:16:54.70

Interviewer

Got it got it OK, so not everything but some unknown words or some unknown vocabulary. So maybe can you give me some examples, perhaps, now were there any words that you were unsure how to pronounce when reading the text? If yes, can you maybe tell me which ones are they?

0:16:56.70 --> 0:17:3.960

Participant

It's like "side-to-side-fi-to-chrome-or-fei-to-chrome-or-psy-to-chrome". Or I don't know, that one.

0:17:1.570 --> 0:17:2.340

Interviewer

OK got it.

0:17:3.780 --> 0:17:5.60

Interviewer

Yeah, I know yeah that one.

0:17:6.450 --> 0:17:8.190

Interviewer

And is there any other?

0:17:10.50 --> 0:17:12.100

Participant

Uh not really.

0:17:13.110 --> 0:17:13.520

Interviewer

OK.

Read aloud condition

1:4:21.40 --> 1:4:38.130

Interviewer

OK, so, uh, my first questions are related to, were there any words that you were unsure how to pronounce when reading the text? If yes, can you tell me, tell me which ones.

1:4:39.690 --> 1:4:45.310

Participant

Yeah, I think the, like cla dys takes. (cladistics)

1:4:46.320 --> 1:4:47.930

Participant

Cladistics yeah.

1:4:48.170 --> 1:4:52.270

Interviewer

Yeah, cladistics. Yeah. So.

1:4:52.580 --> 1:4:57.510

Participant

Yeah, but this word impressed me so much. Like, it's much easier than the previous one, you know?

1:4:57.670 --> 1:5:5.490

Interviewer

Ha ha ha, it it impress you a lot. Why? Why does it impress you? Yeah. Can you tell me more?

1:5:6.220 --> 1:5:31.280

Participant

Like it's easier to pronounce, like you don't have to guess the pronounce of this part like PHY. I don't know how to pronounce it, but I think it's easier to kind of guess the pronunciation of cladistics, and it's and it's easier to remember the whole word or, and the pronunciation of it.

1:5:32.500 --> 1:5:39.340

Interviewer

It's easier to remember the whole word and the pronunciation of it.

1:5:39.870 --> 1:5:40.300

Participant

Yeah.

1:5:41.670 --> 1:5:55.970

Interviewer

Got it. Got it. So yeah, PHY and cladistics. Yeah, this one is better, right. OK. So when you saw this word cladistics, then and what impact, if any, did this word have on your comprehension?

1:5:58.50 --> 1:6:29.920

Participant

Umm. This word like, I think the whole text like centers on this word, like it tells us about the revolutionary approach, and and the Uh like although, it does not appear quite frequently throughout the text, but it was like the text was all about it like it it appears at the beginning, appears at the end.

1:6:30.340 --> 1:6:31.660

Interviewer

Hmm hmm.

1:6:33.620 --> 1:6:46.380

Participant

Like I remember, one thing that I remember is that, I like, when I read approaching the end of this text, like like like supporters of cladistics.

1:6:47.20 --> 1:6:47.530

Interviewer

Umm.

1:6:47.70 --> 1:7:4.780

Participant

I and I go back to where it appears for the first time, like to kind of confirm confirm my guess that the whole content, the whole passage like centers on this word, and talks mainly about this revolutionary approach.

1:7:6.0 --> 1:7:23.450

Interviewer

So when you saw the word at the end about the supportive characteristics, so you kind of go back to the beginning when you first saw the word to confirm your understanding that the whole text was, you know centers on this concept.

1:7:23.870 --> 1:7:24.320

Participant

Yeah.

1:7:24.790 --> 1:7:36.550

Interviewer

Hmm, interesting to know. So besides cladistics, were there any examples? Anything else? I mean, uh, the words which you were not sure how to pronounce when reading aloud this text.

1:7:37.270 --> 1:7:46.80

Participant

Like uh, many like terminologies about a professions of people's. Like en en to mo lo gist (entomologist).

1:7:46.840 --> 1:7:52.590

Interviewer

Hmm. OK. Yeah. entomologist right. Yeah. Yeah.

1:7:54.320 --> 1:8:1.70

Participant

And also like the one in paragraph B, like pa li on to lo gist (palaeontologist).

1:8:1.650 --> 1:8:24.790

Interviewer

Oh yes, yes, these are the the, the, the gist words, right? Yeah. The people so, when you see these words like entomologist, paleontologist, eh same questions to you, what did you do or think when you saw these words, and what impact, if any, did you think that these have on your comprehension?

1:8:26.580 --> 1:9:21.360

Participant

I don't think, it does not prevent me from like understanding the text. I think whether I know how to pronounce these words or the meaning of them have nothing to do with my understanding of the whole text. Like again, I think 1 information that can be inferred from these two words like they are about the kind of jobs of these people, of these people like, and and also I think as for these two words it's also easier for me to, uh, to, to, kind of guess the pronunciation of them, because like like en ton, en ter mo lo gist (entomologist). I think there are some similar pronunciations in my head like like, antonymy, or autonomy, or similar like that, like something like "mologist" or "logist".

1:9:22.90 --> 1:10:6.350

Participant

So I think it's it's not that difficult like for example, like in the first passage, like like pe to chromes (phytochromes) took me a lot of time to kind of figure out the pronunciation of it. But this one, even though I did not know its meaning, I can just go with, like, entomologist, because I'm so familiar with words like share, similar, like spelling and pronunciations with it. So like I have previous, ex experiences with like similar words, so I can, so I can guess the pronunciation of this word when I (en)counter it faster, like I it took me less time on it.

Read-while-listen

1:51:29.650 --> 1:51:48.40

Interviewer

OK, OK. So didn't really grasp the content. Got it. OK, so now about the reading conditions. So how did you feel when reading while listening to the audio? What if anything, made it easier to understand the text? What made it harder?

1:51:49.0 --> 1:52:2.450

Participant

Well, harder, I can say the hard thing first. It it's it's the fact that I couldn't go back to my text. So one time I was kind of like, I want to go back to the text, but then the audio goes on. So was it about?

1:52:3.90 --> 1:52:24.920

Participant

Umm. It was like the... Yeah D, D when I was when the audio was reading D, I just kind of like jumped and read, read ahead of the audio, and then I finished till the paragraph D ended like read it again. Like regardless of the audio. So in that case the audio was a kind of a hindrance to me.

1:52:25.340 --> 1:52:31.500

Interviewer

OK, sorry. Uh, can I check my understanding because you are saying that you kind of jumped?

1:52:32.100 --> 1:52:32.710

Participant

Yeah.

1:52:32.670 --> 1:52:49.300

Interviewer

And the and you, you said you read ahead of the audio, so. So what did you mean when you jump? So when you read paragraph D, you were not really, you you mean that you were not really following the audio and then you read ahead. Was that what you mean?

1:52:35.820 --> 1:52:36.870

Participant

Yeah, I read ahead.

1:52:48.470 --> 1:53:12.680

Participant

Yeah similar, but I was I following, I was following the audio at first, but then like I thought that, oh, this is hard to grasp. And then, like, let's just read it myself. So regardless of the audio, I just like read and then. And but not from the like start. I I think that was about like line 3, 3.

1:53:13.520 --> 1:53:26.30

Interviewer

OK, so you're saying that at first, at paragraph D you were trying to follow the audio, but maybe around line, 3. You were feeling that, Ohh, this is kind of difficult. So you were trying to.

1:53:27.630 --> 1:53:40.200

Interviewer

Then you? Uh? But I I just wonder. Because usually when you find something difficult, you were saying that you tried to reread, right? So that was like going back right. But this scenario you were trying to go ahead, was it was it? Umm.

1:53:40.20 --> 1:54:30.130

Participant

Uh, that was because, that was possible, because. I think it was, yeah, the like, I mean, like, uh, line three and four, it's information. That's something that's not really that new, because, so because it's something of, it's a very familiar topic of technology, like ethical thing. You know like beyond the scope of modern technologies, and how we can use it. So it's kind of something that I'm familiar with. So I could kind of like skim read and then Oh I know what this means OK. I just read to the. I just read it fast, like "modern technologies, however, and will be left to future generations to explore" (participant read it very fast). So I just read it fast, and then I just went back to D the first of the part of D and then read it again, while the audio was like slowly reading line three and four.

Appendix G - Codes Table (Remarks: 73 codes (including parent codes))

RS – Read silently, RA – read aloud, RWL – read while listen

Name	Description (and example)
<p>I. Affordances and challenges</p>	<p>What the participant perceived as things that facilitated or hindered their comprehension in a certain reading condition. They can be positive or negative perceptions. I only coded what participants experienced in the reading session. If they referred to something like their learning experience in the past, I did not code it. These usually were responses directly related to the question “what helps/facilitates/hinders your reading in this condition?”, but may also be mentioned at other places in the interview, e.g. “why was it difficult?” These are about the reading condition itself, which is different from the text, e.g. content, topic of the text.</p>
<p>(A) Attention and effort</p>	<p>Participants reported how reading in a certain condition may lead to more focus/less effort needed for reading, or distraction or more cognitive load.</p>
<p>A (i) Distraction</p>	
<p>Attention split because of another reading voice or accent</p>	<p>Participant felt their attention might be distracted by another reading voice, or the accent or difference in pronunciation of another voice. <i>E.g. “when he’s given the pronunciation in French, sometimes I spent too much time being trying to remember how he pronounced things, or being surprised at something is pronounced that way, it’s like enjoying the way he pronounced it. And then I was like, OK, no, no, no. But you need to continue reading, right. And then he would be, you know, in a different place.”</i></p>
<p>Attention split because of read aloud and think at the same time</p>	<p>Participant had difficulty reading aloud and understand what they read at the same time. Attention put on reading aloud or pronouncing words instead of comprehension. <i>E.g. “Because reading out loud made me kind of focus on like, saying the word properly. And I think that I think, yeah, well, so it kind of like comparatively, uh, no, no, I mean relatively and I couldn’t focus more on the contents of the text.”</i></p>
<p>Attention split because of reading and listening at the same time</p>	<p>Participant expressed difficulty in reading and listening at the same time because their reading and listening are at different places. Their attention may be split to doing different things, or they needed to put in more effort in order to sync or keep pace with the audio, or to handle two tasks or more at the same time. <i>E.g. “When I was when the audio was reading D, I just kind of like jumped and read, read ahead of the audio, and then I finished till the paragraph D ended like read it again. Like regardless of the audio. So in that case the audio was a kind of a hindrance to me.”</i> <i>E.g. “but the pace that he was going on because there was a different pace than mine that made it, umm, somewhat difficult because, because if he was going slower than I, I would want to take advantage of the extra time, and read something again. But then, sometimes I found that while I was rereading it, he would already, you know, be past that section or that sentence. And so then I had to catch up.”</i></p>
<p>“Get lost” during reading</p>	<p>In-vivo code. Participant felt very confused. They mentioned they 'get lost' during reading. <i>E.g. “I think one problem with reading while speaking is that when you come across some long sentences, you cannot, like when you are really, really, really, you get lost in the process, like it’s like.... you forget where you are or you, you just get lost.”</i></p>
<p>A (ii) Increased attention</p>	

Help staying focused	Participant felt the reading condition helped them focus or concentrate. <i>E.g. "it keeps me focused on the understanding the text, like I would not like easily get lost or think about other things when I'm, when I'm, like I have to stick to the task of speaking."</i>
A (iii) Less effort	
Feeling relaxed and need less effort to understand	Participants expressed that they felt "relaxed" or "easy". They may express a sense of passivity like they don't need to do things on their own. Just follow. <i>E.g. "I think I when I rated how easy or difficult it was to understand, I looked at how hard I had to think. Like how many cog, how many cognitive resources I was putting into it. Like here I could sort of just relax and take it in. I didn't feel like I was really trying to remember things actively."</i>
(B) Audio pace	Participants described how they felt the pace of the audio may help or hinder reading.
Audio is too fast or too slow	Participants mentioned that the audio pace is too fast or slow, which makes it more difficult to read. Codes may have appeared in "attention split due to reading and listening at the same time". But here participants specified the pace of audio is "fast", "slow" (or both), while in "attention split" they may, but not necessarily have mentioned this. (See above) <i>E.g. "there were times in which his voice was much slower than my reading voice, like in my mind. So I would be in a different part than he was and so I would needed to pace myself to make sure that I was following along."</i>
Audio pace is just right	The audio pace is just right. <i>E.g. "the pace at which the reading was happening was perfect. And it gave me enough time to digest what was being discussed."</i>
(C) Use of reading strategies	Participant likes/dislikes a certain condition because it enables/makes it difficult for them to use certain reading strategies.
C (i) Easier to use strategies	
Able to adjust pace	Participant described how they were able to read with flexibility like speeding up, slowing down, or skimming through different parts of the text as needed. <i>E.g. "the advantage would be that I can read it a bit faster than when I read it out loud, because it's something that I can just like, like jump, it jumped there, like the words a bit, and then just go to and just do it with my pace."</i>
Able to re-read	Participant was able to re-read when needed. <i>E.g. "I can go like I can go back and read the paragraph again and then and I I kind of like grasp the information most accurately. So I think that would be the best."</i>
C (ii) More difficult to use strategies	
Cannot re-read	Participant wanted to re-read but couldn't. <i>E.g. "I can say the hard thing first. It it's it's the fact that I couldn't go back to my text. So one time I was kind of like, I want to go back to the text, but then the audio goes on."</i>
Cannot adjust pace	Participant could not adjust reading pace. <i>E.g. "it does not allow you or give you the flexibility to determine the pace of reading like, we always keep the same pace going on. You cannot stop whenever you want."</i>
Harder to visualise	Participant found it harder to picture something. <i>E.g. "I think what made it more challenging was that, since I was reading, when I was reading silently, it was harder for me to visualize something, some of the entities in the piece."</i>

C (iii) Readers' strategies	These refer to the strategies participants used to help themselves to cope/read in a certain condition, instead of the condition itself which makes it easier/more difficult for them to apply a strategy.
Focus on main points instead of details	Participant focused on main points instead of details in order to help themselves read. <i>E.g. "I adjusted, adjusted, my strategy halfway... I focused more on the on understanding the passage, or the paragraph on the whole, like I try to get like, get the whole meaning of the paragraph, like from a more comprehensive perspective. You know, instead of like focus more on details so that I can keep pace with it, and focus more on what the theories are about instead of a word, a particular word means."</i>
Parse a sentence into smaller clauses	Participant believed the action of parsing a sentence during a certain reading condition helped. <i>E.g. "the fact that I broke each sentence into clauses, umm so that I could read more easily, also made it easier for me to remember. So if I just read say, "the science of evolutionary relationships have undergone a major change in recent decades." (no pause) Like if I read it without breaking it into clauses, it may have been harder for me to remember anything at all. But the fact that I broke it into clause has made it easier for me to package the information."</i>
(D) Word recognition or decoding	This group of codes are related to pronunciation/decoding of words and word recognition. They are comments about how a certain reading condition overall helped/hindered reading, and not about the impact of dealing with just a particular word (as in "II. Dealing with words with unsure pronunciation" below), although occasionally the examples may involve individual words which appear in both categories.
Confusion in pronunciation hinders word recognition	Participant found it difficult to identify a word because of being unsure of its pronunciation. <i>E.g. "Fee Pe ter chromes (phytochromes), for the first time, like I tried to pronounce it like. But when I when I come across some new words, and with different pronunciations or or just the same word. I would try to go back to the place where, like Pe to chromes (phytochromes) was talked for the first time, to check whether they are the same word, because I can easily forget the pronunciation of the word, you you know what I mean."</i>
No need to decode or confirm pronunciation	Participant mentioned they didn't need to pronounce the words or "confirm pronunciation" of words <i>E.g. "I think some easy things was that I didn't have to stop to confirm the pronunciation of some words. Well, for example Apocalypse and the things that we talked about."</i>
Stuck with pronunciation	Participant found it difficult to comprehend due to the need to pronounce words <i>E.g. "There's some of the some of the words and vocabularies. And I kind of I was kind of stuck with pronunciation and then like couldn't really see you know take the meaning."</i>
Cannot sound out words	Participant wanted to sound out the words but couldn't. <i>E.g. "I have to kind of imagine myself, hearing my voice in in phytochromes, so that was a kind of suppression for me, and inhibition? No, like suppression for me. That was I think that would be the hard part."</i>
Some words become more explicit	Participant felt that some words became more stand out during reading. <i>E.g. "So if it's a difficult and unfamiliar word, you don't get to like kind of, um, you have to really focus on the word, um, in order to remember it, and uh recognize it in, in, in future texts, right? In the future paragraphs. But because he read Rene Barjavel like in a French way, I mean, in a way that I didn't know."</i>

	<i>that the person in this text was very, very. OK, I'll find the right word for this. OK. It's very, very explicit. It was very explicit to me."</i>
(E) Miscellaneous	These are other things participants mentioned which do not seem to fit in a particular category in A – D and there was only one reference or one participant mentioning it.
Reading habit	Something that participant is used to. <i>E.g. "because it's something that I always do, and Umm and I think it's the best way that I can like."</i>
Second modality	Read aloud and listen at the same time is like reading something twice. <i>E.g. "when I'm reading out loud, I'm reading with my mind. So like my brain is processing it, but then I'm listening. I'm hearing it. And so I have to process it again, right? And so it's kind of like reading it twice at the same time."</i>
Intonation is interesting	Participant found the intonation used in the audio makes things interesting. <i>E.g. "The recording was, the person who had made the recording was inflecting their voice, you know, enough, that it wasn't monotonous."</i>
Stress	Participant found reading in a certain condition more stressful. <i>E.g. "I was more anxious about reading it correctly, quote and quote."</i>
Easier to omit seemingly unimportant points	Participant felt it was easier to miss out information. <i>E.g. "that's what I think I need to understand and like for this from this text, so that's why I just you know like skipped the farmer's part, and then you know like when it comes to the question. It's just like ohh, I don't remember anything about that."</i>
II. Dealing with words with unsure pronunciation	Participants were asked if there was any word that they were unsure how to pronounce, how they dealt with it, and the impact on their comprehension, if any.
(A) Example of words unsure how to pronounce during RS or RA	Participants gave examples of words that they were not sure how to pronounce during reading silently or reading aloud condition. <i>E.g. "Palette palaeontologist."</i>
(B) Example of words that the audio pronounced differently from the way participant would have pronounced	Participants gave examples of words that the audio pronounced differently from the way participant would have pronounced. <i>E.g. "And other than that, the French name. René Barjavel? I'm not sure how he pronounced it, I don't remember, but it was definitely different from how I imagined it."</i>
(C) Impact on comprehension	
Little or no impact on comprehension	Participant felt that not sure of how to pronounce a certain word had little or no impact on their understanding the text, or that the audio pronounced a word in a way different from how they would have pronounced had little or no impact on their comprehension. <i>E.g. "I don't think, it does not prevent me from like understanding the text. I think whether I know how to pronounce these words or the meaning of them have nothing to do with my understanding of the whole text."</i> <i>E.g. "I was glad to hear the way that it was properly pronounced. Umm, I do know that it would probably be different from the way he pronounced it, because I don't speak French, so I I'm not used to making those sounds anyway."</i>
Distraction	Participant found dealing with unsure pronunciation of a word distracting. <i>E.g. "Because while I was, because while I was looking at these names, I ended up speculating about how to pronounce them, and that might have distracted me a little bit."</i>
Slow down reading	Participant's reading might be slowed down because of words with unsure pronunciation.

	<i>E.g. "sometimes I stopped at the the name of people. So for example, like you know, we, we, Wigge, W-i-g-g-e. Like Arabi, Arabidopsis."</i>
Difficulties in recognising a word	This can overlap with "confusion in pronunciation hinders word recognition" under "(D) Word recognition or decoding" above in "Affordances/Challenges". But in the above the participant expressed the perception that they could not recognise a word is a hindrance to read in a certain condition. Here it focuses on the impact on comprehension of a particular word. <i>E.g. "Like, like I don't know, it's pronounced as sermo meter or what, cause like there's another pronunciation in my mind, like in my head, but it's quite, it's kind of different from that. Like like I I will like, spontaneously pronounce it as "ser rom meter". But, but when I look at this word, I I will pronounce it ser more meter. So I think it's different."</i>
Pronouncing words without understanding	Participant recalled that they tried to pronounce the words with unsure pronunciation without understanding the content. <i>E.g. "For example, the word cladistics. Umm, I just, use the, then try to pronounce it without necessarily remembering what it meant."</i>
(E) Strategies or behaviour	
Check if the word is important	Participant dealt with the word they were not sure how to pronounce by checking whether the word is important for understanding the content or not. <i>E.g. "because it was just like someone, for me, was just like someone. It's not relevant necessarily who this person is."</i>
Decoding	Participant tried to pronounce the word:
- breaking down a word into pieces	By breaking down the word into smaller parts. <i>E.g. "I tried to, for example, the name of the line read ar chi o, ar chi o ter ryx, (Archaeopteryx). I tried to, can I break the word down, in pieces like Arch.chi.terex, in order to be able to forget about these in pronunciation."</i>
- relating to words with similar spelling or pronunciation	By relating to other words with similar spelling or pronunciation. <i>E.g. "can guess the pronunciation from its, how it's spelled, like PHY. I can guess the pronunciation from like some some similar words like Physics. I may call it fe to chromes"</i>
Guess how to pronounce	Did not describe a real method but just said they used intuition, or guessed. <i>E.g. "I had to guess the pronunciation."</i>
Look at it as a kind of image	Did not try to pronounce the word but instead 'viewing' it. <i>E.g. "I can just like look at look at it as the kind of image."</i>
III. Inner Voice	
(A) Examples of inner voice (general)	
Example of inner voice	Participant gave examples of what they heard reading in mind to themselves. <i>E.g. "I read to myself. The phytochromes?"</i>
Example of not using inner voice	Participant gave examples of what they did not read in mind to themselves. <i>E.g. "So when I first encountered the word phytochromes, I reread it until, like, yes, two times, but then throughout the text when it appears again I don't read it in my mind anymore. Like my mind skips that word because I already know that that word exists."</i>
(B) Frequency of inner voice	
Hearing inner voice some of the time	Participant reported they only heard inner voice some of the time.

	<i>E.g. "I think I only heard some of them."</i>
Hearing oneself reading in mind all the time	Participant reported that they heard their inner voice all the time during reading. <i>E.g. "I think I've heard everything, to be honest."</i>
(C) Situation when hearing inner voice	
Using inner voice to remember new words	Participant explained that they read to themselves with an inner voice in order to remember a new word. <i>E.g. "Yes, because it's something that I haven't really heard before, and I had to read it to myself in order to kind of hear it. I don't know. I yeah, kind of like I had to, like, hear myself reading it, so that I have to, like, kind of imprint it into my mind."</i>
Using inner voice to recall or recognise a word	When participant said the word to themselves to try recalling the meaning of a word or identifying a word they have seen before. <i>E.g. "Yeah, yeah, I did, and then like you know, I just confirm I don't know this word, because sometimes it's not like what, what I say is, you know like in the example of Japanese. Pronunciation sometimes when I you know try to pronounce you know, either in English or Japanese way, you know like I may know that word actually, but you know like I just confirmed, oh I don't know this word."</i>
Reread using inner voice	Participant mentioned they re-read something using their inner voice in order to remember something or understand difficult concepts. <i>E.g. "or me going through an idea that I didn't quite grasp at the first time that I read it."</i>
L1 version of pronunciation of the English word	Participants mentioned they heard the L1 pronunciation of the word. <i>E.g. "Japanese use the katakana, which is like you know direct translation of the English, uh English words and then thermometer you know this is like really. How to say, like pronounce in Japanese way in my language, so you know like when I was reading it, I was just like ohh, yeah, OK, yeah, sometimes like you know Japanese pronunciation comes in."</i>
(D) Situation when not hearing inner voice	
Already know the word	Participant explained that they did not read with their inner voice because they have already known the word, which is not new to them anymore. <i>E.g. "So when I first encountered the word phytochromes, I reread it until, like, yes, two times, but then throughout the text when it appears again I don't read it in my mind anymore. Like my mind skips that word because I already know that that word exists."</i>
Not trying to understand	Participant did not read with their inner voice because they were not trying to understand something. <i>E.g. "I kind of like I didn't even try to understand what what the the meaning of the word was. It's something like professional. I kind of like regarded it as that."</i>
Not to mix with audio	Participant did not read with inner voice because they did not want their voice to be mixed with the audio. <i>E.g. "Like like when, for example, when my inner voice goes faster than the video, I will ask my inner voice to stop here and listen to the video."</i>
Depending on difficulty	Participant described they read to themselves but did not read out every word fully when reading something easy. <i>E.g. "I think it actually depends on the extent to which the text is difficult to me. Like, as for the easier part, like international team of scientist, I I would prefer to like read and like cutting cutting into part like, I would not like reading like "an international team of scientists". I read it as a like more complicated</i>

	<i>phrase. Like, this is a part, then led by the University of Cambridge as another part. Like, it kind of accelerate, the rate of reading.</i>
(E) Type of inner voice	
Hearing own voice	Participant reported hearing their own voice. <i>E.g. "I think it was my own voice, like how I would have pronounced that, pronounced the word out loud."</i>
Not sure whose voice it is	Participant reported that they did not know whose voice was producing the inner voice. <i>E.g. "It's still not my voice. I, I didn't, just like describe the voice in detail."</i>

Appendix H – Ethics approval

From: Liam Gearon <liam.gearon@education.ox.ac.uk>
Sent: Saturday, May 14, 2022 8:11 AM
To: Hoi Mok <hoi.mok@kellogg.ox.ac.uk>
Cc: Robert Woore <robert.woore@education.ox.ac.uk>; Student CUREC <student.curec@education.ox.ac.uk>
Subject: CUREC

Dear Hoi Mok

Inner and outer voices: L2 readers' experiences of silent reading, reading aloud and reading-while-listening

CIA-22TT-092

The above application has been considered on behalf of the Departmental Research Ethics Committee (DREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you, then, that, on the basis of the information provided to DREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly, approval has been granted.

Please continue to follow all current guidance issued by CUREC during the pandemic, notably COVID-19: CUREC guidance on research involving human participants, <https://researchsupport.admin.ox.ac.uk/governance/ethics/coronavirus>

If relevant please also check the CUREC website for their best practice research guides, these can be very useful in refining the writing up of ethical considerations in your research – see <https://researchsupport.admin.ox.ac.uk/governance/ethics/resources/bpg>

Good luck with your research study,

Keep well and safe,

Yours sincerely,

All good wishes,

Liam

Chair, DREC

Liam Francis Gearon, PhD, FHEA, FRSA, Docent



Senior Research Fellow, Harris Manchester College, University of Oxford
Associate Professor, Department of Education, University of Oxford
Conjoint Full Professor, Newcastle University, Australia
Docent, University of Helsinki, Finland
Extraordinary Professor, North-West University, South Africa
Visiting Professor, Irish Institute for Catholic Studies, MIC, Limerick, Ireland
Honorary Senior Research Fellow, School of Education, University of Birmingham

Appendix I - Participant information sheet and consent form

L2 readers' experiences of silent reading, reading aloud and reading-while-listening PARTICIPANT INFORMATION SHEET (main study)

You are being invited to take part in a research project. Before you decide whether to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. You are welcome to ask me (via email) if there is anything that is not clear or if you would like more information. Take time to decide whether you wish to take part.

Why is this research being conducted?

This study aims to explore participants' experiences, and the perceived benefits and drawbacks, of reading-while-listening, reading aloud and silent reading in a second language (L2). It is hoped that through this research, we can gain a deeper understanding of the role of phonology (the sounds of language) in L2 reading, and how best to facilitate L2 reading comprehension and learning. We are also interested in knowing whether one's language backgrounds may have an impact on one's experiences of these different types of reading.

Why have I been invited to take part?

You are invited to take part because you are (1) an advanced second language learner in English, (2) aged 18 or above, and (3) studying in a university in UK. We hope to include students from a range of first language backgrounds in the study. We are inviting around 6 students to take part.

Do I have to take part?

No. It is up to you to decide whether or not to take part. You can withdraw yourself from the study, without giving a reason, and without negative consequences, by advising me of this decision verbally or via email. The deadline by which you can withdraw any information you have contributed to the research is June 30th 2022. After this, the results will already be being written up (in anonymous form). If you withdraw, any data already collected up until this point will be permanently and securely deleted. You can keep this information sheet to remind you of what the project is about.

What will happen if I take part in the research?

I will invite you to participate in two short sessions online on Microsoft Teams. You can do this in any quiet environment. We can discuss and arrange dates/times which are convenient to you. You will be asked to read short texts, which will be general academic texts written in English. There will be three different reading conditions overall: reading silently, reading the text aloud, and reading while listening to audio recording.

After reading in each condition, I will ask you to rate how easy or difficult you found it to understand the text, then answer some comprehension questions. Finally, I will invite you to a short interview in which I will ask you about your experiences of reading the text. Each of the two sessions is expected to last about one hour and you will be offered a break half way through.

With your consent, I would like to audio record the read-aloud task and the interviews. This is so that I have an accurate record of what you've said and can listen back afterwards to ensure that I have noted down complete information. Please note that there are no right answers in the interviews, and your reading comprehension answers and your reading aloud are for research purposes only. They are not part of any formal assessment and will not be reported to anyone else. Before the reading session, I will send you a short background questionnaire, which collects information about your language use, e.g. your first and second language, the length of time you

have studied English, length of residence/study abroad in the English-speaking countries etc. This information will help to understand the relationship, if any, between your reading experiences and your language background. All questions are optional.

A consent form to participate in this study is attached with this information sheet. If you agree to take part, please read and sign the form and return it to me at hoi.mok@kellogg.ox.ac.uk before the start of the study.

What information will be collected and why is the collection of this information relevant for achieving the research objectives?

The data collected in this study will be: background information from the questionnaire; answers to reading comprehension tasks; audio recordings of read aloud and interviews. I will also collect consent forms and your contact details (for use in this research project only). The purpose of gathering this data is to explore links between participants' language background, reading aloud, reading comprehension and experiences of reading in English. The data will be used for research purposes only. It will be accessible only by me and will be shared with my supervisor (Dr. Robert Woore in Applied Linguistics in the University of Oxford) as appropriate to support my analysis.

The consent forms will be completed and returned to me in soft copy. They will be saved in a password-protected folder in on Nexus 365 OneDrive for Business, University servers. The original e-mails containing the consent forms will be deleted immediately and permanently after saving the forms to OneDrive. The consent forms themselves will be securely and permanently deleted after completion of the project, using free software fileshredder.org.

Background information (from the questionnaire) and scores on the reading comprehension tasks will be recorded in a spreadsheet, which again will be stored securely in a password-protected folder in on Nexus 365 OneDrive for Business, University servers. Upon completion of my studies, I will transfer this data, in anonymous form, to a password protected folder on my own hard drive. In line with university policy on data storage and management, I will keep this data until it no longer has value (i.e. until any writing up based on it is complete) and for at least three years after completion of the study. After this, it will be securely and permanently deleted using fileshredder.org.

Audio recordings will be stored securely as above, and deleted permanently and securely upon completion of the project. Audio recordings of the reading aloud will be analysed by a native speaker who is an English teacher in a university in Hong Kong, with the aim of investigating any links between reading aloud and reading comprehension. Transfer of audio files between the teacher and me will take place securely via institutional email addresses, accessible only via password-protected login. The teacher will be asked to delete these files permanently (using fileshredder.org) as soon as they finish listening. You will not be identifiable in the audio recording and a pseudonym will be used instead of your name in the file. No other personal details of yours will be shared. Audio recordings of the interviews will be transcribed, after which the transcriptions will be handled in the same way as the questionnaire and reading comprehension data (see above) and the audio recordings themselves will be permanently and securely deleted using fileshredder.org.

In the main data spreadsheet (background and reading comprehension data) and in the transcripts of audio recordings, names will be replaced by pseudonyms (chosen by participants). The key linking pseudonyms to real names will be stored securely as above, in a separate folder to the other data, and deleted upon completion of the project.

Will the research be published? Could I be identified from any publications or other research outputs?

The findings from the research will be written up in my MSc dissertation and may also form the basis of further academic publications or conference presentations. A copy of my dissertation may be deposited in print and/or online in the Oxford University Research Archive, where it will be publicly available to facilitate its use in future research.

I would also like your permission to use, anonymously, direct quotations in any research outputs. Your name will not be used in any research outputs. You will be asked to choose a pseudonym (fake name, or an alphabetic letter/ number) so that you will not be identifiable. The course you study and your department/college will not be mentioned.

What are the possible disadvantages and risks in taking part?

There are no foreseeable disadvantages or risks in taking part in this study.

Are there any benefits in taking part?

While there are no immediate benefits for those people participating in the project, it is hoped that this research will lead to a deeper understanding of the usefulness of reading-while-listening and the role of sound in second language reading. This will be of interest both theoretically and pedagogically. I also hope that taking part may be interesting and that reading the English texts as part of this study may extend your general knowledge.

Expenses and payments

As a token of thanks, you will receive an Amazon voucher worth £20 as a thank you for participating in this study.

Data Protection

The University of Oxford is the data controller with respect to your personal data, and as such will determine how your personal data is used in the study. The University will process your personal data for the purpose of the research outlined above. Research is a task that is performed in the public interest. Further information about your rights with respect to your personal data is available at <https://compliance.admin.ox.ac.uk/individual-rights>.

Who has reviewed this study?

This study has received ethics approval from the Department of Education's Research Ethics Committee at the University of Oxford.

Who do I contact if I have a concern about the research or I wish to complain?

If you have a concern about any aspect of this study, please contact me at hoi.mok@kellogg.ox.ac.uk, or my supervisor Dr. Robert Woore at robert.woore@education.ox.ac.uk. We will do our best to answer your query. We will acknowledge your concern within 10 working days and give you an indication of how it will be dealt with. If you remain unhappy or wish to make a formal complaint, please contact the Chair of the Research Ethics Committee at the University of Oxford who will seek to resolve the matter as soon as possible:

The Chair, Social Sciences & Humanities Interdivisional Research Ethics Committee;
Email: ethics@socsci.ox.ac.uk; Address: Research Services, University of Oxford, Boundary Brook House, Churchill Drive, Headington, Oxford OX3 7GB

Further Information and Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact me using the contact details below.

Thank you for reading this letter and I look forward to working with you on my study.

Ellen Mok, MSc Student

Kellogg College, 60-62 Banbury Road, Oxford, OX2 6PN

+44 (0)1865 612000

hoi.mok@kellogg.ox.ac.uk

CONSENT FORM:

L2 readers' experiences of silent reading, reading aloud and reading-while-listening

Purpose of Study: To investigate second language readers' experiences of silent reading, reading aloud and reading-while-listening. Please initial each box below if you agree with the statement.

I confirm that I have read and understand the information sheet for the above research. I have had the opportunity to consider the information, ask questions and (if appropriate) have had these answered satisfactorily.

I understand that my participation is voluntary and that I am free to withdraw at any point up until 30 June 22, without penalty and without giving any reason.

I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.

I understand that I will not be identifiable from any publications or presentations arising from this study.

I consent to being audio recorded.

I understand how audio recordings will be used in research outputs.

I agree to the use of quotations in research outputs using a pseudonym so that I will not be identifiable

I give permission for you to contact me again to clarify information.

I understand how to raise a concern or make a complaint.

I agree to take part.

Name of participant

dd / mm / yyyy
Date

Signature

Name of person taking consent

dd / mm / yyyy
Date

Signature

Appendix J Oral reading summary

Summary of pronunciation problems

Problem	Example
Incorrect consonant sound	<p>“Decade” – 1st syllable /de/ pronounced as /di:/</p> <p>“Relationship” – ‘ship’ pronounced as ‘sip’</p> <p>“Ornithologist” – ‘th’ /θ/ pronounced as /t/</p>
Incorrect vowel sound	<p>“Maintain” – ‘tain’ pronounced as /e/ instead of /eɪ/</p> <p>“Widely” – ‘wide’ pronounced as ‘white’</p> <p>“One” - /ʌ/ pronounced /ɒ/</p> <p>“Strange” pronounced as “strengē”</p> <p>“evolve” – 2nd syllable /ɒ/ pronounced as /aʊ/</p>
Extra syllable	“Archaeopteryx” as ‘ar. ka. a. o. teryx’
Missing syllable	“Palaeontologist” pronounced as ‘pa.la.on.to.list’
Pronunciation is inaudible	Archaeopteryx
Misplaced stress	<p>“Organism”; stress misplaced on 2nd syllable instead of 1st</p> <p>“Ancestors”; stress misplaced on 2nd syllable instead of 1st</p> <p>“Entomologist”; stress misplaced on ‘lo’ instead of ‘mo’</p>
Pronounced as another word	<p>“theropod” as “therapist”</p> <p>“distinctive” as “distinguish”</p> <p>“ancestry” as “ancestor”</p> <p>“useful” as ‘usually’</p> <p>“distinctly” as “distinguish” and then “distinctively”</p>
Missing ‘s’ at word ending	missing ‘s’ in ‘bones’, ‘turns’, ‘dinosaurs’
Missing consonant sound in word ending	<p>missing ‘d’ sound in ‘shared’</p> <p>missing ‘ch’ sound in “such”</p> <p>missing ‘t’ sound in “caught”</p> <p>missing ‘n’ sound in ‘unknown’</p> <p>missing ‘s’ sound in ‘evidence’</p>