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An English listening comprehension learning game and its effect on phonological awareness

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Elementary school teachers in France are responsible for teaching English, but most are not specialists. They need support, particularly for listening comprehension. Hence, we designed Luciole, an English listening comprehension learning game for 6-to-9-year-old French pupils. A first study showed that children who played Luciole developed their listening comprehension in English but, unexpectedly, also improved their phonological awareness in French, even though only about 5% of Luciole's activities are related to phonology. Based on these results, another study with a bilingual phonological awareness test and a streamlined data collection method was designed to try to replicate the previous results and to explore their origin. The results for listening comprehension were replicated, but not the results for phonological awareness. We provide guidelines for a more reliable phonological awareness test, and we conclude that using digital tools in the classroom can be beneficial for young learners' listening skills.

1. Introduction

In France, the teaching of English in elementary schools (6-to-11-year-old pupils) is carried out by the class teachers rather than by specialist English teachers. Not having specialised in Foreign Language (FL), many teachers feel linguistically insecure (Delasalle, 2008, p.376; Ministère de l'Education Nationale et de la Jeunesse, 2019, p.5). The official curriculum for foreign languages does not provide much support, as it sets very broad objectives for the end of elementary school, is not detailed by year and does not contain lists of words or structures

to be taught. Moreover, few teachers work with textbooks. According to CEDRE,¹ only 23% of teachers regularly use a textbook (Ministère de l'Éducation Nationale, 2016, p. 47). Instead, teaching material comes from varied sources and often targets one lesson at a time with no actual sequencing. Because of these difficulties, primary school teachers tend to drastically reduce the time allotted to English although the curriculum requires 54 hours of foreign language (FL) teaching a year.² With this context and the associated challenges in mind, we created Luciole,³ a listening comprehension learning game to enrich the toolbox available to primary school teachers and encourage them to offer more English lessons. More specifically, Luciole is a serious game, “designed, prescribed or used with both the aim of *entertaining* and an external finality targeting the player” (Loiseau & Noûs, 2022).

Luciole was tested with two separate cohorts within two different studies. In both studies, the experimentation took place in an ecological setting – following Bronfenbrenner's (1976) propositions on ecological and contextual validity as opposed to a laboratory/controlled condition. While attention was drawn to affect as little as possible the global environment in which the subjects evolve, introducing technologies in an elementary school setting, and carrying out pre and posttests, is in itself an alteration. It can create a bias in relation to the Hawthorne effect that states “those who perceive themselves as members of an experimental or otherwise favored group tend to outperform control groups, even in the absence of applied variables” (Koch et al., 2018, p.3). The choice of the control group in both studies was consequently centered on the neutralisation of said Hawthorne effect.

In this article we present both studies but focus our attention on the second, which studied phonological awareness although it was not initially an objective of Luciole. Thus, the first part of the chapter is dedicated to presenting the scientific and experimental context of the Luciole project and how the question of phono-

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1. CEDRE, or “cycle des évaluations disciplinaires réalisées sur échantillon” (cycle of disciplinary assessments carried out on random samples), tracks the performance of the French school system over time. Every year, a sample of 4,000 students is tested in a given school subject, with the same subjects recurring every 5 to 6 years. Foreign languages were last tested in 2022, but the results have not yet been published. We thus rely on the previous iteration, from 2016.
 2. Some teachers only teach English when there is time left in their weekly schedule, others stop scheduling English lessons after the first few months of the year. This is not seen as a major problem by school inspectors, who feel that the main focus of attention should be on French and mathematics (and who cannot visit classrooms frequently).
 3. Luciole stands for “Ludique au service de la Compréhension de l'Oral en Langue Etrangère”, which means “Playfulness for oral comprehension in a foreign language”, while a *luciole* is a firefly.

logical awareness arose. We then delve into what is phonological awareness and our research questions. The second part of the paper details the two studies in which Luciole was integrated. We conclude with pedagogical implications of our studies.

2. Theoretical background

2.1 Listening comprehension

The FL elementary curriculum in France (6-to-11-year-old pupils) is taught with an emphasis on oral skills (Ministère de l'Éducation Nationale, 2015, p. 31). Listening in particular is a foundational skill as it provides the linguistic input on which subsequent learning will be based (Krashen, 1982). Listening comprehension is a complex skill involving many cognitive operations. According to Field (2008), the two main (macro) operations are decoding and meaning-building. Decoding enables listeners to recognise sounds, words and clauses to establish the literal meaning of what they heard, whereas meaning-building aims to create what Zwaan and Radvansky (1998) call a situation model: relating the new information to what has been said before, using background knowledge to create inferences, to arrive at a general representation of the current discourse. Although both of these processes are important, Field argues (2008, p. 116) that at the earliest levels, the focus should mostly be on decoding the words (and chunks) of the unfamiliar foreign language, that is, working on lower-level processes. The goal of listening instruction for beginners should be to make decoding more efficient, so that cognitive and attentional resources are then freed up to focus on more complex higher-level processes that are part of meaning-building. Roussel et al. (2017) compared training on lower-level vs. higher-level processes with French high school students learning English, Spanish or German, and found that although there was no difference for more skilled students, less skilled students benefited more from lower-level training.

Successful listening comprehension also comprises both bottom-up and top-down processes in interaction (Field, 2004; Graham et al., 2010). Bottom-up processes imply that meaning is built from progressively larger linguistic units recognised in the speech signal whereas using context and prior knowledge to facilitate processing and anticipate upcoming elements is considered as top-down. However, in order for top-down processes to work efficiently and not result in inaccurate guessing, enough linguistic data needs to be recognised (e.g., Tsui & Fullilove, 1998). Listening comprehension thus depends to a great extent on aural word recognition, but work on individual words is not sufficient, as learners also

need to be able to recognise words in the stream of speech, surrounded by other words (Matthews & O'Toole, 2015). Prior work has shown that young beginning French learners of English tend to be unable to recognise more than one word per sentence and have to guess overall meaning based on this single word (Audin, 2003). One way to promote chunking of individual words into phrases and clauses in order to understand sentences is to use activities where recognition of several words is task-essential (DeKeyser & Prieto Botana, 2015).

Finally, although most work on listening comprehension has taken place with adolescent or young adult learners, several studies have investigated teaching listening to elementary school children, especially higher level and top-down processes (inferencing, monitoring the coherence of the situation model being built, etc.). Goh & Taib (2006), for example, showed that 11–12-year-olds were able to benefit from listening strategy instruction. Prior work has also been conducted on using digital tools to enhance young learners' listening skills (Suh et al., 2010; Verdugo & Belmonte, 2007). However, we are not aware of work with 6–7-year-old learners specifically targeting lower-level processes with a digital game as in this study. Plonsky and Ziegler (2016, p.31) have stressed “the need for more research on primary and secondary learners in K-12 contexts” using CALL (computer-assisted language learning). We integrated these considerations at the core of the design of *Luciole*, as we will show in a later section.

2.2 Phonological awareness

Phonological awareness is defined as “one’s ability to recognise, discriminate, and manipulate the sounds in one’s language, regardless of the size of the word unit that is the focus” (Anthony & Francis, 2005). It requires phonological units to be identified on three levels (syllable, onset and coda as well as phoneme) for intentional, conscious processing (Demont & Gombert, 2007). Phonological awareness tasks are thus metalinguistic (Gombert, 1990), and go beyond the simple perception of a fact of language: language becomes an object of observation and reflection (White & Ranta, 2002, p.261). Phonological awareness has been the subject of much research since the late 1970s and early 1980s (for a review, see Gillon, 2007), given its importance to master the written code. The study by Liberman and colleagues (1974) was one of the first to highlight the relationship between phonological awareness and learning to read. The correlation between performance on phonological tasks in kindergarten and future reading performance has been demonstrated in English L1 (e.g., Bryant et al., 1989; Stanovich et al., 1984) as well as in French L1 (e.g., Casalis & Louis-Alexandre, 2000). Phonemic awareness (one of the components of phonological awareness) is considered as the best predictor of future reading level (e.g., Hulme et al., 2002). More

precisely, according to Savage & Carless (2005), phoneme manipulation is the best predictor of reading proficiency. Høien et al. (1995), for their part, demonstrated that it is the identification of phonemes that best predicts this proficiency. This research mainly concerns L1, and in particular alphabetic languages such as French and English, but it has also been considered in L2 (Kanta & Rey, 2003). Unlike reading, much less research has been done on the links between writing and phonological awareness. However, Tunmer (1989) found that the phonemic segmentation scores of English-speaking children aged 7 to 11 were correlated to their spelling test scores, and Cataldo & Ellis (1988) showed that explicit phonemic awareness is an important factor in early writing development.

It should be noted that phonological awareness does not develop spontaneously, but requires explicit instruction (Ehri et al., 2001) or learning of the alphabetic system (reading and writing) (Morais et al., 1979). In the French school system, this explicit training on phonological awareness is mainly carried out in the L1 in kindergarten. Such training however is not regularly implemented in the L2 by post-kindergarten teachers, either because they do not know how or because this is not in line with the teaching trend.

Some studies have underlined a link between L1 and L2 phonological skills. According to Melby Lervåg & Lervåg's meta-analysis (2011, p.128) on first and foreign languages, “[t]he fact that we found significant correlations between L1 and L2 on [...] phonological awareness skills can be seen as evidence for cross-linguistic transfer. It should be noted, however, that the findings only demonstrate a relationship, and not the mechanism that causes it” (ibid, p.128). Various authors defend the hypothesis that phonological awareness is not linked to a specific language but rather a general metalinguistic skill (Comeau et al., 1999; Cummins, 1979), which, as a consequence, is important for language learning (White & Ranta, 2002).

2.3 Relationship between phonological awareness and listening comprehension

Explicit work on phonology, in the form of phonological awareness activities, enables the development of a phonemic repertoire in the L2 (Beaucamp, 2006; Hilton, 2009), and phonemic awareness plays a crucial role in L2 pronunciation (Kivistö de Souza, 2015). The relationship between L2 listening and the development of phonological awareness has been studied to a lesser degree.

In French L1, Bianco (2010) indicates that oral language comprehension and phonological competence are independent. However, it should be noted that the phonemic repertoire is called upon to distinguish words from one another (Bianco, 2016). This ties in with the cohort theory (Marslen-Wilson & Tyler,

1980), according to which there are interactions between the phonological information provided orally and the lexicon available in memory. As soon as the first sounds of a spoken word are heard, “candidates” are called up in memory because they begin with these sounds. Hence, phonological awareness could also have a beneficial impact on listening, as it could help distinguish between minimal pairs (similar sounding words), and thus help aural word recognition, and ultimately listening comprehension.

In L2, Li, Cheng and Kirby (2012, p.50) argue that listening might enhance phonological awareness, because “spoken language experience contribute[s] to the ability to analyse spoken sounds”. There are few studies on the influence of phonological awareness level on listening comprehension level. However, the noteworthy meta-analysis conducted by Choe, Lee, and So (2020, p.1294) indicates that “phonemic awareness instructions to beginners [...] or primary school students [...] might have a large effect on enhancing their listening skills”. In this way, our study of the Luciole game can contribute to thinking about the links between phonological awareness and listening comprehension.

2.4 The Luciole application

Luciole, a tablet-based autonomous serious game, takes around 7 to 10 hours to complete and offers more than 100 replayable activities contextualised within a narrative. In this game, the player takes on the role of Sasha, an 8-year-old French boy. Recruited by Firefly, an English spy agency, Sasha travels across the British Isles to rescue animals kidnapped by “bad guys”. To do so, the player has to carry out a series of missions, guided by a mentor who supports him both in his training as a spy and in his discovery of the English language.

During his adventure, Sasha interacts mainly with native English speakers, who communicate either in English, or in French with a strong accent. Instructions are given in French but spoken by native English speakers. This use of foreign accent in French is meant for pupils to downplay errors in foreign language communication, which is one of the objectives of EFL in primary schools (Ministère de l’Education Nationale, 2015, p.32).

Another central focus of Luciole is the development of bottom-up processing. The first step is to recognise aural vocabulary, and the second is to integrate the meaning of several elements into chunks. Training recognition of aural vocabulary is done via repeated form-meaning matchings (learners click on a picture and hear the corresponding word, or vice versa). In order to produce more robust lexical representations, the same word is pronounced in different voices (by different characters in the story), so that subsequent recognition might be enhanced (Barcroft & Sommers, 2005). Systematic activities where recognition of several

words is task-essential are also proposed. In other words, the task can only be performed successfully if several elements are attended to and their meaning integrated. For example, when one character tells the hero to “take three shirts” in preparation for a trip, the player needs to drag shirts, and not shoes, into the shopping basket. They must drag three of them not two or four. In the progression, these tasks first target individual words, which, as we pointed out, is a pre-condition to successful top-down strategies. But as the player progresses, the length of utterances increases. In certain activities processing the input completely is required (such as in the example above), in others, the player has to be able to focus on parts of the utterance (e.g., in “*To open the doors, the key is the QR code with the square number 17.*”, pupils have worked on the words “square” and “seventeen” and they need to find a page in a booklet where a square and the number 17 are associated with a QR code). 5% of the activities focus explicitly on phonological aspects of English. We target aspects that are known to be difficult for French speakers (for example, initial /h/, or final /s/).

3. Methodology

3.1 Researching the impact of Luciole on listening comprehension and phonological awareness – Two studies

In this chapter, we present two studies carried out using Luciole. The first study on the efficacy of Luciole in the classroom was a longitudinal study conducted from 2018–2019 as part of the Fluence Project (Mandin et al., 2021). This project’s objectives were to design and experimentally validate digital tools for educational purposes. Based on the research literature and on a needs analysis carried out within the classrooms, two tablet applications were developed: Luciole, targeting listening comprehension in L2 English, and EVAsion, an application targeting reading fluency.⁴ Because of this, the pre-/ post-tests used involved both listening in L2 English and reading in L1 French, as will be detailed below. In this study, our research questions were as follows:

- RQ1. To what extent does Luciole help develop English listening comprehension?
- RQ2. Did the emphasis on listening in the Luciole groups have detrimental effects on speaking skills?

4. A third app (also targeting L1 reading fluency) will not be mentioned here.

As will be developed in more detail below, the results of this first study showed that Luciole groups outperformed the control groups in listening comprehension (as expected), but also in phonological awareness in French (which was not expected). This led us to design a second study that was part of the Ecrimo2 project, carried out in 2022. Our aims were to confirm previous findings on listening comprehension, and to try to replicate the effect on phonological awareness, with a different test of phonological awareness, easier to administer, and focusing on both French and English. To this effect, we added the following research questions:

- RQ3. What effect might the use of Luciole have on the development of phonological awareness in French L1 and English L2?
- RQ4. Which features of Luciole contributed to the improvement of phonological awareness?

To answer this last question, we compared two versions of the Luciole app: the original version (Luciole O, or “original”), and a version of the app without exercises focusing explicitly on phonology (Luciole_NP, or “no phonology”).

3.2 Participants

3.2.1 Study 1 participants

Study 1 was conducted with 722 participants in 52 1st grade classes (6–7 years old) in 35 schools. All schools participated on a voluntary basis, and all parents gave informed consent and filled in a questionnaire about language background. 96% (692) of the students spoke French at home, 23% (163) also spoke one or several other languages (28 different languages were mentioned, the main ones being Arabic – 59 students, Turkish – 17, Portuguese – 13 and English – 13) and 13 participants took English lessons outside of school. Almost all children were complete beginners in English, having had at most 8 weeks of English lessons in 1st grade before the experiment, equivalent to 12 hours, although some of them had also learnt a few words (*one, two, three,...*) and expressions (*Hello, how are you?*) in kindergarten or through older siblings.

Pre-test results were used to divide the cohort into two groups (Luciole and the control group using a French reading app, EVAsion) with equivalent baseline to be comparable. Each group was the control group for the other app. Classes were assigned to the Luciole (English) group or to the French reading group (EVAsion) based on pre-test scores and class sizes, using the covariate constrained randomisation method implemented in the *cvcrand* package in R (Yu et al., 2020). This method enabled baseline differences between the two groups of 26 classes to be minimised in terms of mean scores and standard deviation on pretests. Both

groups also had the same number of classes in urban vs. rural schools, and in socially disadvantaged areas.

679 students of the original cohort took the post-tests (340 in the experimental group, and 339 in the control group).

3.2.2 *Study 2 participants*

43 1st grade classes were involved in the second study, for a total of 501 participants (mean 6.5 years old). As for the previous study, all schools participated on a voluntary basis and parents gave informed consent and filled in a questionnaire about language contact. 88% of the pupils were of French nationality, 28% (141) also spoke one or several other languages (English for 26 (5%) of them, with 20 English speakers in the control group and 6 in the Luciole group) and 21 took or had taken English lessons outside of school at least once. The participants were distributed as follows: 82 in the Luciole_O subgroup (playing the original game), 100 in the Luciole_NP subgroup (playing the game without the phonology exercises), and 319 in the control group.

3.3 Research design

3.3.1 *Study 1 design*

3.3.1.1 *Experimental design*

Pre-tests for study 1 were carried out in November, 2 months after the beginning of the school year. The pupils in all groups started playing on the apps in February and continued for 10 weeks until the end of April or early May (there was slight variation in starting / ending times depending on class schedules, school trips or unforeseen circumstances). They were asked to play 3 times a week for 20 minutes, for a total of 1 hour each week, and 10 hours in total. They usually played autonomously in small groups (“stations”) while the teacher was working with other groups on something else, as most classes did not have one tablet per pupil. As the curriculum calls for 1 ½ hours of English per week and Luciole training took 1 hour, teachers in the Luciole groups were encouraged to use the remaining 30 minutes a week for regular English lessons, to make sure that all groups received the same number of hours of English instruction.

The control groups had English lessons as usual. They did not use the Luciole app, but they were an active control group, in the sense that they were also using an educational app, focusing on different content (L1 French reading fluency). This enabled us to control for the effect of introducing a digital tool in the classroom (Boggio et al., 2023). The post-tests were carried out in June, around one month after the end of the study.

3.3.1.2 *Pre-test tasks*

The pre-tests comprised both French and English tasks. French tasks included known precursors of reading ability: oral vocabulary recognition and sentence comprehension, letter identification and phonological awareness tasks. The phonological awareness tasks included syllable counting, rhyme judgement, an oddity task, and phoneme positioning, phoneme blending, and phoneme deletion.

The English tests included a listening task with 20 items (described below in the post-test section) and a speaking task which was a picture description task. Because the pupils were complete beginners, they guessed at most of the listening test items and could not perform the picture description task, which was simplified for the post-test. All tests were administered one-on-one by trained research assistants.

3.3.1.3 *Post-test*

The French post-test tasks included phonological awareness tasks: 10 items where students had to delete the first consonant of a word (e.g., delete /g/ from *gomme* to get “*omme*”), and 8 items of phonemic segmentation with words of 3, 4 or 5 phonemes (for example, from *clé*, participants were expected to pronounce separately /k/ /l/ /e/).

The English tests included 2 tasks. The first was the same 20-item listening task as in the pre-test, with 14 items measuring meaning recognition of individual words and 6 items measuring sentence comprehension. All the items (both single words and sentences) were multiple choice questions where pupils heard a word or a sentence in English and had to point to the corresponding picture out of 4 possibilities. For example, the pupils heard “cat” and had to point to the picture of a cat among 4 pictures of animals (see Figure 2 below in 3.3.2). The task started with a training item in French to make sure everyone understood what to do. Each item was scored 1 if the answer was correct, 0 otherwise.

The second English task was an 8-item production task. Pictures were presented to the pupils to elicit individual words or phrases in English (the French prompt can be translated as: “I am going to show you a picture and you are going to tell me in English what you see”). The first 4 pictures were designed to elicit individual words (for example, the picture of a cat) and were scored 1 if the answer was correct, 0 otherwise. The last 4 were designed to elicit phrases (for example, a picture of 3 dogs) or sentences (a person performing an action). They were scored 2 if at least 2 words were combined correctly, 1 if a single word (noun or verb) was used correctly, 0 otherwise.

3.3.2 Study 2 design

For the second study, the participants were divided into two groups, one (the experimental group) using Luciole, and the other (the control group) using a French app as in the first study, but one focusing on dictation this time (Ecrimo). As in the first study, each group was the control group for the other app. The experimental group was further divided into two subgroups, Luciole_O and Luciole_NP (with or without explicit phonology exercises). All participants were first pretested from the end of February to mid-March. Then, they were required to use the app specific to their group (either Luciole or Ecrimo), for at least 22 sessions of 20 minutes per week, autonomously in the classroom. These sessions were spread out across a three-month period, after which they were post-tested by the end of June.

Both the pre- and post-tests were taken collectively, on tablets, enabling individual responses from all participants to be collected at the same time. Both tests comprised 3 tasks:⁵ a listening task in English, as well as an auditory discrimination task and a phoneme positioning task in English and French. To be sure to measure a progression between pre- and post-tests and avoid any ceiling effect, 12 items were added to the post-test version (7 for listening, 3 for auditory discrimination and 2 for phoneme positioning).

3.3.2.1 Listening task

The listening task was like the one in the previous study. The participants listened to a word or a sentence in English and had to choose the corresponding image from four (see Figure 1).

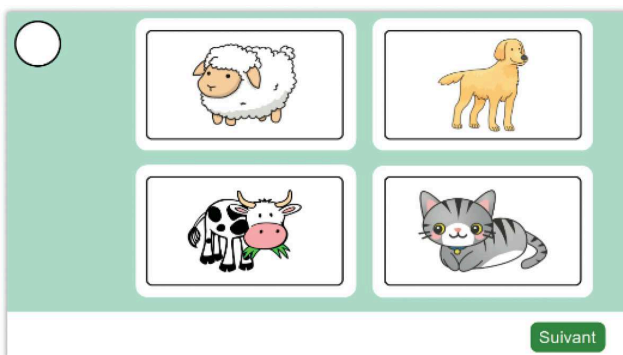


Figure 1. Response screen for the listening task – item “dog”

5. A fourth task of word dictation was administered. However, as this task was in French, we do not consider the results of this task in this study.

In most of the sentences, we evaluated the comprehension of two target words. For example, for the item “it’s a **small fish**” (see Figure 2), the participant would get one point for choosing the picture containing the **small** fox or the big **fish**, when one of the two targets was correct, and two points for choosing the picture with the **small fish**.

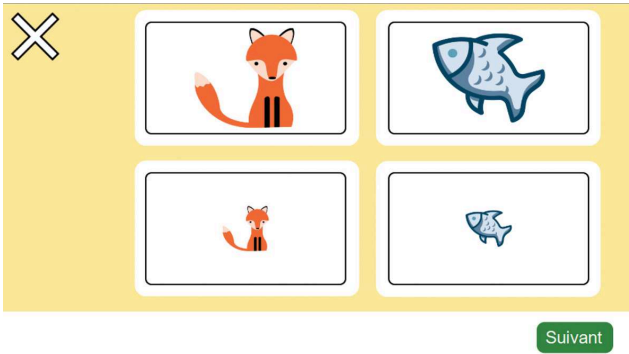


Figure 2. Response screen for the listening task – item “it’s a small fish”

This task was composed of an example item in French and of 18 items in the pre-test and 25 items in the post-test; the items were of increasing complexity. The list of items for each test is available in Table 1; target words are highlighted if applicable.

Recordings came from Luciole’s resources,⁶ except for complex items, which were recorded specifically for the pre- and post-tests. Recordings alternate between male and female speakers. The images came from the public domain. Nevertheless, we tried to maintain coherence in the graphics used for each item.

3.3.2.2 Auditory discrimination

The auditory discrimination task consisted of listening to two tokens which were words or non-words. Children had to indicate whether the tokens were the same or different by touching the appropriate symbol (= and ≠ respectively). This task began with two examples in French, one with the same tokens and the other with different tokens. For the test items, there were two French items and four English items in the pre-test, and three French items and five English items in the post-test. The list of items is available in Table 2.

6. In most cases they were recordings made by characters of the game but not used in the game.

Table 1. List of items for the listening task

Item	Pre-test points	Post-test points
rose (example in French)	0	0
black	1	1
dog	1	1
three	1	1
triangle	1	1
eyes	1	1
milk	1	1
purple	1	X
happy	1	1
star	1	1
train	1	1
eleven	1	1
sleeping	1	1
numbers	1	1
eight	X	1
jumping	X	1
hat	X	1
brown	X	1
nose	X	1
ship	X	1
the snake is green	2	2
there are two dogs	2	X
it's a small fish	2	2
there are six pigs	2	2
he's wearing a yellow shirt	2	X
he's wearing a yellow shirt	X	2
I can see two dogs	X	2
the girl has green eyes and black hair	X	2
the picture contains a cute little cat drinking from a bowl	X	1
Total of points	23 points	31 points

X: Item not included in the test

Evaluated words for complex items are identified in bold.

Table 2. List of items for the auditory discrimination task

Item	Pre-test points	Post-test points
zouché-zouché (example Fr – non-word)	0	0
dafé-daché (example Fr – non-word)	0	0
zoudé-zougé (F – non-word)	1	1
copré-coprè (Fr – non-word)	1	1
lurite-lurite (Fr – non-word)	X	1
coast-toast (En – word)	1	1
chap-chap (En – word)	1	1
badge-badge (En – word)	1	1
thought-sought (En – word)	1	1
clove-clothe (En – word)	X	1
paigel-peggel (En – non-word)	X	1
lathogic-lathogic (En – non-word)	X	1
Total of points	6 points	10 points

X: Item not included in the test

Difference between tokens is identified in bold, when applicable.

In the pre-test, the two tokens were always pronounced by the same speaker. We recorded the French items and for the English items used those from Wepman's Auditory Discrimination Test (Wepman & Reynolds, 1994). For the post-test, all items were re-recorded to have a token pronounced by a female-speaker and the other by a male-speaker for each item.

3.3.2.3 *Phoneme positioning*

In the phoneme positioning task, the participants had to listen to a phoneme, then to a non-word, and had to position the phoneme in the non-word. To do this, a number of circles corresponding to the number of phonemes in the non-word was displayed on the tablet (see Figure 3).

The task included two examples with French real words and 8 to 10 test items, 3 to 4 French items and 5 to 6 English items, depending on the version, pre- or post-test. Table 3 lists the items of this task and the target phoneme for each item. Target phonemes and items were pronounced by native speakers of French for the French items and English for the English items. Target phonemes for the English items were mostly close to French phonemes, with a different realisation, to test whether they were easily recognised in this context.

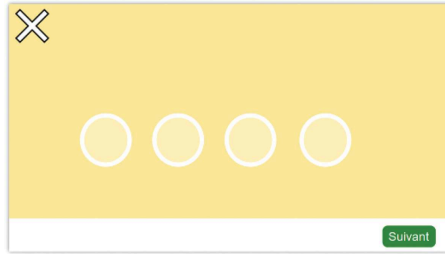


Figure 3. Response screen for the phoneme positioning task for a 4-phoneme item

We recorded the French items and the two English additional items of the post-test; the remaining English items were taken from either the CTOPP (Wagner et al., 1999) or the CNRep (Gathercole et al., 1994). Recording of target phonemes came from the Kinephones project (Magnat, 2017).

Table 3. List of items for the phoneme positioning task (API transcription)

Item	Pre-test points	Post-test points
/kado/ (Fr example)	0	0
/ɛadi/ (Fr example)	0	0
/luno/ (Fr)	1	1
/jɛɾwa/ (Fr)	1	1
/biks/ (Fr)	1	1
/bipu/ (Fr)	X	1
/ti:g/ (En)	1	1
/bæloʊp/ (En)	1	1
/ɹu:bid/ (En)	1	1
/sɑt/ (En)	1	1
/penəl/ (En)	1	1
/sɪθ/ (En)	X	1
Total of points	8 points	10 points

X: Item not included in the test

Target phoneme is identified in bold.

4. Results

4.1 Results of Study 1

4.1.1 English listening comprehension and oral production

Our first research question was whether Luciole-trained groups would show better English listening comprehension than the control groups. The comparison between pre- and post-tests showed progress in English listening comprehension in the experimental group (Luciole) and the control group (EVAision). However, the Welch two sample t-test showed that pupils in the Luciole group had significantly better English scores at the end of the school year than pupils in the EVAision group: EVAision=8.41 vs. Luciole=11.18; $t=-10.59$, $df=676$, $p<.0001$. These results are displayed in Figure 4.

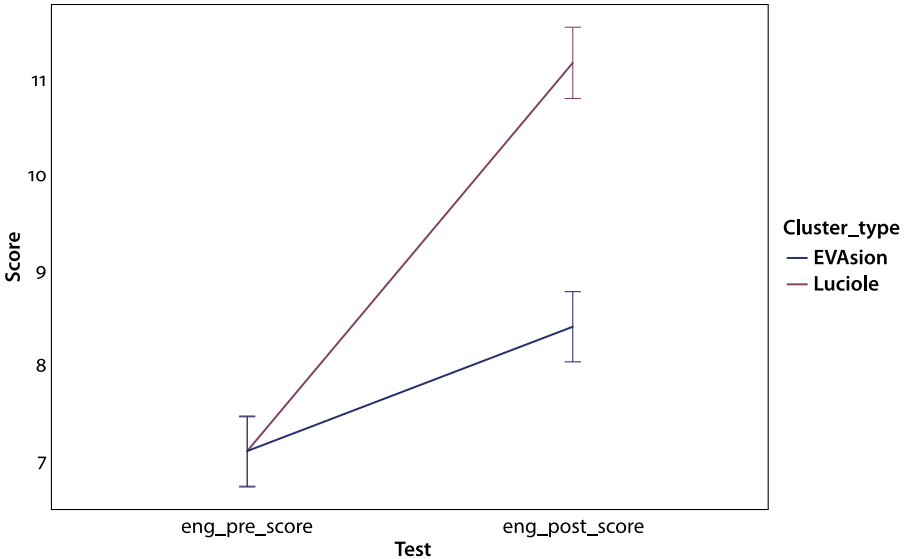


Figure 4. Pre-test and post-test scores (“eng_pre_score” and “eng_post_score”, maximum possible score=20) on the English listening task according to the group (“cluster_type”; “Luciole” ($n=340$) is the experimental group, and “EVAision” ($n=339$) the control group)

Our second question was whether the emphasis on listening for the Luciole groups would have detrimental effects on their speaking skills. Contrary to what might have been expected, Luciole groups also showed significantly better oral production (out of a possible 12 points): EVAision=1.66 vs. Luciole=2.97, $t=-9.50$, $df=671$, p -value $<.0001$.

4.1.2 Phonological awareness

Phonological awareness in French was tested because it was expected that the control group, trained in French reading skills, would show better phonological awareness after training. However, Luciole groups' results in phonological awareness were also significantly higher than the EVAsion groups', both for phoneme deletion ($W=55280$, $p<0.004$), and for phoneme segmentation ($W=67044$, $p<0.0002$), according to the Wilcoxon rank-sum tests we performed.

4.2 Results of Study 2

Study 2 replicated the results of the first study in terms of listening comprehension. The mean scores on the post-test listening task were 18.15 for the control group (Ecrimo), and 19.91 for the Luciole groups. Figure 5 shows the boxplot for the scores of the two groups.

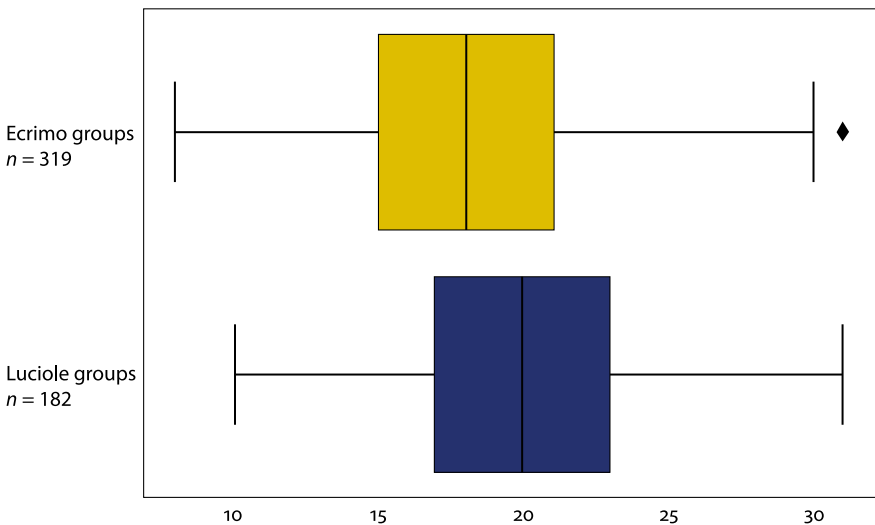


Figure 5. Boxplot of the post-test listening task scores for the two main groups

Since the distributions were not normal, we performed a Mann-Whitney U test to compare the means between the control and experimental groups. The statistical analysis confirmed the results of our first study on listening comprehension, as both Luciole subgroups performed significantly better on this task than the control group (for Luciole_O vs. Ecrimo: $U=17015$, $p\text{-value}=2.5e-05$; for Luciole_NP vs Ecrimo: $U=19123$, $p\text{-value}<0.003$). There was no significant difference between the 2 experimental subgroups (20.61 for the Luciole_O group, and 19.34 for the Luciole_NP group).

Our next research question was whether the use of Luciole_O and Luciole_NP would influence phonological awareness, tested with a phoneme discrimination task and a phoneme positioning task. The mean scores on the pre-test discrimination task were high for all the groups (Ecrimo: 4.75/6; Luciole_O: 4.73/6; Luciole_NP: 5.02/6), with more than 50% of correct answers for all the items. The Luciole_NP group performed significantly better than the two other groups (for Luciole_NP vs. Ecrimo: $U=18086$, $p\text{-value}=0.03$; for Luciole_NP vs Luciole_O: $U=3419$, $p\text{-value}=0.04$). The mean scores on the post-test discrimination task were lower (Ecrimo: 6.08/10; Luciole_O: 6.27/10; Luciole_NP: 6.73/10). Only 5 items (zoudé-zougé (F – non-word), lurite-lurite (Fr – non-word), coast-toast (En – word), badge-badge (En – word), thought-sought (En – word)) got more than 50% of correct answers. As in the pre-test, the Luciole_NP group performed significantly better than the other groups (for Luciole_NP vs. Ecrimo: $U=20429$, $p\text{-value}=7.47e-06$; for Luciole_NP vs Luciole_O: $U=3336.5$, $p\text{-value}<0.03$).

For the pre-test phoneme positioning task, only two items obtained more than 50% of correct answers (/luno/ (Fr) and /ti:g/ (En)) and there was no significant difference between the mean scores of the groups (Ecrimo: 3.22; Luciole_O: 3.30; Luciole_NP: 3.37). In the post-test phoneme positioning task, the same two items obtained more than 50% of correct answers plus a third one that we added for this version of the test, /bipu/ (Fr). The statistical analysis did not show any significant difference between the mean scores of the groups (Ecrimo: 3.22; Luciole_O: 3.30; Luciole_NP: 3.37). Thus, the results of the first study on phonological awareness were not replicated.

5. Discussion

5.1 Listening comprehension in English

In both studies, the experimental group playing with Luciole had significantly better results in English post-tests compared to the control group, who followed regular English lessons with their classroom teachers. The effects were also robust enough to show one month after the end of treatment, when the post-tests were administered.

As expected, Luciole had significant effects on listening comprehension after 10 hours of training on the English app. Several design features of Luciole might explain these results: the app contained systematic activities to train lower-level listening comprehension processes (aural word recognition and chunk building), which were targeted by the post-tests. It is also possible that the Luciole app was

more efficient at supplying input than the regular lessons followed by the controls, and that students in the experimental groups received more input overall than those in the control groups in the same amount of time. This confirms that systematic activities focusing on aural word recognition in context are useful in developing listening comprehension in young beginners.

In the first study, Luciole groups also received significantly higher scores than the control groups in the spoken production post-tests. The fact that the Luciole app did not include any speaking activities did not prevent the experimental groups from outperforming the control groups, whose regular English lessons included more speaking activities. Spending more time on listening activities did not have a detrimental effect on speaking. It is possible that the experimental group received input that was easier to process, as well as a greater quantity of input, which had an effect on output, as hypothesised by input-first theories such as Krashen (1982)'s comprehensible input hypothesis or VanPatten (2002)'s theory of input processing.

However, it should be pointed out that the audio recordings of the isolated words in the listening task in the second study were taken from recording sessions for the Luciole app. Since these are only short, isolated words used by several characters in the game, we do not consider this biased the results. The number of hours of English instruction to which the children were exposed in both studies were also not well controlled for. Still, the size of the cohorts, and the experimental design (neutralising social variables and the Hawthorne effect) added to the consistency of the results across experiments demonstrate the replicability of the effect of the Luciole application on the subjects. Luciole has thus proved its value for educational purposes when used with young beginners in a school context.

5.2 Phonological awareness

In the first study, phonological awareness tasks were included in the post-tests because this skill is known to be correlated with reading. If the French reading app (EVAsion) proved effective at improving reading skills, it might be expected that the control groups playing on the reading app would receive better scores in phonological awareness after training (recall that before training, the groups were equivalent on all measures). However, Luciole groups had significantly better results. This had not been hypothesised, mostly because Luciole trained pupils in L2 English, and the phonological awareness tasks were in L1 French.

Our first study revealed a beneficial effect on the development of phonological awareness in French that we did not expect, since Luciole is a game for learning English and the phonological awareness tasks were in French. This led us to further explore this phenomenon in the second study. According to the meta-

analysis by Melby-Lervåg et Lervåg (2011), there is evidence of the impact of exposure to an L2 on metalinguistic skills in L1. However, this meta-analysis only took into account studies where participants had at least 4-hour long L2 classes daily. Yet, Yelland and colleagues (1993) found benefits for as little as one hour of instruction per week over 6 months. In our studies, Luciole offers explicit phonological activities, but there are very few of them (5 out of 114 activities), and they focus on phonological aspects of English that are difficult for French speakers, such as phonemes specific to English. Still, they might have been responsible for the improvement of phonological awareness in French. In order to test the possibility that the explicit phonology exercises were responsible for Luciole groups' superior phonological awareness, we developed a version of the app without those activities (Luciole_NP) and experimented it against the initial version (Luciole_O). Contrary to our hypothesis, the Luciole_NP group received higher scores in the first awareness task (phoneme discrimination) in the post tests. However, this was already true in the pre-tests, which makes the results hard to interpret. Luciole_O and Luciole_NP groups did not receive significantly different scores on the second awareness task (phoneme positioning) either in the pre- or the post-tests. We are thus unable to conclude that the presence of explicit phonological activities influenced phonological awareness, perhaps because these activities were too few in number.

Interested in the effect of L2 exposure on metalinguistic skills, aside from the potential impact of Luciole, we paid deeper attention to the linguistic information collected through the questionnaires. We noticed that, in both studies, nearly 1/4 of the participants were in contact with another language outside of school. However, according to our analyses they did not perform better than the other participants in phonological awareness tasks. The difference is that here, the contact with the other language mostly occurs in private settings, where the language is used to communicate and is not considered an object of study. This suggests that exposure to language is not enough to induce a metalinguistic reflection, and that explicit activities might be necessary, and more generally being in a learning situation might be more favourable.

The second study did not replicate the results from the previous study on phonological awareness and so did not provide a better understanding of the effect of Luciole on phonological awareness in French. There are probably at least three reasons for this. Firstly, as with any experiment with human subjects, the findings of the first study might be due to individual factors in our participants beyond our control (considering the care taken to minimise the difference in potentially relevant factors between the experimental and control groups and the number of subjects involved – more than 500, this explanation is not the most likely). Secondly, the application with which Luciole was compared in the second

study is a dictation app (Ecrimo), which entails phoneme to letter encoding in French. This task also involves phonemic awareness. Therefore, it is possible that both trainings had a comparable positive effect on phonemic awareness. Lastly, there were multiple limitations in the design of the tests, that came mostly from the difficult research conditions.

We had to conduct the pre- and post-test in 43 geographically scattered classes in less than 3 weeks. For financial reasons, there were only two groups of testers and the duration of the tests had to be kept to a minimum. So, rather than one-on-one tests as in the first study, we chose to conduct the tests collectively with one tablet per pupil. Pupils were tested once, with tasks on two different applications in the same test session, which lasted from 45 to 60 minutes. This might have been too long for the age of our participants and caused tiredness and lack of involvement and concentration. Moreover, the order of the tasks was not randomised and the most difficult task, phoneme positioning, was always taken at the end of the test session.

The choice of the tasks was constrained by time but also by the collective format of the test. This was obviously not a problem for the listening task but was more of a challenge for the evaluation of phonological awareness. This is a complex skill that is usually evaluated through many different tasks. We only had two tasks for this skill with too few items, which was probably not enough and did not allow us to introduce a progression in difficulty. It should also be noted that the phoneme positioning test was particularly complex. Several mental operations were required: identify a phoneme within a word, segment the word into phonemes, then position the target phoneme.

The adjustments we made on the post-test version showed that for the discrimination task, using two different speakers to pronounce the tokens indeed made the task more complex. But overall, these adjustments prevented us from making comparisons between the pre-test and the post-test. This comparison would have been interesting to see whether the Luciole group and the control group both made significant progress, whether both applications led to an increase in phonological awareness.

6. Conclusion and further research

In both our studies, Luciole, an educational EFL listening app, positively influenced the development of listening comprehension in English in 1st grade learners in France. This shows that the use of digital tools in the classroom can be beneficial, even with learners as young as 6 years old. The use of Luciole also had positive effects on students' speaking skills, showing that an emphasis on listening is not

detrimental to productive skills and can serve as a useful foundation to move from comprehension to production (at least with beginning learners), in line with input-first theories. More specifically, our hypothesis that working on lower-level processes (aural word recognition in context and chunk building), would be useful to improve young beginners' listening comprehension was validated.

In terms of phonological awareness, on the other hand, only the first study indicated an effect for Luciole. However, as we have seen, the lack of results in the second study reveals the complexity of phonological awareness development and testing. Our first study led us to support the hypothesis that phonological awareness is a meta-competence and convinced us to continue our research on the factors that influence the development of phonological awareness. Indeed, the effect of Luciole could come from some or all the following factors combined: (1) the use of explicit activities on English phonology, in particular activities on the similarities and differences between French and English phonemes; (2) the fact that learners listen to French pronounced with foreign accents; (3) the exposure to varied input, with several English accents. This indicates an interesting link between listening comprehension and phonological awareness. Whereas the work of Li et al. (2012) and Choe et al. (2020) shows the importance of phonological awareness on listening comprehension, our study shows the potential influence of explicit work on listening comprehension on the development of phonological awareness. Further studies should be carried out to isolate these potential factors and to find out whether this inter-linguistic effect would also be present with a foreign language other than English. If such an effect were to be demonstrated, it could bring to light new arguments in favour of starting to learn a new language as early as the 1st grade, when children are learning to read and write in their L1.

We also must work on creating methodological tools tailored to our needs. There is a need for benchmarked tests of phonological awareness in L2 beginner English. We also need to continue thinking more generally about how to develop methodological tools for data collection which meet current field research constraints, such as limited time and funding. The idea that we are working on is to develop a digital test that can be taken autonomously by pupils in their own time in several sessions, with pre-recorded instructions and items. Hence, more tasks with more items could be implemented, allowing a more precise measure of phonological awareness, closer to standardised tests reported in the literature, with less test fatigue. Once benchmarked and experimentally validated, this test will be made available to the research community.

Furthermore, as Luciole will soon be available to teachers outside the research context, other questions must be addressed. In our research protocol, the teachers had no specific instructions on whether to use Luciole on its own or to accompany its use with complementary activities. As it turned out, some teachers felt the need

to create accompanying activities linked to the game. Hence, even though Luciole has been developed as a stand-alone application on listening comprehension, we plan to provide the means to integrate the game within a teaching sequence. We are currently co-designing complementary activities with schoolteachers, in line with the official curriculum of the French Ministry of Education. The complementary activities will not only focus on listening comprehension but also consider oral production and interaction, to offer a well-rounded curriculum.





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References

-  Anthony, J.L., & Francis, D.J. (2005). Development of phonological awareness. *Current Directions in Psychological Science*, 14(5), 255–259.
- Audin, L. (2003). L'apprentissage d'une langue étrangère à l'école primaire : Quel(s) enseignement(s) en tirer? *Les Langues Modernes*, 3, 10–19.
-  Barcroft, J., & Sommers, M.S. (2005). Effects of acoustic variability on second language vocabulary learning. *Studies in Second Language Acquisition*, 27(03), 387–414.
-  Beaucamp, J. (2006). Pour une pratique consciente de l'oral au service du développement de la compétence de compréhension en ELVE. *SPIRALE Revue de Recherches en Education*, 38, 53–62.
- Bianco, M. (2010). La compréhension de textes: Peut-on l'apprendre et l'enseigner? In M. Crahay & M. Dutrévis (Eds.), *Psychologie des apprentissages scolaires* (pp. 229–254). De Boeck Supérieur.
- Bianco, M. (2016). *Du langage oral à la compréhension de l'écrit*. PUG.
-  Boggio, C., Zaher, A., & Bosse, M. (2023). ECRIMO, an app to train first graders' spelling: Effectiveness and comparison between different designs. *British Journal of Educational Technology*, 54(5), 1332–1350.

- doi Bronfenbrenner, U. (1976). The experimental ecology of education. *Teachers College Record*, 78(2), 1–37.
- doi Bryant, P. E., Bradley, L., Maclean, M., & Crossland, J. (1989). Nursery rhymes, phonological skills and reading. *Journal of Child Language*, 16(2), 407–428.
- doi Casalis, S., & Louis-Alexandre, M.-F. (2000). Morphological analysis, phonological analysis and learning to read French: A longitudinal study. *Reading and Writing: An Interdisciplinary Journal*, 12(3–4), 303–335.
- doi Cataldo, S., & Ellis, N. (1988). Interactions in the development of spelling, reading and phonological skills. *Journal of Research in Reading*, 11(2), 86–109.
- doi Choe, S., Lee, K., & So, Y. (2020). The effects of phonemic awareness instructions on L2 listening comprehension: A meta-analysis. *Journal of Asia TEFL*, 17(4), 1294–1309. <https://s-space.snu.ac.kr/handle/10371/180079>.
- doi Comeau, L., Cormier, P., Grandmaison, É., & Lacroix, D. (1999). A longitudinal study of phonological processing skills in children learning to read in a second language. *Journal of Educational Psychology*, 91(1), 29–43.
- doi Cummins, J. (1979). Linguistic interdependence and the educational development of bilingual children. *Review of Educational Research*, 49(2), 222–251.
- doi DeKeyser, R., & Prieto Botana, G. (2015). The effectiveness of processing instruction in L2 grammar acquisition: A narrative review. *Applied Linguistics*, 36(3), 290–305.
- doi Delasalle, D. (2008). Enseigner une langue à l'école: A-t-on les moyens de relever ce défi dans le contexte actuel? *Ela. Etudes de Linguistique Appliquée*, 151(3), 373–383.
- Demont, E., & Gombert, Jean. E. (2007). Relations entre conscience phonologique et apprentissage de la lecture: Peut-on sortir de la relation circulaire? In E. Demont & M. N. Metz-Lutz (Eds.), *L'acquisition du langage et ses troubles* (p. 47–79). SORAL.
- doi Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T. (2001). Phonemic awareness instruction helps children learn to read: Evidence from the National reading Panel's meta-analysis. *Reading Research Quarterly*, 36(3), 250–287.
- doi Field, J. (2004). An insight into listeners' problems: Too much bottom-up or too much top-down? *System: An International Journal of Educational Technology and Applied Linguistics*, 32(3), 363–377.
- Field, J. (2008). *Listening in the language classroom*. Cambridge University Press.
- doi Gathercole, S. E., Willis, C. S., Baddeley, A. D., & Emslie, H. (1994). The Children's Test of Nonword Repetition: A test of phonological working memory. *Memory*, 2(2), 103–127.
- Gillon, G. T. (2007). *Phonological awareness: From research to practice*. The Guilford Press.
- doi Goh, C., & Taib, Y. (2006). Metacognitive instruction in listening for young learners. *ELT Journal*, 60(3), 222–232.
- Gombert, J.-E. (1990). *Le développement métalinguistique*. PUF.
- doi Graham, S., Santos, D., & Vanderplank, R. (2010). Strategy clusters and sources of knowledge in French L2 listening comprehension. *Innovation in Language Learning and Teaching*, 4(1), 1–20.
- Hilton, H. (2009). *Systèmes émergents: Acquisition, traitement et didactique des langues* [Habilitation à Diriger des Recherches]. Université Lumière, Lyon 2.
- doi Høien, T., Lundberg, I., Stanovich, K. E., & Bjaalid, I.-K. (1995). Components of phonological awareness. *Reading and Writing*, 7(2), 171–188.

- doi** Hulme, C., Hatcher, P.J., Nation, K., Brown, A., Adams, J., & Stuart, G. (2002). Phoneme awareness is a better predictor of early reading skill than onset-rime awareness. *Journal of Experimental Child Psychology*, 82(1), 2–28.
- Kanta, T., & Rey, V. (2003). Relation entre la conscience phonologique et l'apprentissage d'une langue seconde. *Travaux Interdisciplinaires du Laboratoire Parole et Langage d'Aix-en-Provence (TIPA)*, 22, 135–147.
- Kivistö de Souza, H. (2015). Phonological awareness and pronunciation in a second language (Unpublished doctoral dissertation). Universitat de Barcelona. In *TDX (Tesis Doctorals en Xarxa)*. <http://www.tdx.cat/handle/10803/393726>
- doi** Koch, M., von Luck, K., Schwarzer, J., & Draheim, S. (2018). The novelty effect in large display deployments – experiences and lessons-learned for evaluating prototypes. In T. Gross & M. Muller (Eds.), *Proceedings of 16th European Conference on Computer-Supported Cooperative Work*. European Society for Socially Embedded Technologies (EUSSET).
- Krashen, S.D. (1982). *Principles and practice in second language acquisition*. Alemany Press.
- Li, M., Cheng, L., & Kirby, J. (2012). Phonological awareness and listening comprehension among Chinese English-immersion students. *International Education*, 41(2). <https://trace.tennessee.edu/internationaleducation/vol41/iss2/4>
- doi** Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology*, 18(2), 201–212.
- doi** Loiseau, M., & Noûs, C. (2022). À la recherche de l'attitude ludique. In H. Silva (Éd.), *Regards sur le jeu en didactique des langues et des cultures* (p. 61–83). Peter Lang.
- Magnat, É. (2017). *Kinéphones*. <https://kinephones.hypotheses.org/>
- Mandin, S., Zaher, A., Meyer, S., Loiseau, M., Bailly, G., Payre-Ficout, C., Diard, J., Fluence-Group, & Valdois, S. (2021). Expérimentation à grande échelle d'applications pour tablettes pour favoriser l'apprentissage de la lecture et de l'anglais. *Transformations dans le domaine des EIAH: Innovations technologiques et d'usage(s)*. 10e Conférence EIAH, online.
- doi** Marslen-Wilson, W.D., & Tyler, L. K. (1980). The temporal structure of spoken language understanding. *Cognition*, 8(1), 1–71.
- doi** Matthews, J., & O'Toole, J.M. (2015). Investigating an innovative computer application to improve L2 word recognition from speech. *Computer Assisted Language Learning*, 28(4), 364–382.
- doi** Melby-Lervåg, M., & Lervåg, A. (2011). Cross-linguistic transfer of oral language, decoding, phonological awareness and reading comprehension: A meta-analysis of the correlational evidence. *Journal of Research in Reading*, 34(1), 114–135.
- Ministère de l'Éducation Nationale. (2015). *Programmes pour les cycles 2 3 4*.
- Ministère de l'Éducation Nationale. (2016). *Cedre 2016. Anglais en fin d'école et de collège* (LES DOSSIERS DE LA DEPP).
- Ministère de l'Éducation Nationale et de la Jeunesse. (2019). *Guide pour l'enseignement des langues vivantes: Oser les langues vivantes étrangères à l'école*. Ministère de l'Éducation Nationale et de la Jeunesse. Retrieved on 25 April 2024 from <https://eduscol.education.fr/document/347/download>
- doi** Morais, J., Cary, L., Alegria, J., & Bertelson, P. (1979). Does awareness of speech as a sequence of phones arise spontaneously? *Cognition*, 7(4), 323–331.

- doi** Plonsky, L., & Ziegler, N. (2016). The CALL-SLA Interface: Insights from a second-order synthesis. *Language Learning & Technology*, 20(2), 17–37.
- doi** Roussel, S., Gruson, B., & Galan, J.-P. (2017). What types of training improve learners' performances in second language listening comprehension? *International Journal of Listening*, 33(1), 1–14.
- doi** Savage, R., & Carless, S. (2005). Phoneme manipulation not onset-rime manipulation ability is a unique predictor of early reading. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 46(12), 1297–1308.
- doi** Stanovich, K. E., Cunningham, A. E., & Cramer, B. B. (1984). Assessing phonological awareness in kindergarten children: Issues of task comparability. *Journal of Experimental Child Psychology*, 38(2), 175–190.
- doi** Suh, S., Kim, S. W., & Kim, N. J. (2010). Effectiveness of MMORPG-based instruction in elementary English education in Korea. *Journal of Computer Assisted Learning*, 26(5), 370–378.
- doi** Tsui, A. B. M., & Fullilove, J. (1998). Bottom-up or top-down processing as a discriminator of L2 listening performance. *Applied Linguistics*, 19(4), 432–451.
- Tunmer, W. E. (1989). Conscience phonologique et acquisition de la langue écrite. In L. Rieben & C. Perfetti (Eds.), *L'apprenti lecteur: recherches empiriques et implications pédagogiques* (pp. 197–220). Delachaux et Niestlé.
- doi** VanPatten, B. (2002). Processing instruction: An update. *Language Learning*, 52(4), 755–803.
- doi** Verdugo, D. R., & Belmonte, I. A. (2007). Using digital stories to improve listening comprehension with Spanish young learners of English. *Language Learning & Technology*, 11(1), 87–101.
- Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). *Comprehensive Test of Phonological Processing* (PRO-ED).
- Wepman, J. M., & Reynolds, W. M. (1994). *Auditory Discrimination Test (ADT)*. Western Psychological Services.
- doi** White, J., & Ranta, L. (2002). Examining the interface between metalinguistic task performance and oral production in a second language. *Language Awareness*, 11(4), 259–290.
- doi** Yelland, G. W., Pollard, J., & Mercuri, A. (1993). The metalinguistic benefits of limited contact with a second language. *Applied Psycholinguistics*, 14(4), 423–444.
- Yu, H., Li, F., Gallis, J. A., & Turner, E. L. (2020). *Cvcrand package* (0.1.0) [Logiciel]. <https://cran.r-project.org/web/packages/cvcrand/vignettes/cvcrand.html#:~:text=%20cvcrand%20is%20an%20R%20package,defined%20weights%20on%20the%20covariates>
- doi** Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin*, 123(2), 162–185.