

O CONSTRUTO DA ATENÇÃO NOS ESTUDOS SOBRE FONOLOGIA DE SEGUNDA LÍNGUA ENTRE OS ANOS DE 2010 E 2021

THE CONSTRUCT OF ATTENTION IN STUDIES
IN L2 PHONOLOGY BETWEEN 2010 AND 2021

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Resumo: A aquisição de uma segunda língua (L2) é uma tarefa cognitiva altamente exigente que, em termos de fonologia, acontece através do cerco da primeira língua (L1). O peso dado às pistas, ou seja, a atenção dada a traços específicos na fala de L2 e a capacidade de mudar o foco de atenção para traços relevantes é essencial para o processamento da fala em L2 e tende a ser afetado pelos padrões da L1. O presente estudo foi realizado com o objetivo de produzir uma revisão sistemática dos estudos relativos à atenção e ao conhecimento fonológico de L2. Foram descritos e analisados os participantes das pesquisas, a avaliação da atenção e do conhecimento fonológico e os principais resultados de dezoito estudos publicados entre 2010 e 2021. Os dados coletados indicam que a maior parte da pesquisa realizada é de estudos transversais com controle da atenção e tarefas de discriminação perceptiva com aprendizes adultos de inglês como L2. A maioria dos estudos apontou que a atenção tem um papel importante na aquisição fonológica de uma L2. Além disso, em um estágio inicial de aquisição, a atenção parece ser mais importante do que para estágios mais avançados quando a automatização é estabelecida. Focar, selecionar, mudar, dividir e sustentar a atenção, assim como ser flexível e ter bom controle inibitório, têm ligação especial com aquisição fonológica de uma L2. A necessidade de mais investigação com variáveis controladas, outras combinações de L1 e L2, e múltiplos instrumentos de avaliação fica evidente.

Palavras-Chave: Aquisição fonológica. Atenção. Segunda Língua. Cognição. Revisão sistemática.

Abstract: The acquisition of a second language (L2) is a highly demanding cognitive task that, in terms of phonology, happens through the siege of the first language (L1). The cue-weighting, that is, the attention given to specific cues in the L2 speech and the ability to change the focus of attention to relevant cues is essential for L2 speech processing

and tends to be affected by the patterns of the L1. The present study aimed to produce a systematic review of the studies concerning attention and L2 phonological knowledge. Research participants, attention and phonological assessment, and the main results of eighteen studies published between 2010 and 2021 were described and analyzed. The data gathered indicates that the bulk of the research carried out is of cross-sectional studies with attention control and perceptual discrimination tasks with L2 English adult learners. Most studies pointed out that attention has an important role in L2 phonological acquisition. At the beginning of acquisition, attention seems to be more important to L2 speech processing than for proficient L2 speakers when automatization takes place. Focusing, selecting, shifting, dividing, and sustaining attention as well as being flexible and having good inhibitory control have a special role in L2 phonological acquisition. The need for further investigation with controlled variables, other L1/L2 combinations, and multiple assessment instruments is evident.

Keywords: Phonological acquisition. Attention. Second Language. Cognition. Systematic review.

Introduction

Second language (L2) acquisition is a highly demanding cognitive task (Sternberg; Sternberg, 2011). It is known that even the acquisition of reading is related to phonological acquisition in that listening comprehension precedes reading comprehension (Babayigit; Shapiro, 2020). “Selective attention to phonology, i.e., the ability to attend to sub-syllabic units within spoken words, is a critical precursor to literacy acquisition” (Yoncheva; Maurer; Zevin; Mccandliss, 2014, p. 262). The most common cognitive processes researched in this area are working memory (e.g., Wen; Mota; Mcneill, 2015), inhibition (e.g., Darcy; Mora; Daidone, 2014), and attention control (e.g., Darcy; Mora; Daidone, 2014).

Attention has long been established as essential to any kind of learning to occur (James, 1890; Nissen; Bullemer, 1987), including L2 acquisition (De Los Santos; Alves, 2021; Skehan, 2015). In the words of Willian James (1890, p. 255) “only those items which I notice shape my mind - without selective interest, experience is an utter chaos. Interest alone gives accent and emphasis, light and shade, background and foreground - intelligible perspective, in a word”. Conscious and unconscious processes are involved with attention can be defined as “the means by which we actively process a limited amount of information from the enormous amount of information available through our senses,

our stored memories, and our other cognitive processes” (Sternberg; Sternberg, 2011, p. 137). James (1989, p. 256) emphasizes that “every one knows what attention is” and states that attention “is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought” and adds that “focalization, concentration, of consciousness are of its essence”. Attention is, thus, a set of basic processes such as arousal, focused attention, selective attention, divided attention, and sustained attention (Strauss; Sherman; Spreen, 2006). The multiplicity of basic processes under the attention umbrella is described by Strauss, Sherman and Speen (2006, p. 546):

These include sensory selection (filtering, focusing, automatic shifting), response selection (response intention, initiation, and inhibition, active switching, and executive supervisory control), attentional capacity (structural and energetic capacity, arousal, effort), and sustained performance (fatigability, vigilance).

According to the revised Speech Learning Model (SLM-r), when learners are exposed to a second language, they have already tuned their cue weighting patterns for phonological category formation with the parameters that are important in their L1 and, thus, learners’ selective and sustained attention is modelled by the first language (Flege; Bohn, 2021). The problem lies in that, very often, the languages differ from one another in which cues should be weighted more and what is different enough for proper phonological category formation resulting in that the perceptual saliency of oral speech differs between native and non-native speakers (learners) of a target language. Concerning attention and phonetic learning, Guion and Pederson (2007, p. 57) found that “with explicit directing of attention, adult learners can better discern novel phonetic contrasts”, attributing to teachers and material designers an important role in learners’ L2 phonological category formation. It is also important to consider that differences regarding attention are due not only to learners’ L1, but also to individual differences in attentional allocation (Flege; Bohn, 2021).

The importance of carrying out the present study lies in the fact that significant positive correlations between attention control and L2 phonological acquisition have been found as well as inconclusive results. It is necessary to understand if and how attention plays a specific role in L2 phonological acquisition so that interventions aimed at facilitating learning of an L2 and training attention can be properly designed and administered based on scientific and reliable data. Also, this study presents a variety of instruments to

assess both attention and L2 phonological knowledge¹ which can guide future research. The contrasting results may be due to research methodology including variable control. A variety of data-gathering instruments have been used to assess cognitive constructs and a variety of learner profiles and measures of L2 phonological acquisition. As Strauss, Sherman and Spreen (2006, p. 546) put it, “tests of attention typically measure more than one attentional process”. Moreover, since attention is a set of codependent basic processes, data-gathering instruments fail to assess one dimension of attention in isolation (Strauss; Sherman; Spreen, 2006). Besides not being able to isolate a type of attention completely during assessment, other executive functions, memory (Strauss; Sherman; Spreen, 2006), and language proficiency (as discussed for Working Memory in Mitchell *et al.*, 2015) may interfere in the results compromising construct validity. Finally, definitions for the constructs of attention and working memory tend to overlap which is not surprising since attentional processes are central to cognition. The control of variables may explain part of the contrasts in research outcomes.

The present study aimed at producing a systematic review of the studies investigating attention and L2 phonological knowledge. To do so, we intend to answer the following research questions for the studies reviewed:

1. Who are the participants?
2. How is attention dealt with and how is it assessed?
3. How is L2 phonology dealt with and how is it assessed?
4. What are the main results of the studies?

In the following session, the methodology of the present study is described.

1 Method

The present study is a systematic review of the research carried out concerning attention and L2 phonology between the years of 2010 and 2021. First, the analyzed studies were supposed to be restricted to peer-reviewed articles published in scientific magazines, but the universe of the research was broadened because of the small number of publications found. To select the studies to comprise the investigated sample, a search was conducted on Google Search, Portal Periódicos Capes, and Direct Science filtering for a combination of the following words in keywords, abstract and title: L2, second language, phonological, and attention. The terms were chosen because they reflected the specific scope of the present study. The date of publication was set between the years

¹ Phonological knowledge is a general term which comprises metalinguistic knowledge as well as phonological awareness. Phonological awareness refers specifically to awareness of language sounds and the ability to work with them.

2010 and 2021. Then, their titles and abstracts were individually examined to select the final sample with only the articles that addressed the focus of the present study: the relationship of attention and L2 phonology. A great number of articles delivered from the search tools brought the word “attention” meaning “consideration” resulting from thousands of possibilities, eighteen publications that attended the criteria.

The final sample was comprised of eighteen publications: fourteen peer-reviewed articles, two peer-reviewed book chapters, and two PhD dissertations in Linguistics. They were, then, examined chronologically from the oldest to the most recently published and identified by author and year of publication. The data was organized in tables and discussed considering the five research questions proposed.

2 Results

As aforementioned, only eighteen publications concerning the relation between attention and L2 phonology could be found for the period between 2010 to 2021 after running over thousands of results from search tools with words such as L2, second language, phonology, and attention. Some of the selected studies investigated not only attention and L2 phonology but also other cognitive constructs and linguistic variables. We discuss here only the method and results on the focus of the present study: L2 phonology and attention. The data obtained from the studies concerning research design is organized in Table 1.

Table 1 – Research design

Longitudinal studies	Nicolay; Poncelet, 2013
Brain research – Event Related Potential (ERP)	White; Titone; Genessee; Steinhauer, 2015 Hisagi; Shafer; Strange; Sussman, 2015
Quasi-experimental studies	Porrettta; Tucker, 2015 Gökgöz-Kurt, 2016 Mora; Mora-Plaza, 2019
Cross-sectional studies	Isaacs; Trofimovich, 2011 Safronova; Mora, 2013 Darcy; Mora; Daidone, 2014 Yang; Yang; Kang, 2014 Darcy; Park; Yang, 2015 Fukuta; Yamashita, 2015 Safronova, 2016 Zou; Chen; Caspers, 2016 Asano, 2017 Chang, 2018 Lewandowski; Jilka, 2019 Kwakkel; Droop; Verhoeven; Segers, 2021

Source: The author

In twelve studies (66.7%), participants were submitted to a battery of tests either in one session or in a few sessions within a short amount of time, and therefore, were classified as cross-sectional studies. Three studies (16.7%) comprised a pretest phase, an intervention, and a posttest phase and were classified as quasi-experimental. Two studies (11.1%) involved amplitude or latency of Mismatch Negativity (MMN) in Event Related Potential (ERP) and were classified as brain research. Finally, one study (5.5%) was a four-wave longitudinal study with four moments of data gathering throughout three years. Cross-sectional studies are usually more feasible and less-time consuming and, thus, expected to correspond to the most common study type among the revised publications.

Analysis and discussion of the results for the four research questions proposed will be shown.

2.1 Participants

The profile of the participants varied across the studies concerning their L1, their L2, their language experience and their ages. The data regarding L1 and L2 is displayed in Table 2.

Table 2 – Distribution of studies according to participants' L1 or L2

	L2 English	Other L2s
L1 English	-	Isaacs; Trofimovich, 2011 (Accentedness) Porretta; tucker, 2015 (Finnish) Darcy; Mora; Daidone, 2014* (Spanish)
L1 Spanish	Safronova; Mora, 2013 (Catalan/Spanish) Darcy; Mora; Daidone, 2014* Safronova, 2016 (Catalan/Spanish) Mora; Mora-Plaza, 2019 (Catalan/Spanish)	-

Other L1s	White; Titone; Genessee; Steinhauer, 2015 (French) Darcy; Park; Yang, 2015 (Korean) Fukuta; Yamashita, 2015 (Japanese) Hisagi; Shafer; Strange; Sussman, 2015 (Japanese) Gökgöz-Kurt, 2016 (Arabic, Mandarin Chinese, Japanese, Vietnamese, Korean, Turkish) Lewandowski; Jilka, 2019 (German)	Zou; Chen; Caspers, 2016 (Dutch learners of Mandarin) Asano, 2017 (German learners of Japanese) Chang, 2018 (11: American English, Russian, Japanese, Korean, Mandarin Chinese and L2: English and Korean)
Other L1s - kindergartens	Nicolay; Poncelet, 2013 (French) Yang; Yang; Kang, 2014 (Chinese) Kwakkel; Droop; Verhoeven; Segers, 2021 (Dutch)	-

* One group L1-English/L2-Spanish and another group L1-Spanish/L2-English

Source: The author

Chang (2018) had 28 participants of each of the following L1 groups: American English, Russian, Japanese, Korean, and Mandarin Chinese. Gökgöz-Kurt (2016) also had a mixed L1 group as participants: Arabic, Mandarin Chinese, Japanese, Vietnamese, Korean, and Turkish. The number of participants in each group varied from 2 to 10. Darcy, Mora and Daidone (2014) had two different groups of L1 and L2: L1-Spanish/L2-English and L1-English/L2-Spanish. Out of the fifteen remaining publications, two had a variety of English as their L1, three had a variety of Spanish, two of French, two of Japanese, two of German, two of Dutch, one of Korean, and one of Chinese.

Concerning L2, English was the most frequent language being the L2 of thirteen studies (72.22%) including Darcy, Mora and Daidone (2014) that had two groups of L2. The other languages researched as an L2 were Spanish, Finnish, Korean, Mandarin, and Japanese. Isaacs and Trofimovich (2011) had native English listeners as participants, but the independent variable was being a music major and L1 played a role only in the selection of L2s to be rated for their accent by the participants. Chang (2018) investigated both English and Korean as L2s with five different L1s as mentioned in the previous paragraph. Two combinations of L1 and L2 had no English participants: Dutch learners of Mandarin Chinese (Zou; Chen; Caspers, 2016) and German learners of Japanese (Asano, 2017).

Concerning age, participants can be divided into two groups: five-year-old kindergartens and young adults. None of the research found had teenagers or older people as participants. Three studies investigated five-year-old kindergartens enrolled in a bilin-

gual school where the L2 was English. The L1 of the children was French in Nicolay and Poncelet (2013), Chinese in Yang, Yang and Kang (2014), and Dutch in Kwakkel *et al.* (2021). The studies that involved adult participants most frequently identified them as undergraduate students explaining the prevalence of young adults as participants. Most participants were rewarded, and college credits were an alternative to payment for some of the researchers. Therefore, availability and easiness of reward made undergraduate students a good option as participants.

Regarding gender, there was a balance between male and female participants in some of the studies that reported this data. Some had more participants from one gender, but the selection of participants was usually based on availability. Women have shown to have some advantage in phonological acquisition (Lange; Zaretski, 2021), especially before four years old (Toivainen *et al.*, 2017), but this variable is neither controlled nor discussed in most studies. The number of participants was usually greater than thirty.

At least from the eighteen studies found after exhausting investigation, the variety of participants' profiles concerning L1 is evident. The only variable replicated across most of the studies was L2 English. Neither L1 Portuguese nor L2 Portuguese was investigated. Even though the search engines were set to elicit results from any language, further investigations were carried out in Portuguese to verify whether there wasn't any study with either L1 Portuguese or L2 Portuguese. Only studies in which attention was referred to as something considered important and that should be properly investigated (e.g., Santos; Alves, 2021) or briefly mentioned as something to be called attention to through instruction (e.g., Silveira; Alves, 2009) could be found.

2.2 Attention and phonology assessment

To grasp a message from the input, one must allocate their attention in what is most relevant and because the relevant phonological cues vary across languages, selective attention plays a very important role in L2 learning. However, besides phonemic distinctions, to communicate one needs to be able to switch rapidly their attention to other dimensions such as the lexical dimension requiring a great amount of attention control.

As previously mentioned, the definition of attention is not a consensus among researchers, and it is usually seen as a set of basic processes and not as something unitary. In the eighteen publications analyzed, attention could be organized into three groups. The bulk of the research on L2 phonology and attention deals with attention control. Executive attention and oriented/divided attention comprised the other two groups.

Each group of studies is discussed next.

1.2.1 Attention Control

Attention control was the focus in ten out of the eighteen studies (55.56%). It refers to the ability a person has to choose what to focus on and when to switch attention to something else. How attention control and L2 phonology were assessed are displayed in Table 3.

Table 3 – Assessment of attention control and L2 phonology

Assessment of AC	Study	Assessment of L2 phonological knowledge
Trail Making Test	Isaacs; Trofimovich, 2011	Rating of 40 non-native speech samples for accentedness, comprehensibility, and fluency.
A speech-based attention shifting task (with variation of attention between two speech dimensions)	Safronova; Mora, 2013	Vowel discrimination task AXB in CVC minimal pairs
	Darcy; Mora; Daidone, 2014	L2 phonology: a speeded ABX categorization task
	Darcy; Park; Yang, 2015	1. Speeded segmental categorization with ABX (word and non-words)/ 2. Rapid encoding of word stress with sequence repetition (tígu, tíbu; míban, mibán)/ 3. Phonotactics and onset clusters with a speeded lexical decision.
	Safranova (2016)	L2 vowel perception -perceptual assimilation task - categorical vowel discrimination task
	Gökgöz-Kurt, 2016 + attention network test (ant)	Pre and posttest: Two-option forced-choice identification task; Treatment: Online training on word-boundary palatalization.
	Mora; Mora-Plaza, 2019 + an auditory selective attention + an auditory inhibition task	(Two vowel contrasts) AX discrimination, an identification task, a delayed repetition task
Comparison of performance in two conditions	Zou; Chen; Caspers, 2016	Phonological discrimination of Mandarin tones and segment-tone integration – an ABX task
Addition of acoustic complexity in the discrimination task	Asano, 2017	Discrimination of consonant length

Simon Test	Lewandowski; Jilka, 2019	Retelling of a cartoon and a conversation about stays in English speaking countries. A direct imitation (Hindi, German, English) and a delayed imitation. Perception: prosody pair comparison, prosody interpretation, and accent identification.
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Source: The author

Six of the ten studies (60%) that explicitly dealt with attention control followed similar methods and used a speech-based attention shifting task developed by scholars of the Universitat de Barcelona. The most frequent author is Joan C. Mora, who is an associate professor in the Department of Modern Languages and Literatures at the Universitat de Barcelona, Spain. The speech-based attention shifting task triggers the variation of attention between two dimensions. Usually, one of the dimensions is a spectral cue represented by voice quality determined by genre – male or female, in which participants must answer whether an utterance was produced by a male or a female voice, and the other dimension can be a temporal or semantic cue. The temporal cue can be vowel or consonant duration and natural stimuli can be manipulated in order to present the same phoneme with different lengths. In this case, participants must select or answer something indicating whether the utterance contained the short or long version of the phoneme. Nonwords can be used respecting the phonotactics of target language. When the task is speeded as in Darcy, Mora and Daidone (2014), it means the participants were told to answer as accurate and as quickly as possible. The measures were accuracy, reaction time, and shift cost.

Four other studies addressed attention control. Isaacs and Trofimovich (2011) used the Trail Making Test (TMT). The TMT is a neuropsychological test designed to be adopted by the U. S. Army as part of a test battery. It is now in public domain. The TMT tests visual attention and task switching by requiring participants to connect 25 dots with a line as quick and as accurate as possible. Lewandowski and Jilka (2019) used the Simon Task to assess attention control and mental flexibility. The Simon Task involves having participants make leftward decisions for one stimulus and rightward responses to another while shifting the position the stimulus appear on a screen in a way that congruent and incongruent stimuli demand attention control. Reaction times and accuracy are the measures considered. The other two studies did not have specific tasks to assess attention, but manipulations and comparisons. Zou, Chen, and Casper (2016) compared performance in the segment-and-tone with the segment-or-tone condition in a discrimination

ABX task. Finally, in Asano (2017) there was the addition of acoustic complexity in the perceptual discrimination task. An example of such complexity given by Asano (2017) was a task-irrelevant pitch fall.

Gökgöz-Kurt (2016) had an additional attention control assessment tool because they wanted a validated instrument to be compared to the speech-based attention shifting task. The chosen task was the Attention Network Test (ANT). The ANT tests alerting, orienting and executive control. The ANT is a computerized task and involves a sequence of visual stimuli with cues to help prediction of upcoming target presentation or location. Participants must indicate the direction that a central arrow, surrounded by other arrows, is pointing to.

Concerning L2 phonological knowledge, perception was the main domain researched. Discrimination and identification tasks focusing on phoneme distinction, cue-weighting, and suprasegmentals such as stress, prosody and connected speech as well as phonotactics of the target language were tested. ABX, AXB, and AX designs are all mentioned as discrimination tasks administered. Tasks were, usually, specifically designed to suit pairs of L1 and L2. For example, some tasks, such as the Phonotactics and onset clusters with a speeded lexical decision administered in Darcy, Park and Yang (2015) used a repair strategy of epenthesis clusters transferred from Korean phonotactics to L2-English in order to assess L2 phonological knowledge because the L2-English consonant clusters are not allowed in Korean. Production was only tested recently by Mora and Mora-Plaza (2019) through an immediate repetition task and by Lewandowski and Jilka (2019) through a cartoon retelling, a conversation, and an accent imitation task.

Gökgöz-Kurt (2016) was the only of these studies with a quasi-experiment design, that is, a treatment between pre and posttests. The treatment required training of both perception and production of connected-speech in English, more specifically palatalization in word-boundaries such as in 'kiss you'. Finally, Isaacs and Trofimovich (2011) was the only study that did not administer a classic categorization or identification task. Participants had their phonological knowledge tested by rating 40 non-native speech samples for their accentedness, comprehensibility, and fluency. The independent variable was being a major in music.

The variety of features being tested calls for further replication of method and variable control to be possible to generalize the results found. Each of the studies had very specific and unique goals and methods. The choices of assessment of attention and assessment of L2 phonological knowledge matched. For instance, Lewandowski and Jilka (2019) used the Simon task, a task dealing with congruent and incongruent stimulus, for

assessing attention, and participants could converge phonetically with their interlocutors. Moreover, the authors tested whether participants would perceive accents and produce accents of different languages when the language of communication was English, a feature partially tested only by Isaacs and Trofimovich (2011) with a very different group of participants - English music majors - and very different research goals.

2.2.2 Executive Attention

Three studies addressed executive attention which is known as the attentional component of executive functioning: alerting, orienting, and executive control. Even though it is not clear how and to what extent executive attention and attention control differ, for the terms used and goal similarities, the three studies were grouped for analysis. Besides having as focus of investigation executive attention, Nicolay and Poncelet (2013), Yang, Yang, and Kang (2014), and Kwakkel *et al.* (2021) had five-year-old bilingual (L2 – English) kindergartens as participants. How attention and phonological knowledge were assessed is displayed in Table 4.

Table 4 – Assessment of Executive attention and L2 phonology

Assessment of Executive attention	Study	Assessment of L2 phonological knowledge
Test of Attentional Performance in Children (KiTAP) “The Bat” – a go-no-go task; Dual-task subtest – “The Owls”; Mental flexibility – “The Dragon’s house”	Nicolay; Poncelet, 2013	Speech perception task - Minimal pair discrimination task (nonsense syllables obeying French phonotactics) Phonological awareness task -vowel phoneme detection task (15 four-picture series: listen, repeat, answer if hear the target phoneme)
The Attentional Network Test	Yang; Yang; Kang, 2014	Phonological tasks assessing onset and rime awareness – ABCX
A go-no-go task with an auditory and a visual component/ The Head-Toes-Knees-Shoulders task	Kwakkel; Droop; Verhoeven; Segers, 2021	Phonological awareness in Dutch and in English: a phoneme segmentation and a phoneme blending task.

Source: The author

Nicolay and Poncelet (2013) was the only four-wave longitudinal study. The first data gathering session (T0) was right after enrollment in the first immersion school year of their French participants and involved collecting basic data. The second was at the end of kindergarten (T1), the third at the end of the first grade (T2), and the fourth at the

end of second grade (T3). To assess executive attention, a standardized battery of tests of Attentional Performance in Children (KiTAP) had three tasks administered in T0. In an inhibitory go-no-go task named “The Bat”, black bats and cats appeared on a screen one at a time randomly and children had to press a key when the bat appeared. In an auditory selective attention task named “The owls”, there were “squeak and deep owl screeches one at a time in regular alternation. The children’s task was to press a reaction key as quickly as possible each time they detected an irregularity in the sequence” (Nicolay; Poncelet, 2013, p. 661). Finally, the mental flexibility component was tested through a task named “The Dragon’s house” in which a blue and a green dragon appeared on the screen in unpredictable places and either a left or right key should be pressed with the appearance of each dragon according to instructions given.

Yang, Yang, and Kang (2014) used The Attentional Network Test (ANT) also used by Gökgöz-Kurt (2016) and described in session 2.2.1. The ANT assesses the three aspects of executive attention: alerting, orienting, and executive control and can be used with both children and adults. Yang, Yang, and Kang’s (2014) participants were Chinese learners of English.

The other study concerning executive attention was Kwakkel *et al.* (2021). Kwakkel *et al.* (2021) sometimes referred to executive functioning as sustained attention, behavioral self-regulation, and verbal short-term memory and other times as attention control, behavioral self-regulation, and verbal short-term memory. The sustained attention/attention control was assessed by a continuous performance task – a go-no-go task with an auditory and a visual component. Their participants were bilingual five-year-old Dutch learners of English and were tested on a few linguistic and cognitive variables as happened in the other two studies with children just mentioned.

For the behavioral self-regulation parcel of executive functioning, the Head-Toes-Shoulders-Knees Task (HSKT) (McClelland *et al.*, 2014) elicited, among other aspects, attention focusing. The task consisted of following orders from an instructor with specific rules, such as: when the instructor said, “Touch your head”, participants had to touch their toes. Sustained attention was tested by a continuous performance computerized go-no-go task with two parts. The first part was the auditory task in which stimuli were either high sounds or low sounds. Children were supposed to press a button as they heard a high sound. The second part was the visual task in which stimuli were either circles or squares and children were supposed to press a button as they saw a circle.

Phonological knowledge was addressed in the studies considering phonologi-

cal processing. Nicolay and Poncelet (2013) used two tests. The first was a minimal pair discrimination task with nonsense syllables obeying French phonotactics in which two types of nonsense syllable pairs were heard in the 50 slightly different stimuli trials such as ASRA versus ARSA. The other 50 pairs heard were comprised of identical syllables. The syllables presented had one of the following structures: CCV, VCCV, CCCV. In order to test phonological awareness more specifically, a vowel phoneme detection task in which 15 four-picture series matched to disyllabic French words were presented. Participants had to listen, repeat, and answer whether they heard the target phoneme as in “This is an igloo; repeat igloo.... Are you hearing /i/ in igloo?” (Nicolay; Poncelet, 2013, p. 660).

Yang, Yang, Kang (2014) used two four-word oddity tasks to assess phonological awareness in both Chinese and English words: one concerning the onset of words in which out of four words heard one had a different onset (e.g., rod, rock, box, rot) and another concerning rimes in which one out of four words heard, one did not rhyme (e.g., fan, cat, rat, mat). The authors considered neither using segmenting nor blending tasks to assess phonological awareness in that they argue these abilities develop as a consequence of reading. For illiterate children they considered onset and rime detection abilities as more adequate measures of phonological awareness considering their participants’ profiles. Kwakkel *et al.* (2021), on the other hand, used two tasks in Dutch and two tasks in English to assess phonological awareness: a phoneme segmentation task and a phoneme blending task. In the phoneme segmentation task, participants had to segment words into phonemes and in the phoneme blending task, participants had to blend phonemes into words. The number of phonemes augmented progressively in both tasks.

2.2.3 Oriented and Divided Attention

Divided attention corresponds to attending to multiple (2 or more) sensory stimuli simultaneously. Oriented attention is not a specific type of attention, but a way of referring to attention as it was directed to specific cues and dimensions of stimuli for methodological reasons in the analyzed studies. In this session, oriented and divided attention are grouped because one study, Fukuta and Yamashita (2015), investigated both conditions. The other four studies presented in this session addressed oriented attention alone. The data is shown in Table 5.

Table 5 – Assessment of Oriented and Divided attention and L2 phonology

Assessment of Divided/oriented attention	Study	Assessment of L2 phonological knowledge
Dual-task condition – description while parallel finger tapping	Fukuta; Yamashita, 2015 (divided/oriented)	Normal condition – oral description of four-frame cartoons; Reasoning demand condition –oral description and ordering of the frames; and a dual task condition.
Influence in the amplitude and latency of Mismatch Negativity (MMN) in Event Related Potential (ERP)	Hisagi; Shafer; Strange; Sussman, 2015 (oriented)	An auditory attend and count task A discrimination of a Japanese length contrast for consonants
	White; Titone; Genessee; Steinhauer, 2015 (oriented)	Free speech on a chosen topic. A perceptual discrimination task (a – ha – fa)
Attention oriented through explicit instruction	Porretta; Tucker, 2015 (oriented)	A speeded forced-choice identification task and a speeded AX discrimination task (manipulated stimuli)
Direction of attention to phonetic cues according to their estimated relative functional load (RFL).	Chang, 2018 (oriented)	A speeded AX discrimination task. A speeded one-interval four-alternative-forced-choice (4AFC) identification task with English nonce words/one with Korean nonce words.

Source: The author

Fukuta and Yamashita (2015) investigated divided attention and oriented attention. Their experiment consisted of assessing phonological knowledge through an oral production task in L2-English. The task consisted of an oral description of four-frame cartoons. Accuracy, complexity, and fluency were rated. The task was administered under three different conditions: a normal condition, a reasoning demand condition in which the cartoons were out of order and participants were required to order them while describing the story, and a dual task condition in which participants had to engage in a parallel finger tapping task. For the parallel finger tapping task, participants were randomly required to hit a key while speaking. The dual-task condition allowed for divided attention assessment and the reasoning demand condition distracted participants.

Hisagi *et al.* (2015) and White *et al.* (2015) used electrophysiological responses in their studies. Both studies considered attention as an influence in the amplitude and/or latency of Mismatch Negativity (MMN) in Event Related brain Potentials (ERPs). “The MMN is a fronto-central negativity, typically elicited by an infrequent ‘deviant’ sound within a sequence of repeating ‘standard’ sounds or sound patterns (the auditory odd-ball paradigm)” (White *et al.*, 2015, p. 164). It has been identified as a as a “sensitive measure

of automatic and language-specific phonemic discrimination” (White *et al.*, 2015, p. 164).

Hisagi *et al.* (2015) had to perform tasks during and following the ERP session. There were visual and auditory tasks. The auditory stimuli were nonce words obeying the phonological rules of Japanese and the visual stimuli were circle and oval shapes in four different sizes. During the session, a visual attend task required participants to count visual deviant shapes ignoring auditory speech sounds and an auditory attend task required them to count the short vowel deviants while looking at the screen. After the ERP session, participants were submitted to a perceptual discrimination task of the word forms: miɸɸi and miɸi with 100 trials.

White *et al.* (2015) investigated MMN amplitude and latency when a discrimination task with / Ø, h, f/ as in a, ha, fa as the stimuli. The onset /h/ in English tend to be challenging for French speakers as was the case of the participants. Also, previously to the MMN session participants spoke freely on a chosen topic and a thirty-second sample of this speech was selected for analysis. Raters judged six dimensions: overall pronunciation, pronunciation of initial /h/ (vs Ø), Vocabulary, Grammar, Fluency, Overall native-ness (13-point scale).

Non-native consonantal length was the focus of Porretta and Tucker’s (2015) study. Phonological knowledge of L1-American English and L2-Finnish participants was assessed through a speeded forced-choice identification task and a speeded AX discrimination task on Finnish non-words (e.g., /hupo/-/huppo/). The intervocalic consonant duration was manipulated. After pretest, participants were explicitly instructed on Finnish consonant length. Then, a posttest was administered. Instruction was how attention was oriented to temporal cues in Finnish.

Finally, Chang (2018) dealt with attention considering relative functional load. Functional load has to do with phonetic cues that distinguish phonological contrasts and the number of contrasts that involves this cue as well as the number of other cues that help in the target distinction. It refers to the importance of the specific cue to a specific distinction. To assess phonological knowledge, L2 perception of unreleased final voiceless stops and attention were investigated through three perceptual tasks: a speeded AX categorical discrimination task, a speeded one-interval four-alternative-forced-choice identification task with English nonce words and another with Korean nonce words.

2.3 L2 phonology and attention - results

Some of the mentioned studies investigated more cognitive, linguistic, and personality variables. To maintain the focus proposed for the present systematic review, only

data directly concerning attention and L2 phonological knowledge is dealt with in this study. The same applies for the presentation of the results of the reviewed studies, only those directly concerning the relationship between attention and L2 phonological knowledge are presented.

2.3.1 Results for the studies on attention control

Attention control, as previously mentioned, was the classification of attention more mentioned in the eighteen studies reviewed. Table 6 displays the results of the six studies that investigated attention control assessed by a speech-based attention shifting task.

Table 6 – Attention control assessed with the speech-based attention shifting task - results

Study	Results
Safronova; Mora, 2013	Participants who were better able to shift focus of attention between voice quality and segmental duration were more successful at focusing on the relevant spectral cue in L2 vowel discrimination task.
Darcy; Mora; Daidone, 2014	The better the attention control the more accurate performance in ABX for L2 learners.
Darcy; Park; Yang, 2015	No correlations for attention control
Safranova, 2016	Lower attention control was related to faster and more accurate discrimination of L2 sounds.
Gökgöz-kurt, 2016	Both groups improved from pre to posttest, but the improvement for the trained group was significantly higher. The better the attention control, the higher the phonological learning.
Mora; Mora-Plaza, 2019	Cognitive attention control explains a substantial amount of variance in L2 vowel perception and plays an important role in L2 speech learning.

Source: The author

Four studies found positive correlations between measures of phonological knowledge and the speech-based attention shifting task used to assess attention control. The better the performance in the attention control task, the better the performance in phonological assessment task. Darcy, Park and Yang (2015) found no correlations and Safranova (2016) found a negative significant correlation. Darcy, Park and Yang (2015) failed to find a correlation between attention control and phonological knowledge. Many factors might explain this result that refuted their hypothesis that attention control would predict phonological acquisition and that would corroborate results from most of the other studies that investigated this relationship. One of them is task design – attention

control was only assessed by the speech-based attention shifting task and in English which was the L2 of the participants. A standard non-verbal task or in the participants' L1 could have been used as in Gökgöz-Kurt (2016). Another explanation could lie in the tasks designed to assess phonological knowledge. Also, as attention is a set of different basic attentional processes, the aspect of attention and of phonological knowledge tested through the designed tasks may not correlate.

Another study that did not corroborate the hypothesis made was Safranova (2016). Even though a correlation was found between attention control and phonological knowledge, the hypothesis was refuted in that lower attention control was related to faster and more accurate discrimination of non-native contrasts. The author speculated that better attention control may not lead to faster and more accurate discrimination of non-native contrasts and that the ability to focus attention on more salient and relevant cues might be a better predictor. Also, the measures drawn from the results of the speech-based task (accuracy and shift cost) did not correlate with each other, suggesting they measure two different constructs. Therefore, as in Darcy, Park and Yang (2015) another standardized task for assessing attention control could have been employed.

Four other studies dealt with attention control but used other instruments to assess it. Table 7 displays their results.

Table 7 – Attention control not assessed by a speech-based attention shifting task - results

Study	Results
Isaacs; Trofimovich, 2011 (trail making test)	There were no effects of phonological memory or attention control on accentedness judgements.
Zou; Chen; Caspers, 2016 (comparison of performance)	The acquisition of new tonal categories in L2 involves a redistribution of attention along perceptual dimensions and the development of segment-tone integration.
Asano, 2017 (addition of complexity)	Without extra demand, discrimination was high. The non-learners were affected by memory and control load. Learners were only affected by the attention control load.
Lewandowski; Jilka, 2019 (simon task)	Phonetic skills and Switch cost in a Simon Task impacted the degree of phonetic convergence.

Source: The author

Isaacs and Trofimovich (2011) used a classic Trail Making Test to assess attention of major and non-majors in music and found no correlation between their attention control results and non-native accentedness judgements suggesting an absence of bias from

attention in their judgements. It can be speculated that a different assessment task could have delivered a different result. Zou, Chen and Caspers' (2016) results pointed to the need for attentional redistribution throughout L2 learning of tones. This is very important for learners whose L1 are not tonal languages when aiming at learning Mandarin Chinese.

Asano (2017) found that whereas memory and attention control load affects discrimination of Japanese consonant-length contrasts by German non-learners of Japanese, attention control load affected performance even for the German learners. The author suggested that the reduction of listeners' sensitivity by demanding tasks might explain listening difficulties faced even by advanced learners due to the great number of distractors present in daily situations.

Finally, Lewandowski and Jilka (2019) found that attention control assessed by the Simon Task, referring to a measure of inhibition, had a significant correlation with phonetic convergence, that is, the process in which the pronunciation of two directly interacting people becomes more like each other. It means that the participants who could inhibit wrong reactions better and faster were the ones who more converged in the dialog task.

2.3.2 Executive attention and L2 phonological knowledge – results

Three studies had five-year-old participants and all of them focused on phonological knowledge and executive functions. Table 8 displays the results.

Table 8 – Executive attention in five-year-old children and phonological awareness - results

Study	Phonological knowledge and attention
Nicolay; Poncelet, 2013 (French/L2 English)	Auditory attention and flexibility are involved in beginning of L2 vocabulary acquisition, especially the receptive one.
Yang; Yang; Kang, 2014 (Chinese/L2 English)	Phonological awareness (PA) and executive attention (EA) correlated. Orienting attention and Chinese and English PA strongly correlation. EA correlated only with English PA.
Kwakkel; Droop; Verhoeven; Segers, 2021 (Dutch/L2 English)	English phonological awareness was directly predicted by Dutch phonological awareness and sustained attention.

Source: The author

Nicolay and Poncelet (2013) was a four-wave longitudinal study and found that

in the three years of data-gathering, correlations between attention, phonological development and L2 acquisition changed. Executive attention and phonological awareness are essential for the first steps of L2 acquisition and, in general, within time other variables interfere reducing the correlation strength. The authors state that in the context of French children enrolled in an L2-English immersion school program, as was the case of the study, auditory selective attention and speech perception predict L2 vocabulary development.

For the Chinese children in Yang, Yang and Kang (2014), a bidirectional relation between phonological awareness and executive attention was found. Regarding attention, orienting attention was strongly related to both English and Chinese phonological awareness. However, executive control related only to phonological awareness in English. Kwakkel *et al.* (2021), on the other hand, found different results for Dutch children learning English in that Dutch phonological awareness and sustained attention predicted English phonological awareness. The authors found support for cross-language transfer from L1 to L2 phonological awareness among bilingual children considering the investigated sample.

The difference between the results from Yang, Yang and Kang (2014) and from Kwakkel *et al.* (2021) may be due to the L1 of the participants, in that Dutch and English are closer than Chinese and English. Also, differences in research method and variable control affect research findings.

2.3.3 Oriented and divided attention – results

The five studies investigating oriented attention had a greater methodological variation than the other grouped studies. Two of them used electrophysiological measures, one of them focused on both oriented and divided attention, one had instruction as attention trigger, and one used the measure of cue relative functional load. Results are displayed in Table 9.

Table 9 – Oriented and divided attention and phonological knowledge - results

Study	Results of L2 phonological knowledge
Fukuta; Yamashita, 2015	Attentional demands affected accuracy and fluency.
Hisagi; Shafer; Strange; Sussman, 2015	Both acoustic-phonetic properties and phonological experience affects automaticity of speech processing.

White; Titone; Genessee; Steinhauer, 2015	Low proficient learners need oriented attention whereas highly proficient learners process contrasts like native speakers do.
Porretta; Tucker, 2015	Naïve English listeners of Finnish perceive increasing consonant duration but not as well as Finnish speakers. The instruction group outperformed control.
Chang, 2018	Findings support a cue-centric view of transfer based on perceptual attention over a direct phonotactic view.

Source: The author

In Fukuta and Yamashita (2015), participants were submitted to different demand conditions: a reasoning and a dual task. The dual task condition was a way of assessing orientation/division of attention and it was shown that it affected accuracy and fluency in a negative way. The authors stated as a pedagogical implication that task demands may need to be eased to facilitate orientation of attention to the items to be learned and practiced in class. They also pointed that since their participants were highly proficient learners, results cannot be generalized to lower proficient levels without further investigation.

Hisagi *et al.* (2015) and White *et al.* (2015) had MMN in ERPs as the main data-gathering instrument. Hisagi *et al.* (2015) found that Japanese listeners discriminate Japanese consonantal length contrast better than American English listeners, who do not have consonantal length as a distinctive cue, do. Without attention, L2 speech processing needs to be automatic. The study results showed that both acoustic phonetic properties and L2 experience affect automaticity of speech processing. White *et al.* (2015) found that even learning L2 later in life, French speakers highly proficient learners of English process the contrast /h/ vs Ø with similar neurocognitive mechanisms of English native speakers. Low proficient learners, on the other hand, need attention orientation to the phonological characteristics of the contrasting sounds to discriminate them properly.

Porretta and Tucker (2015) showed that mere knowledge of a difference in consonantal length directs the attention of naïve listeners of Finnish to the distinctive phonological contrast and leads them to improve their performance in discriminating short and long consonants even when their L1 does not present such distinctive feature.

Finally, Chang (2018) investigated the hypothesis that “transfer effects in perception come from L1-specific processing strategies, which direct attention to phonetic cues according to their estimated relative functional load (RFL)” (CHANG, 2018, p. 85). Having speakers from different L1s (American English, Russian, Japanese, Korean, and Mandarin Chinese) as participants and two target languages, English and Korean, Chang

(2018) pointed out that transfer from L1 to L2 cannot be entirely predicted by contrasts in phonotactics. Their results indicated that perceptual attention to distinctive cues explain transfer processes better supporting the hypothesis investigated.

Final Considerations

The need for further investigations about attention and L2 phonological knowledge is clear from the small number of studies produced on the topic from 2010 to 2021 and from the diversity of methodologies employed. The eighteen studies found investigated different aspects of attention assessed by different tasks and related to different aspects/domains of phonological knowledge assessed by different tasks on different target objects. The guiding research questions aimed at investigating participants, data-gathering instruments and main results concerning attention and L2 phonology from the selected studies.

Participants were from different L1s and different L2s with English being the L2 in thirteen out of eighteen studies. Three of the thirteen studies happened on the context of bilingual education with five-year-old kindergartens. The other fifteen studies had young adults as participants. Portuguese was neither the L1 nor the L2 in any of the reviewed studies. Gender was not a considered variable. In most studies participants were either paid for their participation or received college credits for it. The difficulty of finding participants may lead to the profile found. Such difficulty is even bigger in Brazil, where participants cannot be paid.

Attention control, executive attention, divided attention, selective attention, sustained attention, and oriented attention were terms that appeared in the studies and that seemed to overlap occasionally. A speech-based attention shifting task was the most frequent task used to assess attention control. Standard test batteries and individual tasks such as the Attentional Network Test, the Simon Task and the Trail Making Test were also used. Two studies used Event Related Brain Potentials to identify changes in neural activation as attention was manipulated. Manipulation of attention was also used for behavioral assessment in perceptual and production tasks. Oriented attention was present through instruction and cue manipulation. It is necessary, in future studies, to use more than one type of instrument to properly assess attention. Also, a clear description of the aspect of attention being investigated is extremely important for choice and design of task assessment.

Phonological knowledge was assessed through L1 and L2 phonological awareness,

perceptual identification, perceptual discrimination, oral production, and imitation tasks.

Phonological awareness measures such as segmentation and blending of phonemes, and onset and rime oddity tasks were used when participants were kindergartens. Perceptual discrimination tests were the most frequent measures of phonological knowledge in general and the analyzed contrasts varied considerably. Most contrasts present in the tasks' stimuli were chosen due to the difficulty they impose to learners according to the L1/L2 combination.

Most studies indicated that attention has an important role in L2 phonological acquisition. At the beginning of acquisition attention seems to be more important to L2 speech processing than for proficient L2 speakers when automatization takes place. Focusing, selecting, shifting, dividing, and sustaining attention as well as being flexible and having inhibitory control are all linked to learning in general and have a special role in L2 phonological acquisition. However, many other individual variables such as motivation, working memory, and personality, as well as many linguistic and experience variables, interact to ensure success in L2 acquisition.

There is a clear need for future research on the relationship between attention and L2 phonological acquisition. Future researchers can benefit from the present systematic review by presenting possible data-gathering instruments for different participants' profiles, as well as providing data to build hypotheses which under different circumstances with control of different variables can provide results that can refute or corroborate such hypotheses.

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