

## Article

# Teaching English with Oral Chunk-Based Training

Veronica Mendoza <sup>1,\*</sup>  and Ekaitz Zulueta <sup>2</sup>

<sup>1</sup> Department of English and German Philology and Translation and Interpreting, University of the Basque Country, UPV/EHU, 01006 Vitoria-Gasteiz, Spain

<sup>2</sup> Department of System Engineering and Automatic Control, Vitoria-Gasteiz, University of the Basque Country, UPV/EHU, 01006 Vitoria-Gasteiz, Spain; ekaitz.zulueta@ehu.eus

\* Correspondence: veronica.mendoza@ehu.eus; Tel.: +34-945-01-3229

## Abstract

Some generative linguists report that in formal settings, learners of English as a foreign language often strive to acquire morphemes such as the third-person singular –s and produce utterances such as *\*he play*. This study reviews generative linguistics, psychology, neuroscience, and biolinguistics, examining how speech and other forms of action involve hierarchically organised groups (chunks) of words or acts that are invariably produced in linear order. Chunks contribute to brain efficiency, facilitating acquisition and enabling brain automaticity. A study was conducted to improve the accuracy rates of sentence segments featuring the third-person singular –s (e.g., “he VERB+s”) by orally rehearsing chunk-based sentences (e.g., [He plays] [a lot]). Sixty-four children from three Spanish schools, learning English as a foreign language and aged 8–11, participated in this study. The participants, divided into a control group and two experimental groups, completed an oral sentence transformation task following a pre-test–post-test design. The Wilcoxon test showed statistically significant results for the experimental groups after the administration of oral chunk-based training. Quartiles and deciles demonstrated improvement in these groups. The findings suggest that oral chunk-based training could foster chunk and morpheme acquisition. This pedagogy might enhance brain efficiency in learning and promote automatic speech.

**Keywords:** chunk; innate; learned; brain efficiency; automaticity; generative linguistics; psychology; neuroscience; biolinguistics



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## 1. Introduction

Some generative linguists report that in formal settings, learners of English as a second or foreign language often struggle to acquire verbal morphemes such as the third-person singular –s and regular past –ed and produce utterances such as *\*he play* (Calzada & García Mayo, 2021; Ionin & Wexler, 2002; Lardiere, 2009; Martínez-Adrián & Gutiérrez-Mangado, 2015; Muroya, 2018). However, existing linguistic theories do not provide a pedagogical solution to this learning challenge. Significantly, the generative linguist Chomsky (1995, 2015) suggests that language sentences are composed of hierarchically organised phrases (groups of words) that are linearised (concatenated) for production. Chomsky (2015) adds that language acquisition must entail proficiency in linearising hierarchically organised phrases (groups of words) for sentence production; moreover, Chomsky (2006) criticises the psychologist Lashley (1951) for comparing actions such as locomotion with language. Lashley (1951) highlights that sequences of automatic actions, such as routine speech, honed birdsong, expert musical performance, and locomotion, are

built from hierarchically organised groups (chunks) of words or acts that are invariably produced in linear order. Notwithstanding, both authors are relevant to various disciplines. This study examines linguistics, psychology, neuroscience, and biolinguistics to investigate the structuration and expression of action sequences, including speech sentences, with emphasis on chunks. Notably, some researchers (Graybiel, 1998; Graybiel & Grafton, 2015; G. A. Miller, 1956; Zeliadt, 2013) argue that chunks contribute to brain efficiency by offsetting cognitive load during information processing that occurs in learning, which facilitates acquisition, and in planning and producing action sequences, which enables brain automaticity. The present study examined the effects of oral chunk-based training on the accuracy of sentence segments featuring the third-person singular –s (e.g., “he VERB+s”). This is a known area of difficulty for learners of English as a foreign language, especially in Expanding Circle countries (Kachru, 2015), where inflectional morphology in oral production remains a challenge. While current linguistic theories identify the nature of such challenges, they often fall short of offering pedagogical solutions. In this study, oral chunk-based training relied on the rehearsal of chunk-based sentences such as “[He plays] [a lot].” The findings suggest that this pedagogy could facilitate chunk and morpheme acquisition. Significantly, oral chunk-based training might enhance brain efficiency in learning and promote automatic speech.

## 2. Literature Review

This section critically reviews the contributions made by the linguist Noam Chomsky (Section 2.1), the psychologist Karl Lashley (Section 2.2), and various neuroscientists, psychologists, and biolinguists (Sections 2.3 and 2.4) concerning the planning and production of speech sentences and other action sequences, along with their constituents. The emphasis is placed on “chunks”—groups of words or acts—as the units that support brain efficiency, including automaticity.

### 2.1. Chomsky’s Syntax and Its Phrases

In *Syntactic Structures*, Chomsky (1957) introduces a grammar “that generates all of the grammatical sequences” (p. 13) of a language through a finite set of sentence constituents (phrases) and syntactic rules (mainly phrase structure rules). For example, the sentence shown in (1) is formed by a noun phrase (NP, ‘the man’) and a verb phrase (VP, ‘saw the turtle’).

(1) The man saw the turtle.

The NP is composed of an article (Art, ‘the’) and a noun (N, ‘man’). The VP is constituted by a verb (V, ‘saw’) and an NP (‘the turtle’). The phrase structure rules underlying this sentence are displayed in (2):

(2) S = NP + VP

NP = Art + N

VP = V + NP

Art = the

N = man, turtle, bird, ...

V = saw, heard, ...

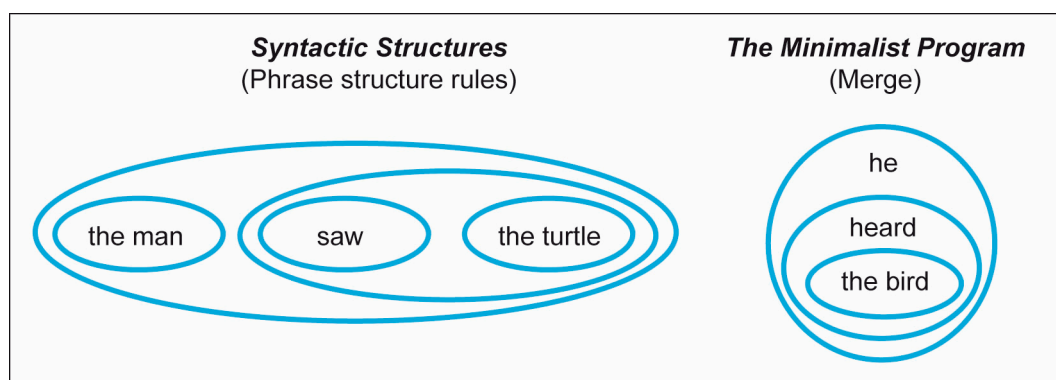
Chomsky (1965) notes that a “generative grammar” (p. 3) constitutes a description of the knowledge that enables a person to perceive and produce language. This grammar is a finite system of “rules that can iterate” (p. 15) to generate an indefinite number of sentence structures. The rule system has three components: syntactic, phonological, and semantic. The syntactic component generates sentence structures that require a semantic and phonological interpretation. The semantic component endows such structures with meaning, while the phonological component provides the structures assigned by the

syntactic component with sound. Chomsky (1965) adds that the latter two components “play no part in the recursive generation of sentence structures” (p. 141). Chomsky’s early work on generative grammar involves three key concepts that remain significant in his later contributions: iteration, recursion, and hierarchy. According to Martins et al. (2016), iteration is “the process of repeating an operation a certain number of times” (p. 1422). Recursion is the ability to generate “multiple hierarchical levels using the same rule” (p. 1421). A hierarchy is a form of organisation in which “higher levels incorporate multiple lower levels in structural representations” (p. 1421). Hierarchical structures are representations where constituents are embedded (nested) within others.

In *The Minimalist Program*, Chomsky (1995, 2015) reformulates his theory, suggesting that the faculty of language—that is, humans’ ability to produce and comprehend language—relies on two main brain systems: a cognitive system and a performance system. Chomsky (1995, 2000, 2011, 2015) argues that, on the one hand, the cognitive system includes a lexicon and a computational system. The latter selects and combines items from the former to create linguistic structures. On the other hand, the performance system consists of the conceptual–intentional system and the articulatory–perceptual system. The cognitive system interacts with the performance system for the semantic and phonological interpretation of linguistic structures at two interface levels: Logical Form, which is concerned with meaning (semantics), at the conceptual–intentional interface; and Phonetic Form, which involves sound (phonology), at the articulatory–perceptual or sensorimotor interface. Additionally, Chomsky (1995, 2000, 2015) discards phrase structure rules. Chomsky (2000) justifies this decision by arguing that “A ‘perfect’ solution to the problem of variety of phrase-structure rules would be to eliminate them entirely in favor of the irreducible operation that takes two objects already formed and attaches one to the other, forming a larger object (. . .): the operation we can call Merge” (p. 13). Given this basic computational operation, two objects,  $\alpha$  and  $\beta$ , form the new syntactic object  $\gamma$ ; for example, ‘the’ and ‘bird’ are assembled as {the, bird}. A second application of merge combines ‘heard’ and {the, bird}, yielding the object {heard, {the, bird}}. A third application to ‘he’ and {heard, {the, bird}} generates sentence (3).

(3) {he, {heard, {the, bird}}}.

Note that the shift from phrase structure rules to merge alters phrase structuration (see Figure 1).



**Figure 1.** Phrase structuration in Syntactic Structures and The Minimalist Program. Adapted from Chomsky (1957, 1995, 2015).

Bolhuis et al. (2014) stress that merge “can apply to the results of its own output” (p. 2); in short, merge is iterative. Consequently, as pointed out by Chomsky (1995, 2015), merge forms larger units, which account for phrase structure. Additionally, Everaert et al. (2015) describe recursion as “a property of a finitely specified generative procedure that allows an

operation to reapply to the result of an earlier application of the same operation” (p. 732). In turn, [De Vries et al. \(2011\)](#), [Fitch and Martins \(2014\)](#), and [Levinson \(2014\)](#) underscore that recursion establishes nested (non-linear, non-adjacent) dependencies between phrases. [Chomsky and Miller \(1963\)](#) suggest these dependencies can be observed, for instance, in sentences featuring an embedded object relative clause, such as (4), where ‘the rat’ (rather than ‘the cat’) relates to ‘ate the malt.’

(4) The rat [the cat killed] ate the malt (pp. 286–287)

Thus, as highlighted by [Chomsky \(1995, 2000, 2011, 2015\)](#), the brain does not organise sentences as linear strings of words; instead, it arranges sentences by recursively building larger syntactic objects, which determines the hierarchical structuration of phrases. More precisely, the computational system executes a finite generative procedure that deploys the syntax of language mainly through the iterative operation of merge, deriving an infinite array of hierarchically organised linguistic expressions accessed by the performance systems and interpreted at the interfaces. Then, syntactic structures are linearised into strings of words at Phonetic Form for externalisation—articulation—([Everaert et al., 2015](#); [Yang, 1999](#)). [Chomsky \(2015\)](#) also underscores that, although linear order is not central to language design, it is crucial for externalisation. In this respect, [Chomsky \(2015\)](#) adds that, “In learning a language, the real problem is mastering externalization.” (p. xi). This suggests that language acquisition must entail expertise in linearising or concatenating hierarchically organised phrases (groups of words) for sentence production. As demonstrated in Section 2.2, the concepts of hierarchy and linearisation appear in [Lashley \(1951\)](#).

In the preface to [Chomsky’s \(2002\) \*On Nature and Language\*](#), [Belletti and Rizzi \(2002\)](#) propose that language acquisition can be understood as the transition from the initial mental state at birth—Universal Grammar—to the mature state of native linguistic competence. According to [Chomsky \(1965, 1986\)](#), Universal Grammar forms part of the innate, biologically endowed language faculty. It refers to the knowledge—also called primary linguistic data—that the child is equipped with at birth. This innate knowledge enables the first-language learner to construct a grammar based on linguistic experience; that is, through exposure to input ([White, 2003](#)). [Belletti and Rizzi \(2002\)](#) argue that native speakers can employ the generative procedure automatically and unconsciously: “Every speaker implicitly masters a very detailed and precise system of formal procedures to assemble and interpret linguistic expressions. This system is constantly used, in an automatized and unconscious manner, to produce and understand novel sentences, a normal characteristic of ordinary language use” (p. 5). Similarly, [Chomsky \(2006\)](#) emphasises the unconscious nature of linguistic knowledge: “Each of us has mastered and internally represented a system of grammar that assigns structural descriptions to (...) sentences; we use this knowledge, totally without awareness (...), in producing these sentences or understanding them when they are produced by others” (p. 92). These perspectives underscore the idea that native language use relies on deeply internalised grammatical systems that operate automatically, without conscious attention. This view aligns with the broader theoretical framework of Universal Grammar and supports the conception of language as an innate cognitive faculty.

[Hauser et al. \(2002\)](#) stress that the faculty of language is generative, hierarchical, and recursive. [Chomsky \(2000\)](#) adds that the faculty of language is innate, stating that “the child, endowed with certain innate capacities, acquires knowledge of a language (...) with little if any choice in the matter” (p. 54). He also describes it as species-specific, noting that it varies “little among humans and without significant analogue elsewhere” (p. 3), including birdsong. Additionally, [Chomsky \(2006\)](#) portrays this faculty as domain-specific and criticises [Lashley \(1951\)](#) for characterising automatic, extemporaneous actions such as walking, a form of locomotion, as syntactic. In Section 2.2, [Lashley \(1951\)](#) suggests that the brain controls automatic actions—such as routine speech, refined birdsong, perfected

musical performance, and locomotion—through schemas. These schemas specify the hierarchical organisation of groups (or chunks) of words or acts and their production in a linear (serial) order. Sections 2.3 and 2.4 further explore how these chunks enable brain efficiency, including automaticity, in language, musical performance, and locomotion, among others. However, actions such as walking are iterative in nature. Martins et al. (2016) assert that iteration, which involves “repeating an operation a certain number of times” (p. 1422), may or may not yield hierarchical structures or create dependencies between constituents.

## 2.2. Lashley’s Syntax of Action and Its Groups

In “The Problem of Serial Order in Behavior,” the psychologist Lashley (1951) asserts that “the syntax of action” (p. 134) is a “schema or pattern of integration” (p. 122) that the brain imposes on words or acts to control the sequences of extemporaneous (automatic) action, including routine speech, honed birdsong, expert musical performance, and locomotion. Building on Lashley (1951), Bermudez (2014) and Fuster (2013, 2015) specify that an action pattern accurately stipulates the items to be integrated into a particular sequence, as well as their structuration (planning) and expression (production).

Regarding structuration, Lashley (1951) suggests that the brain organises automatic actions in a hierarchical manner through action schemas. These schemas integrate groups composed of words or acts to generate sequences (Asano & Boeckx, 2015; Asano, 2022; Fitch & Martins, 2014; Fuster, 2013, 2015; Jin & Costa, 2015; Marler, 1981; Rosenbaum et al., 2007). For example, Fitch and Martins (2014) suggest that Lashley (1951) demonstrates that planning actions involves a hierarchical structure. Drawing on Lashley’s (1951) contribution, Fitch and Martins (2014) state that when encountering a sentence such as, “The boy who patted the cat chased the bird,” an English speaker understands that it is the boy, not the cat, who pursued the bird, despite the phrase “the cat chased the bird.” According to Fitch and Martins (2014), Lashley (1951) shows that relying solely on the order of words is inadequate for processing language effectively. Similarly, in complex tasks, overarching goals (such as making coffee) must be maintained over time, even when various subgoals (groups of acts) are initiated and completed (like grinding the beans, heating the water, and adding cream).

Concerning expression, Lashley (1951) underscores that the brain integrates words or acts not only in a hierarchical fashion but also in the temporal domain to produce automatic actions (Asano & Boeckx, 2015; Fuster, 2003; Graybiel, 1998). For example, during expert performance, a musician translates groups of notes onto the timeline through successive finger movements. Lashley (1951) points out that, despite its hierarchical structure, an action schema is invariably produced “as a temporal sequence, either as a succession of words or of acts.” (pp. 121–122). Therefore, action schemas are arranged in a linear (serial) order. Moreover, these integrative patterns specify the details related to the muscles involved in producing a particular sequence. This includes the order in which muscles must contract, as well as the timing and duration of these muscle contractions (Schmidt & Lee, 2014). Lashley (1951) adds that rhythm, accuracy, and speed permeate automatic action, including proficient speech.

Lashley’s (1951) action schemata are regarded as the basis of the concept of ‘motor programme’ (Summers & Anson, 2009). Note that the term ‘motor programme’ describes a cerebral schema that governs learned actions such as language and birdsong. In contrast, the terms ‘central pattern generator’ and ‘fixed-action pattern’ refer to schemas that command innate actions such as respiration and locomotion in humans and certain animals, and self-grooming in rodents (Aldridge & Berridge, 1998; Kalueff et al., 2016; Schmidt & Wrisberg, 2000).



Section 2.3 focuses on motor programmes, while Section 2.4 focuses on central pattern generators and fixed-action patterns. In both sections, emphasis is placed on chunks and their role in underpinning brain efficiency, including brain automaticity.

### 2.3. Motor Programmes

The neuroscientist Fuster (1997, 2003, 2015) distinguishes between two main areas of the brain: sensory and motor. He also identifies two basic forms of knowledge or memory: perceptual and motor. Sensory areas are dedicated to perception, controlling and acquiring perceptual (declarative) memory, which includes the lexicon, through repetition; in contrast, motor areas, primarily the prefrontal cortex and the basal ganglia, are responsible for purposeful actions, such as speech. These areas acquire motor (procedural, action-related) memory, which includes rules and motor programmes, through repeated practice. To produce goal-directed actions, including meaningful speech, a motor programme is required. This programme (or schema) follows rules and specifies the planning (syntax) and production (output) of a sequence.

Fuster (1997, 2003, 2015) claims that the prefrontal cortex is engaged at the initial stages of learning whenever deliberation and attention to every item (word or act) in the action sequence are required. With practice, overlearned actions, such as routine and unimaginative speech, activate the basal ganglia. Furthermore, the motor programmes controlled by the prefrontal cortex are composed of single-item units. Conversely, Graybiel (1998, 2008) argues that the basal ganglia regulate motor programmes formed by multi-item units—“chunks”. Fuster (1997, 2003, 2015) reports that neuroimaging studies evidence that information initially processed by the prefrontal cortex becomes dependent on the basal ganglia after repeated practice. Once skilled actions become routine and automatic, the activation of the prefrontal cortex ceases. In contrast, the basal ganglia become engaged, indicating that these skilled actions have been relegated to this area (Grafton et al., 1992; Jenkins et al., 1994). Hirokane et al. (2023) also note that, for example, when we start learning to play a musical piece, each note is processed as a single item, but “after many repetitions, several successive adjacent elements gradually form small clusters, which are called chunks” (p. 1).

However, Fuster (2003) highlights that language cannot be learned through mere imitation or rote memorisation: “As Lashley (1951) remarked long ago (...), the mere chaining of words (...) does not make language” (p. 167). Fuster (2013) adds that, “as Chomsky (1957, 2007) has pointedly remarked, recursion is what makes language unlimited” (p. 182). Fuster (2013) asserts that the language code evidences that the possible relations between words are infinite, as is any combinatorial code formed by numerous elements. According to Fuster (2003, 2015), the prefrontal cortex is essential for the novel (creative) and attentive (rather than automatic) planning and production of action sequences, word by word or act by act. For example, the prefrontal cortex collaborates with other brain regions that supply the lexicon to integrate single words hierarchically, recursively, and temporally, e.g., People (word [1]) + sleep (word [2]) + less (word [3]) + as (word [4]) + they (word [5]) + grow (word [6]) + older (word [7]). Fuster (2015) also points out that the prefrontal cortex is not responsible for “overlearned actions, familiar rules and their implementation, as well as routine and unimaginative language” (p. 253).

Research in animals demonstrates that, with sufficient repetition, the basal ganglia exert motor chunking (Graybiel, 1998, 2008; Smith & Graybiel, 2013, 2014, 2016; Zeliadt, 2013). ‘Motor chunking’ is the term used to refer to the process of recoding action sequences into ‘motor chunks’ (Bera et al., 2021). According to Graybiel (1998), a motor chunk is an action-related cluster. It consists of multiple acts that together form a unit of motor (procedural, action-related) memory. (Graybiel, 2008; Graybiel & Mink, 2009; Jog et al., 1999).

Graybiel (1998) emphasises that, once acquired (ingrained in memory through repetition), motor chunks are automatically planned and produced in a specific temporal order by the basal ganglia, e.g., motor chunk [1] + motor chunk [2] + motor chunk [3] + motor chunk [4]. Graybiel (1998) specifies that chunking acts as a mechanism for “information compression” (p. 119), meaning that it reduces cognitive load. This cognitive strategy facilitates information processing, thereby supporting the acquisition and automatic expression of action sequences. Consequently, chunking enhances brain efficiency (Graybiel, 2008; Graybiel & Grafton, 2015).

Graybiel (1998) also highlights that the basal ganglia can recode both motor and cognitive sequences into chunks to achieve information compression. The basal ganglia segment action sequences and acquire chunks, such as when we chunk a phone number to learn it, e.g., 714-362-958 (Graybiel, 1998, 2008; Smith & Graybiel, 2013, 2014, 2016; Zeliadt, 2013). Graybiel (1998) explains that, according to G. A. Miller (1956), it is difficult for us to learn long sequences of numbers or letters, such as a long phone number. However, brain efficiency “can be gained by recoding bits of information to form packages (chunks of information) that, once learned, can be treated as entities in memory” (Graybiel, 1998, p. 129) (Zeliadt, 2013), allowing for reliable recall (retrieval) and efficient performance (Jin et al., 2014).

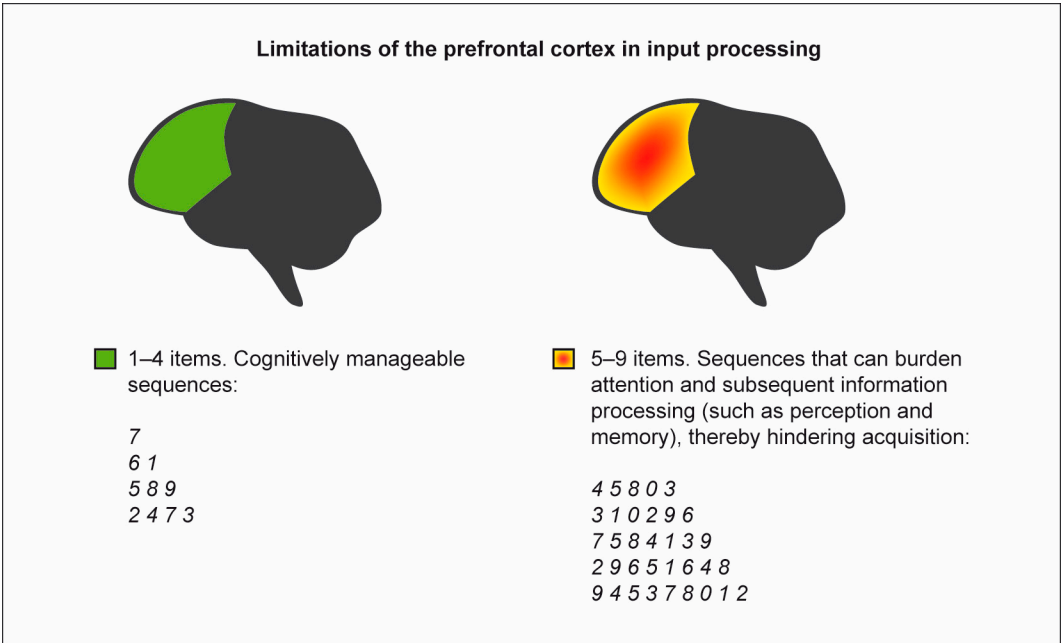
Relatedly, [G. A. Miller \(1956\)](#) claims that the capacity of short-term memory, now known as working memory, is limited to approximately seven items of information, plus or minus two (5–9 items). Therefore, most people can read or listen to a long sequence of numbers and then repeat it correctly from memory, provided the sequence does not exceed approximately seven items; that is, the upper limit of working memory. However, chunks reduce cognitive load during input processing, making learning easier. In turn, the psychologist [Howard \(1983\)](#) conveys a Digit Memory test showing that the longer the sequence, the more difficult it is for us to remember. [Figure 2](#) illustrates the perspectives of [G. A. Miller \(1956\)](#) and [Howard \(1983\)](#) on working memory and information processing. It demonstrates the maximum sequence length that individuals can typically recall (retrieve) accurately after briefly rehearsing each line, starting with the numbers or letters on the first line.

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|
| 7 |   |   |   |   |   |   |   |   | B |   |   |   |   |   |   |   |   |  |
| 5 | 8 |   |   |   |   |   |   |   | X | G |   |   |   |   |   |   |   |  |
| 6 | 9 | 1 |   |   |   |   |   |   | F | H | L |   |   |   |   |   |   |  |
| 3 | 0 | 4 | 2 |   |   |   |   |   | M | N | R | W |   |   |   |   |   |  |
| 8 | 1 | 9 | 5 | 7 |   |   |   |   | P | J | X | F | D |   |   |   |   |  |
| 2 | 4 | 5 | 3 | 6 | 2 |   |   |   | Z | Q | K | C | K | R |   |   |   |  |
| 4 | 7 | 0 | 9 | 3 | 8 | 1 |   |   | N | F | P | W | S | B | X |   |   |  |
| 1 | 6 | 8 | 3 | 4 | 7 | 9 | 5 |   | C | T | D | G | K | Z | J | M |   |  |
| 0 | 4 | 5 | 7 | 9 | 2 | 8 | 3 | 6 | Q | X | C | R | F | N | H | L | P |  |

**Figure 2.** Sequences displaying incremental lengths. Adapted from [G. A. Miller \(1956\)](#) and [Howard \(1983\)](#).

Most people begin to make errors when rehearsing sequences of approximately seven items. This indicates that these sequences may burden attention and subsequent information processing (such as perception and memory), thereby hindering acquisition. [Fuster \(2009\)](#) and [Baars and Gage \(2010\)](#) emphasise that the prefrontal cortex plays a central role in working memory by sustaining attention during information processing. The level of prefrontal activation is directly proportional to the number of items this brain region must attend to; that is, hold in working memory. [Baars and Gage \(2010\)](#) argue that a

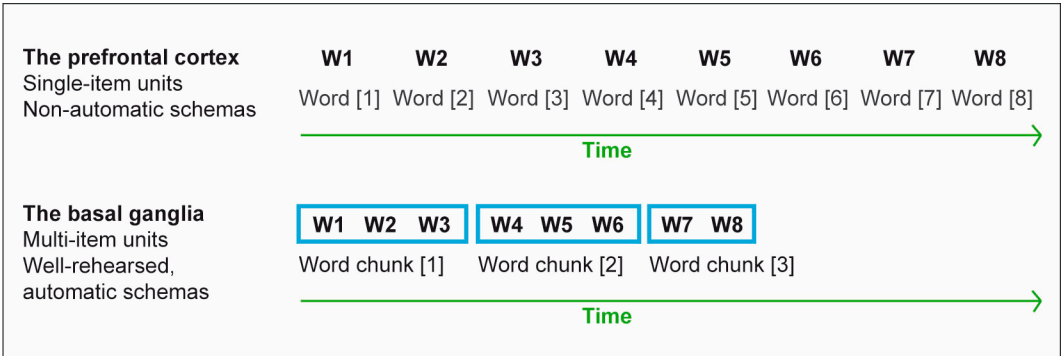
cognitively demanding task—one that heavily taxes our attentional resources—is similar to simultaneously juggling a dozen balls (see Figure 3).



**Figure 3.** Limitations of the prefrontal cortex in input processing. Adapted from [G. A. Miller \(1956\)](#), [Fuster \(2009\)](#) and [Baars and Gage \(2010\)](#).

Furthermore, as previously noted, [Fuster \(2015\)](#) asserts that “routine and unimaginative language” (p. 253) depends on the basal ganglia ([Fuster, 1995](#)). Additionally, [Graybiel \(1998\)](#) underscores that motor chunking could yield the automated actions attributed to the basal ganglia and references [G. A. Miller’s \(1956\)](#) assertion that language acquisition is a clear example of chunking. Likewise, [Jin et al. \(2014\)](#) and [Mackevicius et al. \(2020\)](#) suggest that the basal ganglia regulate the chunks of automatic speech. In turn, [Thibault et al. \(2021\)](#) indicate that the basal ganglia parse sequences into groups, handling the dependencies between these groups within complex hierarchical structures, as in sentences containing embedded object relative clauses (5).

(5) The writer [that the poet admires] writes the paper. (p. 2) (see [Chomsky & Miller, 1963](#))  
[Graybiel \(1998, 2008, 2016\)](#), [Jin et al. \(2014\)](#), [Jin and Costa \(2015\)](#), and [Smith and Graybiel \(2016, 2014\)](#) also note that chunks allow the basal ganglia to plan and produce action sequences automatically (without conscious effort), accurately, and fast. For a comparison between non-automatic and automatic speech programmes, see Figure 4.



**Figure 4.** Speech schemas controlled by the prefrontal cortex and the basal ganglia. Adapted from [Fuster \(2015\)](#), [Graybiel \(1998\)](#), and [Zeliadt \(2013\)](#).



The concept of *chunk* has been extensively examined by linguists (Pawley & Syder, 1983), psycholinguists (Ellis, 1996), developmental psychologists (Braine, 1963; Brown, 1973), and lexicographers (Benson et al., 2010), among others. These multi-word units have been referred to by various terms, including “collocations” (Firth, 1957), “prefabricated patterns” (Hakuta, 1976), “prefabricated routines and patterns” (Krashen, 1981), “ready-made units” (Nattinger, 1980), “lexicalized sentence stems” (Pawley & Syder, 1983), and “formulaic sequences” (Wray, 2002). Numerous authors define chunks as formulaic sequences that are stored in memory as single units, facilitating quick recall (retrieval) with minimal processing effort and promoting fast and accurate language use (Ellis, 1996; Nattinger & DeCarrico, 1992; Pawley & Syder, 1983; Underwood et al., 2004; Wray, 2002). Moreover, chunks are considered a hallmark of proficiency in native speakers (Ellis, 1996; Nattinger & DeCarrico, 1992; Pawley & Syder, 1983).

Researchers suggest that chunking is a central mechanism in language acquisition, supporting learners as they internalise complex linguistic structures. Newell (1990) defines a chunk as a memory unit formed by combining established chunks. The process of chunking, which appears to be ubiquitous in human memory, enables the recursive construction of these structures, resulting in a hierarchical organisation of memory. Building on Newell’s work (1990), Bybee (2010) claims that chunking is a domain-general process that helps explain why people improve at cognitive and motor tasks with practice. Bybee (2002) adds that learning a language involves storing and processing repeated fragments of speech. Humans are sensitive to recurrent sequences of stimuli (Saffran et al., 1996). These perceptual units are stored in memory and strengthened with use. Specifically, repeated experience, both in perceiving and producing language, leads to the automatization of these fragments into single units that can be accessed and executed fluently. Bybee (2010) emphasises that chunking requires repetition, which enhances both perceptual and production fluency. Moreover, Bybee (2010) highlights that the combination of smaller chunks within larger ones yields the hierarchical structure of language. In this regard, Bybee (2002, 2010) notes that grammar arises from frequent usage rather than being an innate mental blueprint, as suggested by generativist theories (Tomasello, 2003).

Chunks play a fundamental role in both first-language and second-language acquisition (Braine, 1963; Brown, 1973; Ellis, 1996; Nattinger & DeCarrico, 1989; Pawley & Syder, 1983). Research by Braine (1963) and Brown (1973) demonstrates that children often learn language by acquiring and using formulaic phrases before fully mastering the underlying grammatical rules. Similarly, Ellis (1996) highlights that second-language learners rely heavily on chunking as a cognitive strategy to process and produce language more efficiently. Nattinger and DeCarrico (1989) further emphasise the importance of lexical phrases as building blocks for fluent language use, arguing that language competence involves mastery of these prefabricated units. Pawley and Syder (1983) introduce the concept of native-like selection of chunks, underscoring that fluency in a second language depends on the ability to use a vast repertoire of such chunks automatically.

Hu (2024), Khalil (2018), Mohammadi and Enayati (2018), and Zafarghandi et al. (2015) consistently highlight the role of lexical chunks as critical tools for enhancing speaking fluency in learners of English as a foreign language. Lexical chunks—such as collocations (“make a decision”), idioms (“on the other hand”), and sentence stems (“I think that. . .”)—allow learners to speak more naturally and quickly because these expressions are retrieved as whole units rather than constructed word-by-word in real time. Chunks reduce the cognitive load associated with on-the-spot language production, enabling learners to speak more fluidly, with fewer pauses, hesitations, or grammatical errors. Both Mohammadi and Enayati (2018) and Zafarghandi et al. (2015) provide experimental evidence showing measurable gains in fluency metrics (e.g., increased words per minute, decreased hesitation)

after learners were explicitly taught lexical chunks. Khalil (2018) also reports that learners developed greater confidence and communicative ease through chunk-based instruction. These findings align with established fluency theories, particularly Pawley and Syder's (1983) model of native-like fluency, which asserts that fluent speakers rely heavily on formulaic sequences to maintain smooth speech. In short, lexical chunks are not just helpful—they are foundational for developing oral proficiency in English as a foreign language contexts.

Khalil (2018), Mohammadi and Enayati (2018), and Zafarghandi et al. (2015) evaluate the effectiveness of chunk instruction in contrast to traditional language teaching methods, using memorisation and repetition of commonly used phrases, role-playing, and dialogue-based practice, as well as awareness-raising activities that emphasise the contextual use of chunks. Results indicate that learners exposed to structured lexical chunks perform better in speaking tasks than those without such instruction, highlighting that lexical chunks do not develop naturally or incidentally for most learners of English as a foreign language. Instead, systematic instruction is essential, especially in environments with limited exposure to authentic spoken English. They also underscore the need for contextualised, communicative practice with chunks for achieving fluency in real conversations, rather than relying solely on rote memorisation.

Furthermore, researchers from various disciplines have examined the connections between the chunks of birdsong, music, and speech. Concerning birdsong, some biolinguists argue that avian song learning involves, for example, song segmentation and chunk learning, and thus resembles human language acquisition (Berwick et al., 2011; Okanoya, 2002, 2004, 2013a, 2013b). When raised by a single tutor, some birds (e.g., Bengalese finches) imitate the songs sung by that tutor. When reared by multiple tutors, chicks segment the songs they hear. During song practice, juvenile birds learn each segment as a memory unit—as a chunk. Subsequently, chicks reuse the learned chunks to build original songs. Humans, in turn, segment speech into smaller blocks, such as Noun Phrases and Verb Phrases, and then reutilise these chunks in their speech (Berwick et al., 2011; Doupe & Kuhl, 1999; Okanoya, 2004, 2013a, 2013b; Takahasi & Okanoya, 2010). Some neuroscientists and other researchers assert that birdsong constitutes an ideal animal model for studying how motor programmes work (Jin & Costa, 2015; Marler, 1981). For example, like the schemata underpinning proficient speech, those underlying honed birdsong involve the acquisition of groups of individual items (notes) and their hierarchical organisation into complex sequences for rhythmic, accurate, and fast production (Jin & Costa, 2015; Lashley, 1951; Mackevicius et al., 2020; Marler, 1981; McCasland, 1987). However, some biolinguists emphasise that, although birdsong has notes, chunks, and hierarchy, it lacks words and semantics. Thus, the intricacy of nested dependencies encountered in language is missing in birdsong (Berwick et al., 2011).

Regarding music, Lerdahl and Jackendoff (1996), who draw on Chomsky's (1957) *Syntactic Structures*, claim that listeners perceive the organisation of a musical through notes that group together to form small units (phrases), which are embedded in larger ones (sections)—ultimately culminating in the entire song (Patel, 2008). In turn, biolinguists such as Asano (2022) and Asano and Boeckx (2015) reference Lashley's (1951) assertion that domain-specific hierarchical structures are linearised onto temporal structures. Consequently, Lashley's (1951) syntax of action facilitates a fruitful cross-domain comparison in terms of hierarchical planning and linearisation. As previously mentioned, Lashley (1951) asserts that during expert performance, musicians process notes in "groups" (p. 123), translating them into the temporal domain—that is, the timeline. This notion applies to other automatic actions, including speech and birdsong.

Some researchers add that, in humans, the basal ganglia are responsible for well-learned motor programmes involved in playing a musical instrument (Grillner, 2013; Zatorre et al., 2007). In birds, the homologues of the basal ganglia control the motor programmes perfected in song learning (Graybiel, 2000; Jin & Costa, 2015; Mackevicius et al., 2020; Smith & Graybiel, 2016).

Section 2.4 describes innate action schemas and evidences similarities with well-rehearsed motor programmes, as both are automatic, made up of groups of acts, and involve rhythm, accuracy, and speed. Lashley (1951) claims that these aspects are crucial for actions such as proficient speech, honed birdsong, expert musical performance, and locomotion.

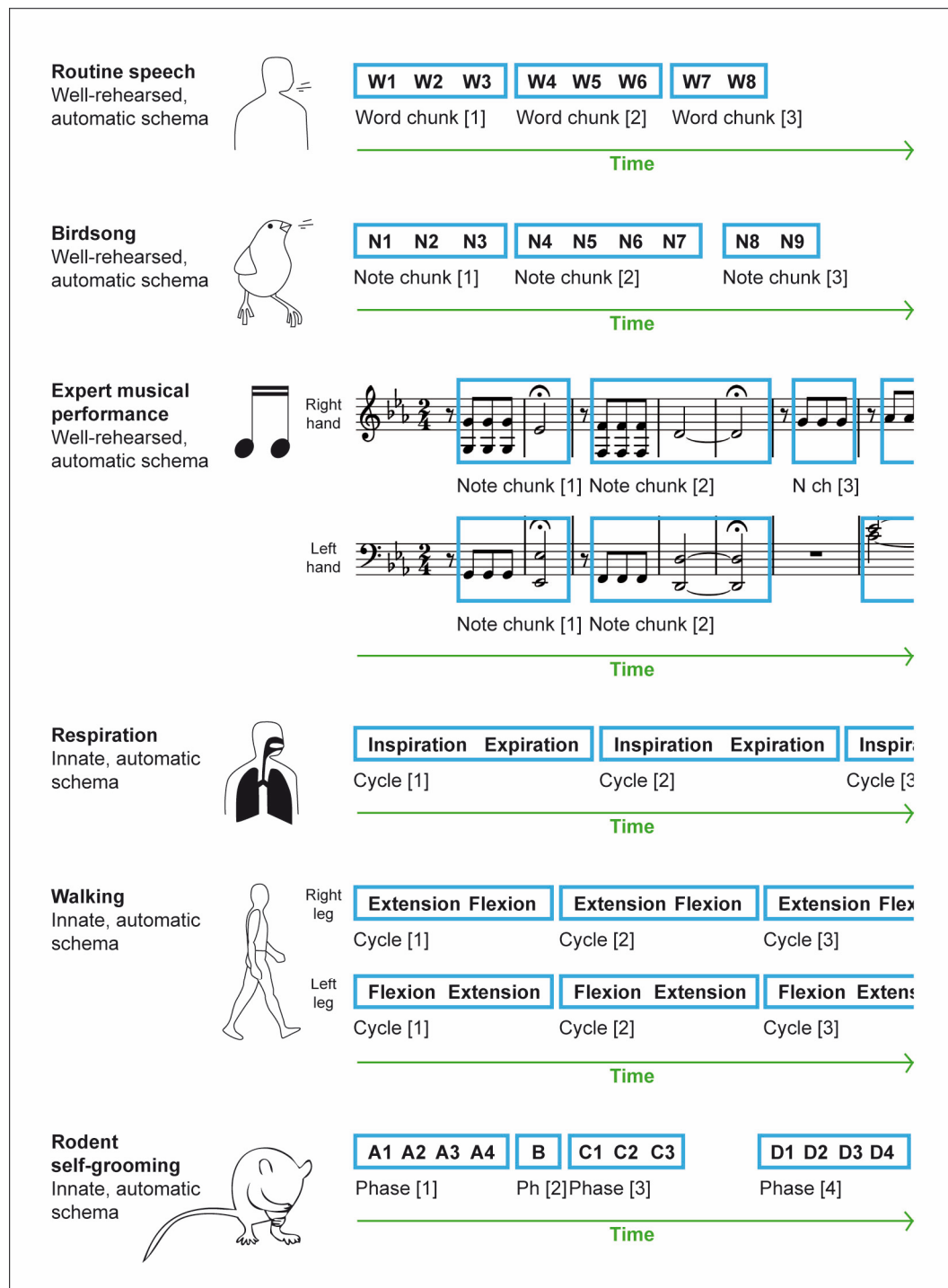
#### 2.4. Central Pattern Generators and Fixed Action Patterns

The basal ganglia play a crucial role not only in controlling well-rehearsed (well-learned) motor programmes but also in regulating innate action schemas, which encompass both central pattern generators and fixed action patterns. Central pattern generators refer to genetically defined information that is shared across various species, whereas fixed action patterns are associated with species-specific information (Aldridge & Berridge, 1998; Grillner et al., 2005; Grillner & El Manira, 2020; Kalueff et al., 2016).

Central pattern generators give rise to cross-species innate behaviours such as respiration, mastication, swallowing, and locomotion, manifested as walking in humans, flying in birds, swimming in fish, galloping in horses, and slithering in snakes (Connors, 2022; Grillner, 1996, 2006, 2013; Harris-Warrick, 2011; Schmidt & Wrisberg, 2000). Note that, although a child is said to “learn” to walk, a progressive maturation of the nervous system is taking place. Identical twins start to walk at the same time, even though one has been trained and the other has not (Grillner, 2013). These schemas yield automatic sequences composed of cycles; that is, repetitive (iterative) groups formed by two or more acts (Duysens & Van de Crommert, 1998; Schmidt & Wrisberg, 2000). For example, the schema of respiration is built from respiratory cycles. Each respiratory cycle, in turn, is composed of two movements: inspiration and expiration. In a similar vein, the walking schema includes step cycles, each of which comprises the movements of extension and flexion (Grillner et al., 2008; Grillner, 2013; Grillner & El Manira, 2020; Lund & Olsson, 1983; Mentis, 2013; von Euler, 1983). Recall that Martins et al. (2016) assert that iteration, which involves “repeating an operation a certain number of times” (p. 1422), may or may not yield hierarchical structures or create dependencies between constituents. Note that innate actions are iterative and organised hierarchically, but they do not involve nested dependencies. Additionally, central pattern generators yield well-timed, rhythmic sequences that can be produced accurately and rapidly (Connors, 2022; Duysens & Van de Crommert, 1998; Grillner et al., 2005; Grillner, 2006, 2013; Grillner & El Manira, 2020; Harris-Warrick, 2011).

Fixed action patterns generate species-specific innate behaviours, such as self-grooming in rodents and egg rolling in greylag geese (Kalueff et al., 2016; Lorenz & Tinbergen, 1939). Some researchers argue that these schemas can be elicited from an animal that has never watched the pattern performed by another animal. Thus, fixed action patterns are considered to be genetically inherited but not learned. In addition, these schemas are so fixed (standardised) that all members of a species always exhibit the same sequence of components (Tinbergen, 1951; Willmer et al., 2005). Specifically, a fixed action pattern constitutes an innate (instinctive, automatic), highly stereotyped (rigid, predictable), well-timed sequence of acts. Once initiated, the pattern runs to completion (Aldridge & Berridge, 1998; Kalueff et al., 2016). For instance, rodent self-grooming is an action schema built from four phases. Each of these groups of acts is composed of one instance or several repetitions of a particular movement: (i) 5–9 elliptical strokes; (ii) 1–2 unilateral strokes; (iii) 3–6 bilateral strokes; (iv) several body licking movements (Aldridge & Berridge,

1998; Kalueff et al., 2016). Figure 5 presents some well-rehearsed and innate chunk-based action schemas.



**Figure 5.** Well-rehearsed and innate chunk-based action schemas. Adapted from Lashley (1951), Okanoya (2013b), Patel (2008), von Euler (1983), Grillner et al. (2005), Mentis (2013), and Aldridge and Berridge (1998).

As previously noted, generative linguistics researchers have found that in formal instructional settings, learners of English as a second or foreign language often struggle to master verbal morphemes, such as the third-person singular –s and the regular past –ed. This difficulty frequently results in errors such as *\*he play* (Calzada & García Mayo, 2021; Ionin & Wexler, 2002; Lardiere, 2009; Martínez-Adrián & Gutiérrez-Mangado, 2015; Muroya,

2018). The present study explores whether oral chunk-based training can improve the accuracy of sentence segments containing the third-person singular –s (e.g., he VERB+s)—a persistent challenge for learners of English as a foreign language, particularly in Expanding Circle countries (Kachru, 2015), where difficulties with inflectional morphology often affect spoken accuracy. While existing linguistic theories explain these challenges, they frequently fall short in offering pedagogical solutions. In this study, oral chunk-based training involved rehearsing chunked sentences, such as “[He plays] [a lot].”

### 3. Materials and Methods

The study reported here aimed to quantify the accuracy rates of the third-person singular –s regarding two sentence segments: “he VERB+s” and “she VERB+s”.

#### 3.1. Sample

Sixty-four learners of English as a foreign language (aged 8–11) from three rural primary schools in Spain participated in a classroom experiment: two schools were located in the Basque Autonomous Community, while one was in Navarre. Participants from School 1 (13 females, 12 males) constituted the control group (Group 1), while those from Schools 2 (7 females, 5 males) and 3 (15 females, 12 males) formed the experimental groups (Groups 2 and 3, respectively). No intact classes were available, a situation that was common to all three groups. Before the experiment began, the school and the children’s parents and legal guardians signed a consent form approved by the Ethics Committee of the University of the Basque Country (CEISH-UPV/EHU, BOPV 32, 17/2/2014), which evaluated and accepted the proposal by Verónica Mendoza Fernández (M10\_2018\_170). The characteristics of the participants varied widely (see Table 1).

**Table 1.** Participants’ characteristics.

| Group      | Age at Testing | Average Age | Years of Exposure | Age of First Exposure | Percentage of Learners with Extracurricular English Lessons | Percentage of Learners Speaking Basque at Home |
|------------|----------------|-------------|-------------------|-----------------------|-------------------------------------------------------------|------------------------------------------------|
| 1 (n = 25) | 8–11           | 9.52        | 6.18              | 3.34                  | 56.00%                                                      | 84%                                            |
| 2 (n = 12) | 8–11           | 9.75        | 6.83              | 2.92                  | 41.67%                                                      | 75%                                            |
| 3 (n = 27) | 8–11           | 9.78        | 6.96              | 2.81                  | 44.44%                                                      | 18%                                            |

However, statistically significant differences were found only in the percentage of learners speaking Basque at home ( $p < 0.001$ ).

As mentioned above, the experimental study was conducted in the Basque Autonomous Country and Navarre. Spanish and Basque are official languages in both regions. The participants in Groups 1 and 2 were Basque/Spanish bilinguals and attended schools where Basque was the medium of instruction. Group 3 was not as homogeneous as the other groups. The 3rd and 4th grade participants in Group 3 had enrolled in Programa de Aprendizaje en Inglés (“English Learning Programme”), a strand of Content and Language Integrated Learning (CLIL), and were taught mostly in Spanish. Conversely, the 5th and 6th grade participants in Group 3 had enrolled in an older programme in which Spanish was the medium of instruction. Additionally, in Group 3, most participants (81.5%) had Basque as a subject. Moreover, all three groups differed in the total number of English hours per week/year (see Table 2).

Regarding methodology, differences in teaching materials and classroom activities were also observed. The control group employed a communicative approach to teaching English within a Project-Based Learning framework. Instruction relied on videos, songs,



crafts, and games to reinforce vocabulary and grammar. The first experimental group followed a Content-Based Instruction model, integrating English language structures and vocabulary into thematically organised units. Instruction included videos, concept maps, songs, crafts, and games to foster motivation and meaningful learning. The second experimental group employed a textbook-based method. Supplementary Materials included flashcards, posters, fill-in-the-gap songs, and memory games designed to boost engagement and reinforce language learning within a structured framework.

**Table 2.** Total number of English hours per week/year.

| Group      | 3 Primary<br>(8 Years Old) | 4 Primary<br>(9 Years Old) | 5 Primary<br>(10 Years Old) | 6 Primary<br>(11 Years Old) |
|------------|----------------------------|----------------------------|-----------------------------|-----------------------------|
| 1 (n = 25) | 3/120                      | 3/120                      | 4/160                       | 4/160                       |
| 2 (n = 12) | 1/40                       | 1/40                       | 2/80                        | 2/80                        |
| 3 (n = 27) | 10/400                     | 10/400                     | 5/200                       | 5/200                       |

Despite these differences, all three groups showed the same level of proficiency in English, as assessed by the Quick Placement Test (Oxford University Press, 2001).

### 3.2. Instruments

In the current study, all participants completed four tasks: an oral production task, a written production task, an oral sentence transformation task, and a grammaticality judgment test. The first two tasks quantified the accuracy rates of the third-person singular –s, while the latter two tasks computed the accuracy rates of two target sentence segments: “he VERB+s” and “she VERB+s.” As stated, the oral sentence transformation task was designed to count the accuracy rates of the –s concerning two target sentence segments: “he VERB+s” and “she VERB+s”. The task comprised 64 sentences (divided into pre-test and post-test, respectively): (i) 32 sentences in the present simple tense in which participants were expected to produce target sentence segments (e.g., “he sings”) and (ii) 32 distractors in the present continuous.

The oral sentence transformation task involved a lead-in sentence (6a, 7a) and a keyword (6b, 7b).

(6a) They sing very often.

(6b) He .....

(7a) She is reading a book now.

(7b) You .....

The participants were asked to produce a sentence by using the keywords and making the necessary transformations.

Half of the verbs used for testing were not included during the treatment.

### 3.3. Procedure

All three groups completed four tasks, including the oral sentence transformation task, as part of the pre-test–post-test procedure. The experiment consisted of three different sessions conducted at one-week intervals. In week 1, the three groups completed the pretest tasks. In week 2, all the groups received three 45-minute lessons on the present simple tense. In week 3, all three groups completed the post-test tasks.

Group 1 followed the school’s methodology (see Section 3.1). In contrast, groups 2 and 3 (the experimental groups) received oral chunk-based training. This pedagogy relies on *sensory chunking*, a technique that consists of teaching a language using chunk-based sentences. In other words, sentences are built from sensory chunks—language blocks

perceptible through the senses, including sight, hearing, and touch. Consequently, sensory chunks can be read, heard, and manipulated (Mendoza-Fernández, 2023) (see Figure 6).

He plays a lot

**Figure 6.** Chunk-based sentence formed by two sensory chunks.

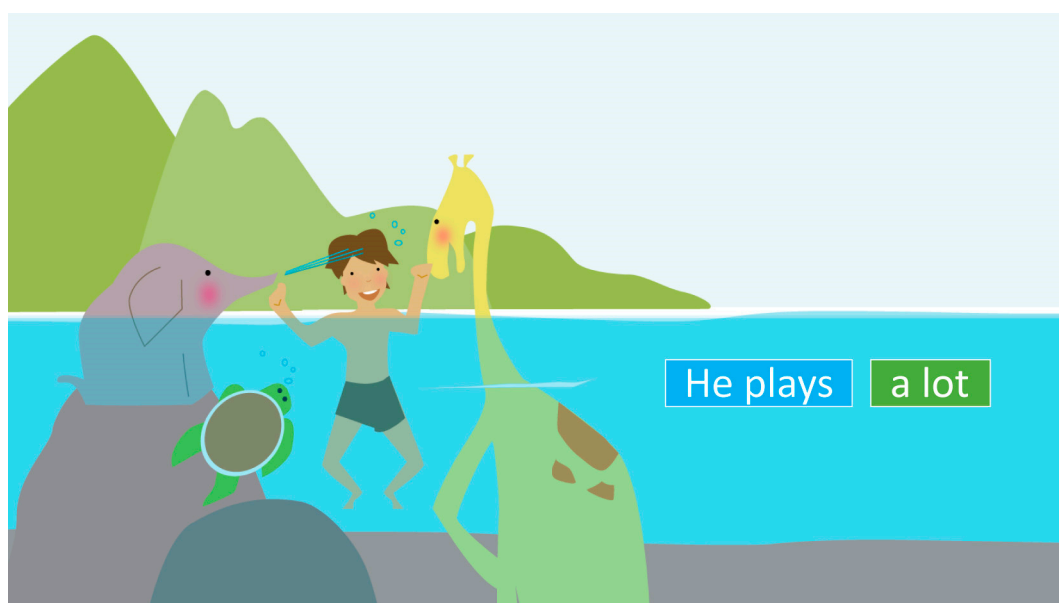
Sensory chunks adopt various shapes, predominantly rectangles.

Based on the works of G. A. Miller (1956), Graybiel (1998, 2008), and Zeliadt (2013), sensory chunking involves breaking down input sentences into perceptible language blocks for oral rehearsal. This pedagogical technique may improve brain efficiency by reducing “the problem of cognitive overload” in information processing, thereby facilitating language acquisition and aiding speech automatisisation.

Oral chunk-based training also draws on Chomsky’s (1995, 2015) phrase structure theory. However, in this pedagogy, specific phrases—such as personal pronouns and verb phrases—can be assembled into larger units (e.g., [He plays]) or used independently. Phrases formed by combining a personal pronoun with a verb phrase are referred to as *verb-conjugation sensory chunks*. Note that Ionin and Wexler (2002) report that second-language learners sometimes produce non-target-like utterances such as *\*she go* (p. 95), which may suggest incomplete acquisition of chunks. In the present study, three verb-conjugation sensory chunks ([he VERB+s], [she VERB+s], and [they VERB]) were incorporated into the chunk-based sentences practised by the experimental groups. Notably, two of these chunks ([he VERB+s] and [she VERB+s]) aligned with the sentence segments investigated in the oral sentence transformation task (see Section 2.2).

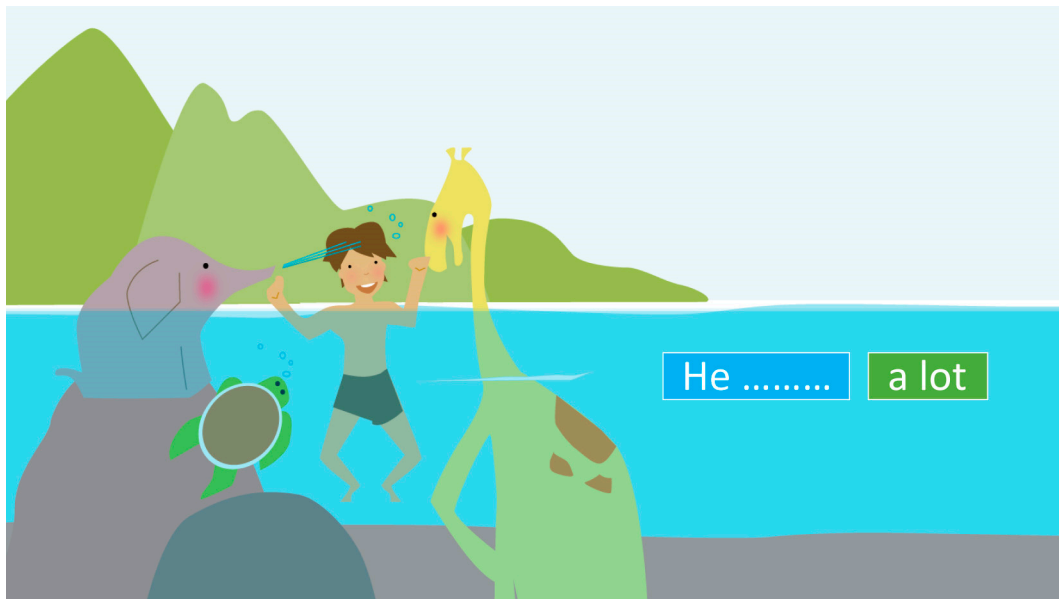
Oral chunk-based training consists of three task types, referred to as “The 3 Phases”: imitation, retrieval practice, and linguistic creativity. In this study, the tasks were designed to help develop natural, fluent, and accurate spoken English, focusing on people’s habits and routines expressed in the present simple tense.

In imitation tasks, the experimental groups imitated the chunk-based sentences spoken by the instructor, such as “[He plays] [a lot],” “[He plays] [tennis] [a lot],” “[She plays] [golf] [a lot],” and “[They play] [football] [a lot].” (see Figure 7).

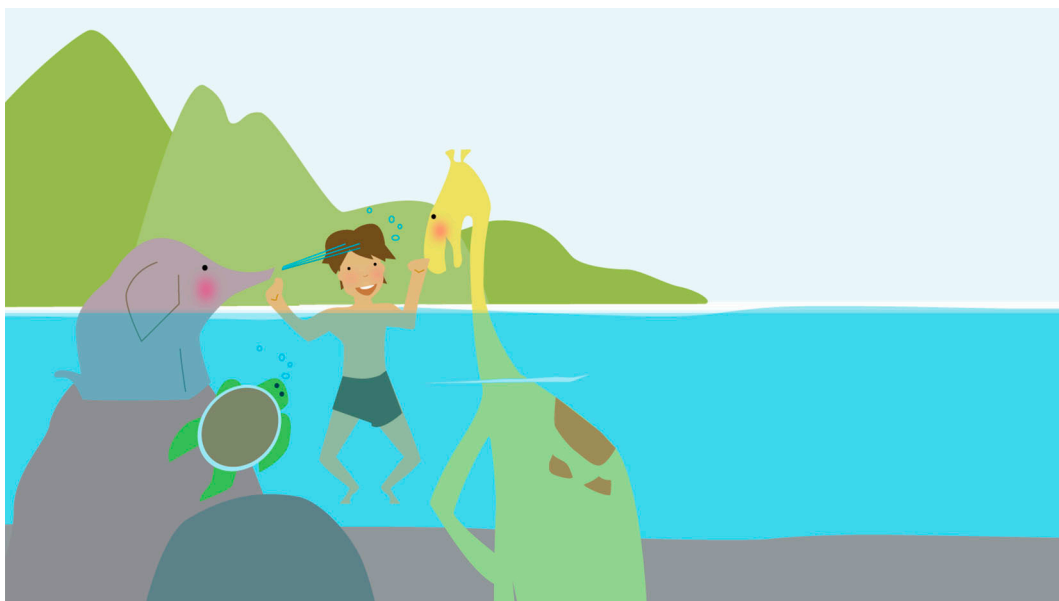


**Figure 7.** Imitation phase.

In retrieval practice tasks, these participants engaged in oral rehearsal that involved retrieving missing information from imitation: target words and chunk-based sentences (see Figures 8 and 9).



**Figure 8.** Retrieval practice phase: verb retrieval.



**Figure 9.** Retrieval practice phase: sentence retrieval.

In both imitation and retrieval practice tasks, oral rehearsal involved context-related information that combined complementary non-linguistic and linguistic stimuli. Context-related visuals and translation were coupled with chunk-based sentences to enhance understanding and meaning. Chunk-based input sentences were presented within an illustrated story (*Tim's Story*) expressed in the present simple tense. In these two phases, the experimental groups rehearsed chunk-based sentences in unison, rhythmically, with increasing speed and voice intensity. Additionally, whenever learners finished orally practising a chunk-based sentence, the teacher praised the participants, cheering and applauding to recognise and celebrate their oral rehearsal. Learners participated in clapping to applaud their own performance.

In linguistic creativity tasks, the experimental groups played a chunk-based fishing game. Sensory chunks, designed as fish with words printed on them, floated in the water. These participants caught fish and concentrated on planning their own chunk-based sentences for oral production, using words from imitation and retrieval practice tasks (see Figure 10).

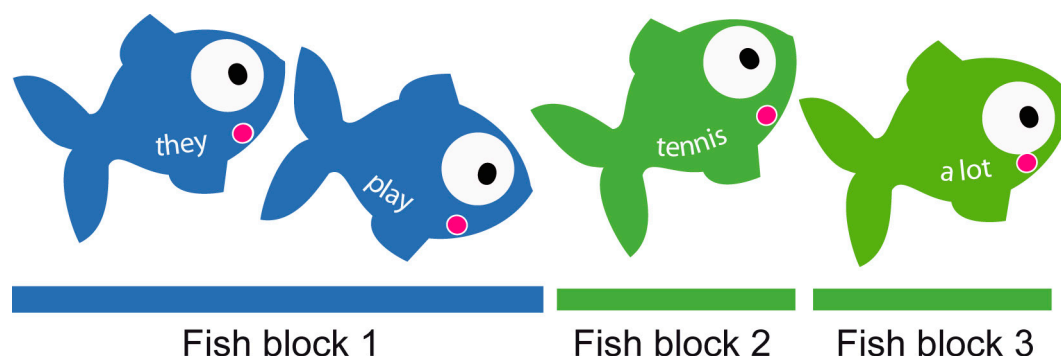


Figure 10. Linguistic creativity phase.

The experimental groups were also required to assemble specific fish blocks using words such as “he”, “she”, “they”, “VERB+s”, and “VERB+Ø”. This allowed these participants to demonstrate their (in)ability to form three verb-conjugation sensory chunks: “he VERB+s”, “she VERB+s”, and “they VERB” (see Figure 8).

Oral chunk-based training employs three techniques that complement sensory chunking: *incremental sentence length*, *the reutilisation and recombination of chunks*, and *sentence pattern iteration*. Drawing on studies conducted by G. A. Miller (1956) and Howard (1983), the technique of incremental sentence length involves gradually increasing the length of chunk-based input sentences. Additionally, Lashley (1951), Chomsky (1957, 1965, 2007, 2015), and Fuster (2003, 2013) argue that language cannot be learned through mere rote memorisation. Consequently, oral chunk-based training does not focus on verbatim sentence learning (rote memorisation). Instead, it seeks to leverage the integrative (combinatorial, distributional) properties of language to foster linguistic creativity. On the one hand, the technique of chunk reutilisation and recombination ensures that longer sentences incorporate sensory chunks previously practised in shorter sentences. In the current study, initial oral training includes sentences composed of two sensory chunks, such as “[He travels] [a lot].” Later practice involves sentences with three or more sensory chunks, such as “[He travels] [to France] [a lot].” Specifically, chunk-based input sentences were divided into three stages of sensory-chunk integration: basic, intermediate, and complex. Table 3 illustrates the teaching of the third-person singular –s, as conducted in the experiment.

Table 3. Stages of sensory-chunk integration.

| Stage                            | Examples                                                                                              |
|----------------------------------|-------------------------------------------------------------------------------------------------------|
| Basic (1 tensed verb)            | [He travels] [a lot]<br>[He sleeps] [a lot]                                                           |
| Intermediate (1 tensed verb)     | [He travels] [to France] [a lot]                                                                      |
| Complex (2 or more tensed verbs) | [I think that] [he travels] [a lot]<br>[I think that] [he sleeps] [a lot] [when] [he travels] [a lot] |

Regardless of the language, oral chunk-based training should gradually increase the number of chunks per sentence by reusing and recombining chunks from previously rehearsed shorter sentences. On the other hand, the technique of sentence pattern iteration involves orally practising a set of sentences that share (iterate) the same syntactic structure

but include some variation in words. Tables 4 and 5 provide two examples of sentence pattern iteration.

**Table 4.** Sentence pattern iteration (1): [SOMEBODY travels] [a lot].

| Sensory Chunk [1] | Sensory Chunk [2] |
|-------------------|-------------------|
| He travels        | a lot             |
| She travels       | a lot             |
| They travel       | a lot             |

**Table 5.** Sentence pattern iteration (2): [SOMEBODY travels] [to COUNTRY] [a lot].

| Sensory Chunk [1] | Sensory Chunk [2] | Sensory Chunk [3] |
|-------------------|-------------------|-------------------|
| He travels        | to France         | a lot             |
| She travels       | to Italy          | a lot             |
| They travel       | to England        | a lot             |

Oral chunk-based training employs chunk reutilisation and recombination to rehearse the integrative properties of language between chunks. Conversely, sentence pattern iteration focuses on practising the combinatorial properties of language within groups, such as verb-conjugation sensory chunks, e.g., [he VERB+s], [she VERB+s], and [they VERB] (see Tables 4 and 5). Moreover, due to processing limitations of the prefrontal cortex, compared to the more efficient processing of the basal ganglia (see Figures 3 and 4), oral chunk-based training is based on the following assumptions:

1. Chunk-based sentence structuration may be more efficient than word-by-word construction, particularly in language teaching aimed at speech automatisation.
2. Shorter sentences should be introduced and rehearsed before longer ones.
3. The shorter the chunk-based sentence, the lower the cognitive load it imposes.
4. The more reused sensory chunks a longer chunk-based sentence contains, the lower its cognitive load.
5. Chunk-based structuration should emphasise the integrative properties of language, both within and between chunks.

Oral chunk-based training employs additional pedagogical tools, including the techniques of *changing stimuli* and *rehearsed information testing*.

This instruction is repetitive, reusing sensory chunks across different phases. Consequently, oral chunk-based training employs the technique of changing stimuli, which involves altering particular stimuli. In the study, sensory chunks adopted different shapes: a rectangle in imitation and retrieval practice tasks, and an animal in linguistic creativity tasks. In addition to their morphological variation, sensory chunks recruit various sensory modalities, depending on the task. In imitation and retrieval practice tasks, sensory chunks can be read (sight) and heard (hearing). Conversely, in linguistic creativity tasks, sensory chunks can be engaged through reading (sight), listening (hearing), and manipulation (touch), enabling learners to assemble these chunks to plan their own chunk-based sentences for oral production. The technique of changing stimuli may prevent “the problem of habituation” to repetitive stimuli (Gross, 2020; Santrock, 2011), thereby promoting awareness, attention to sensory input, and further information processing.

Furthermore, oral chunk-based training operates on the assumption that information that cannot be retrieved cannot be used. Rehearsed information testing assesses learners’ ability to recall previously rehearsed information by first using an overt mode and then a covert mode. In the overt mode, employed in retrieval practice tasks, the experimental groups were asked to remember and produce *missing* linguistic information from the chunk-



ked sentences that had been presented and rehearsed during the phase of imitation (see Figures 8 and 9). In the covert mode, used in linguistic creativity tasks, the experimental groups were *provided* with linguistic information that had been rehearsed during the phases of imitation and retrieval practice. They were then required to recall how to combine this information to plan and express *their own* chunked sentences while playing a chunk-based game (see Figure 10). Rehearsed information testing may promote knowledge gain or help learners notice previously overlooked sensory input, leading to an “awareness gain.” This technique may offset “the problem of inattentional blindness” (Simons & Chabris, 1999) by improving attention to sensory input and subsequent information processing (e.g., perception and memory). Rehearsed information testing also draws on neuroscientists such as Banich and Compton (2011), who discuss memory as comprising three processes: encoding, storage, and retrieval. In turn, psychologists such as Roediger and Karpicke (2006), Karpicke (2012), and Batsell et al. (2017) investigate the *testing effect* in the classroom. This term denotes the improvement in memory and performance that results from employing *retrieval practice*—repeatedly testing a person’s ability to remember prior information. Researchers report that students who read a text and complete test trials (e.g., fill-in-the-blank tests) on it outperform those who only read.

By drawing on disciplines such as neuroscience and psychology, the design of oral chunk-based training takes into consideration a series of “essential brain matters” to bolster brain efficiency, language acquisition, and speech automatisation. These include brain area specialisations, neuronal networks, cognition (the cognitive functions of sensation, attention, perception, memory, and language), as well as motivation and emotion (seeking and achieving reward). Specifically, oral chunk-based training holds that to acquire a language and automatise speech, one must sense (detect) efficient sensory input, attend to it, perceive it (interpret, understand, and assign meaning to it), and learn it (encode it, store it, and retrieve it from memory). Repetition—understood as repeated exposure to context-related sensory configurations coupled with speech practice that involves imitation, retrieval practice, and linguistic creativity—may enhance memory processes (encoding, storage, and retrieval), thereby promoting language acquisition and speech automatisation. Additionally, this pedagogy assumes that motivation and emotion play key roles in modulating this process.

Briefly, to develop sensation and primarily to provide efficient sensory input, oral chunk-based training exposes learners to complementary linguistic and non-linguistic stimuli. Specifically, input sentences are coupled with context-related visuals and translation to enhance understanding and meaning. These sentences depend on sensory chunking and its related strategies. Oral chunk-based training draws on foundational work by G. A. Miller (1956), Graybiel (1998, 2008), and Zeliadt (2013) to develop sensory chunking and support brain efficiency, language acquisition, and speech automatisation. Moreover, both Lashley (1951) and Chomsky (2015) emphasise that language is composed of hierarchically organised groups, which are linearised for expression. In turn, G. A. Miller (1956) and Howard (1983) are instrumental in shaping the technique of incremental sentence length. Lashley (1951) and Chomsky (1957, 1965, 2007, 2015), Chomsky and Miller (1963), Fuster (2003, 2013), and Berwick et al. (2011) enhance the combinatorial properties of language and are relevant to developing chunk reutilisation and recombination, as well as sentence pattern iteration. In this study, sensory chunking and its complementary techniques were employed without any explicit formal instruction.

In addition, this pedagogy aims to address attentional limitations—including “the problem of cognitive overload” (Graybiel, 1998, 2008; G. A. Miller, 1956; Zeliadt, 2013), “the problem of habituation” (Gross, 2020; Santrock, 2011), and “the problem of inattentional blindness” (Simons & Chabris, 1999)—and promote attention to sensory input, awareness, and additional information processing (e.g., perception and memory).

To improve perception—the process of interpreting and assigning meaning to sensory input—this pedagogy combines information from different sensory modalities. In imitation and retrieval practice tasks, learners are presented with chunked sentences that can be read and heard (vision–audition) for oral rehearsal (see Figures 7–9). Chunk-based sentences are paired with visuals and translation to foster understanding and meaning. In linguistic creativity tasks, learners work with previously rehearsed sensory chunks that can be read, heard, and manipulated (vision–audition–touch) to plan chunked sentences for oral production (see Figure 10).

Sprengr (1999), Fuster (2003, 2013), and van Atteveldt et al. (2014) argue that experiences often entail simultaneous—or nearly simultaneous—signals from multiple sensory modalities, highlighting the relevance of multimodal input in learning processes. Such stimuli may be bimodal (e.g., visual–auditory) or multimodal (e.g., visual–auditory–tactile), and can convey both non-linguistic and linguistic information—for example, seeing an object and hearing its name. Furthermore, the neuropsychologists Kolb and Whishaw (2015) point out that humans are primarily visual. Kolb and Whishaw (2015) and Goodale and Milner (2006) also emphasise that the brain requires context—particularly visuospatial information—to assign meaning to objects and events.

Relatedly, Fuster (1995, 2003, 2013) underscores that memory is acquired through the senses and is associative. The brain stores concepts as neuronal networks that connect information from different sensory modalities, such as visual and auditory modalities. For instance, the concept of “bird” may include visual, auditory, tactile, and even olfactory features of the animal, as well as its name, phonemes (sounds), graphemes (letters), morphemes, and foreign names. Concepts are acquired through context-based experience.

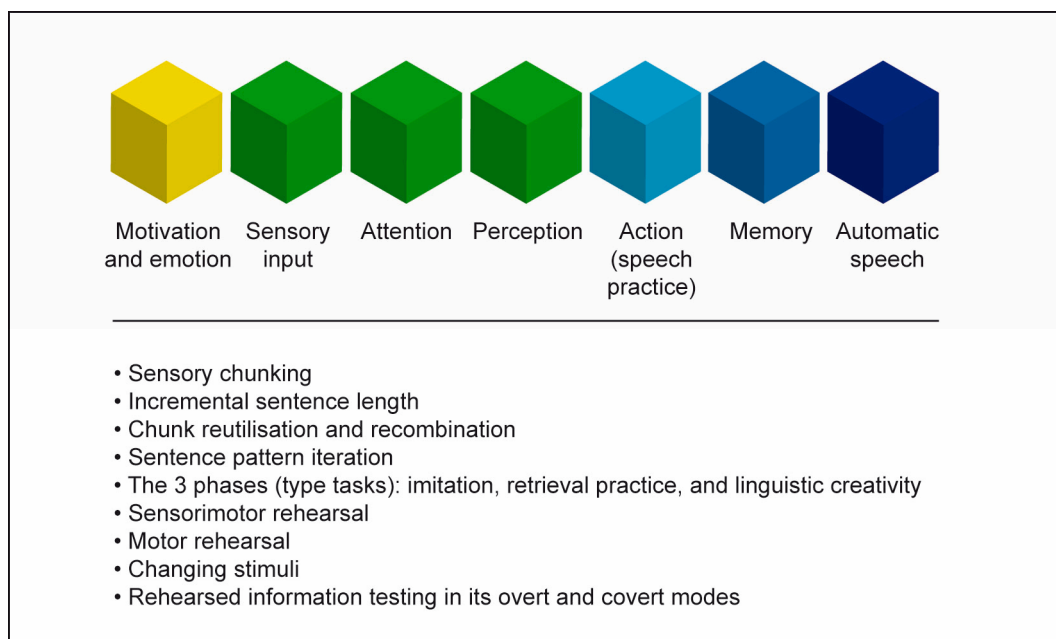
Moreover, Fuster (1995, 2003, 2013) suggests that producing goal-directed action, including meaningful speech, requires specialised neuronal networks to formulate a motor programme—an action schema that governs the planning (syntax) and production (output) of sequences—in accordance with rules. Fuster (1995, 2003, 2013) and E. K. Miller (1999) note that a rule is represented in the brain as a network of associations learned through context-based experience and by recruiting multiple senses, such as vision and audition. These associations help individuals respond to task-relevant cues to achieve specific goals.

Fuster (2003, 2015) further highlights that the prefrontal cortex and the basal ganglia exert sensorimotor integration—the process that transforms perception into action. Neuroscientists such as Boutin et al. (2013) emphasise that understanding how the brain organises relevant context-based information for action planning and production is essential for learning. Humans interact with the external world by efficiently gathering and processing sensory input from various modalities, especially sight and hearing. Researchers such as Graybiel (1998, 2008) point out that the basal ganglia specialise in motor processing—that is, planning and producing action sequences—via chunk-based motor programmes.

In an attempt to promote some specialisations attributed to the basal ganglia, such as the process of sensorimotor integration and chunk-based motor processing, oral chunk-based instruction incorporates the techniques of *sensorimotor rehearsal* and *motor rehearsal*. Sensorimotor rehearsal seeks to help learners convert perception (visuals) into action (speech). Learners are presented with context-related images and complementary chunked sentences that can be read and heard for oral rehearsal. Sensorimotor rehearsal is used in imitation and retrieval practice tasks (see Figures 7–9). Conversely, motor rehearsal concentrates on planning and producing chunk-based sentences. Learners assemble blocks to plan their own chunk-based sentences for oral production using the words practised during the contextualising phases of imitation and retrieval practice. Visuals are not employed. Motor rehearsal is used in linguistic creativity tasks (see Figure 10).

To improve memory, oral chunk-based training relies on repetition that involves repeated exposure to specific sensory configurations and repeated speech practice that comprises imitation, retrieval practice, and linguistic creativity. Psychologists such as Gross (2020) and neuroscientists such as Banich and Compton (2011) argue, for example, that learning includes a series of processes: encoding (sensory input is transformed into data the brain can process), storage (the information is retained and maintained over time), and retrieval (the stored information is accessed for use). At the neuronal level, the psychologist Hebb (1949) proposes that neurons can learn input patterns through repetition. For example, a small child sees a bird for the first time, and his mother points to it, saying, “Bird. That’s a bird.” In response to this experience, specific neurons in the child’s brain form new connections. These neuronal connections are strengthened with each repetition of the experience; in this way, neurons learn input patterns through repeated exposure. Fuster (2003) asserts that, for a memory to be retrieved, its network needs a certain degree of strength. Repetition, understood as repeated exposure to sensory configurations and repeated practice, can aid in forming and strengthening memories. Additionally, neuroscientists such as Graybiel (1998, 2008), Barnes et al. (2005), Graybiel and Mink (2009), Smith and Graybiel (2013, 2014, 2016), and Graybiel and Grafton (2015) highlight that after sufficient practice (repetition), the basal ganglia acquire action plans that exhibit a distinct chunking pattern. Skills require repetition until they become automatic.

Researchers such as Barnes et al. (2005), Smith and Graybiel (2013, 2014, 2016), and Graybiel and Grafton (2015) add that the basal ganglia play a critical role in reward-based learning. With repetition, skills become automatised, distinct chunking patterns are formed, and the need for reward diminishes. Consequently, oral chunk-based training seeks to leverage reward, including intrinsic and extrinsic motivation (e.g., fun, play, knowledge gain, and praise from others) and positive emotion (happiness). In doing so, oral chunk-based training may mitigate the potential adverse effects of repetition—“the problem of habituation,” which can cause “the problem of inattention blindness.” Additionally, this pedagogy may enhance learners’ awareness, attention to sensory input, and subsequent information processing. Figure 11 summarises the process of language acquisition and speech automatisisation, as conceptualised by oral chunk-based training.



**Figure 11.** The process of language acquisition and speech automatisisation, as conceptualised by oral chunk-based training.

For data collection in the oral sentence transformation task, participants were instructed to produce a new sentence using the keyword and make the necessary changes, such as adding the –s ending of the simple present tense, imposed by the keyword (e.g., ‘he’ or ‘she’), to form a grammatically correct sentence. The keyword could not be altered in any way. All three groups were presented with an example before the task began. The example included a lead-in sentence (“They are watching TV now.”), a keyword (“I”), and the expected response from the participant (“I am watching TV now.”). It was presented in written form and read aloud in a slow manner. Additionally, comprehension prompts were used with all groups to ensure that participants understood the task, rather than guiding them toward target forms. Responses were read aloud, recorded, and transcribed for coding.

Statistical analyses were conducted using SPSS (Version 25). The Kolmogorov–Smirnov and Shapiro–Wilk tests revealed significant deviations from normality in most conditions. For pre-test scores, all three groups showed statistically significant non-normal distributions ( $p < 0.001$ ) across both tests. Post-test scores also violated normality assumptions for Groups 1 and 3 ( $p < 0.05$ ), while Group 2 showed marginal significance on the Shapiro–Wilk test ( $p = 0.094$ ) (see Table 6).

**Table 6.** Oral Sentence Transformation. Normality tests.

| Normality Tests |       |                    |    |         |              |    |       |
|-----------------|-------|--------------------|----|---------|--------------|----|-------|
| Accuracy Rates  | Group | Kolmogorov–Smirnov |    |         | Shapiro–Wilk |    |       |
|                 |       | Statistic          | df | Sig.    | Statistic    | df | Sig.  |
| Pretest         | 1     | 0.539              | 25 | 0.000   | 0.203        | 25 | 0.000 |
|                 | 2     | 0.396              | 12 | 0.000   | 0.437        | 12 | 0.000 |
|                 | 3     | 0.251              | 27 | 0.000   | 0.712        | 27 | 0.000 |
| Posttest        | 1     | 0.489              | 25 | 0.000   | 0.437        | 25 | 0.000 |
|                 | 2     | 0.176              | 12 | 0.200 * | 0.882        | 12 | 0.094 |
|                 | 3     | 0.172              | 27 | 0.040   | 0.915        | 27 | 0.030 |

(\*) The true  $p$ -value is greater than 0.200, and the data for that specific group meet the assumption of normality. In contrast, the other groups violated normality assumptions ( $p < 0.05$ ).

Due to significant differences among the three groups and violations of the assumptions of normality and homoscedasticity—as indicated by the Kolmogorov–Smirnov and Shapiro–Wilk tests—, between-group comparisons were not conducted. Given these violations, non-parametric between-group tests were considered but deemed unsuitable due to small sample sizes and imbalances across groups. Instead, within-group analyses were performed using the Wilcoxon signed-rank test, which is appropriate for non-parametric data. This test was used to measure the accuracy rates of the –s concerning the target sentence segments (“he VERB+s” and “she VERB+s”) within groups. These rates were calculated over 100 iterations and then grouped into quartiles and deciles (four and ten intervals of equal width) to compare the results across all tasks.

#### 4. Results

The accuracy rates in the oral sentence transformation task were analysed within groups. In the post-test, only the experimental groups showed an increase in the median, which aligned with the increase in the accuracy rates of the target segments following the treatment. Conversely, the control group achieved a 0% accuracy rate. The standard deviation indicated increased variability for both experimental groups across both tasks. The lower ends of the confidence intervals improved for the experimental groups, and the upper ends indicated a relatively consistent effect of the treatment on these groups (see Table 7).

**Table 7.** Accuracy rates of the –s concerning sentence segments in the oral sentence transformation task.

| Group      | Pre-Test       |        |               | Post-Test |        |                |
|------------|----------------|--------|---------------|-----------|--------|----------------|
|            | M <sup>1</sup> | SD     | CI            | M         | SD     | CI             |
| 1 (n = 25) | 0.00           | 7.000  | [−1.49/4.29]  | 0.000     | 15.676 | [−0.471/12.47] |
| 2 (n = 12) | 0.00           | 10.028 | [−2.62/10.12] | 43.182    | 38.496 | [23.268/72.19] |
| 3 (n = 27) | 5.00           | 21.791 | [6.01/23.25]  | 72.727    | 32.026 | [47.432/72.77] |

<sup>1</sup> M = Median of accuracy rates; SD = Standard deviation; CI = Confidence interval.

Statistically significant differences were found only in the experimental groups: Group 2 ( $Z = -2.756$ ,  $p = 0.006$ ) and Group 3 ( $Z = -4.571$ ,  $p < 0.001$ ). Hedges'  $g$  values were 0.000 for Group 1, 1.42 for Group 2, and 2.40 for Group 3, suggesting strong evidence of learning gains in Group 2 and extensive effects in Group 3. Moreover, the calculation of quartiles and deciles revealed that low accuracy rates decreased and high accuracy rates increased for both experimental groups in the oral sentence transformation task after the treatment was administered (see Tables 8 and 9).

**Table 8.** Quartiles showing the accuracy rates of the –s based on learner percentage and concerning sentence segments in the oral sentence transformation task.

| Quartiles    | Group 1  |           | Group 2  |           | Group 3  |           |
|--------------|----------|-----------|----------|-----------|----------|-----------|
|              | Pre-Test | Post-Test | Pre-Test | Post-Test | Pre-Test | Post-Test |
| <25%         | 96.0%    | 92.0%     | 91.7%    | 33.3%     | 77.8%    | 18.5%     |
| 25.00–49.99% | 4.0%     |           | 8.3%     | 25.0%     | 14.8%    | 22.2%     |
| 50.00–74.99% |          | 8.0%      |          | 8.3%      | 3.7%     | 18.5%     |
| 75–100%      |          |           |          | 33.3%     | 3.7%     | 40.7%     |

**Table 9.** Deciles showing the accuracy rates of the –s based on learner percentage and concerning sentence segments in the oral sentence transformation task.

| Deciles  | Group 1  |           | Group 2  |           | Group 3  |           |
|----------|----------|-----------|----------|-----------|----------|-----------|
|          | Pre-Test | Post-Test | Pre-Test | Post-Test | Pre-Test | Post-Test |
| <10.00   | 96.0%    | 84.0%     | 91.7%    | 33.3%     | 55.6%    | 7.4%      |
| 10–19.99 |          | 4.0%      |          |           | 14.8%    | 3.7%      |
| 20–29.99 |          | 4.0%      |          |           | 7.4%     | 11.1%     |
| 30–39.99 | 4.0%     |           | 8.3%     | 8.3%      | 11.1%    | 7.4%      |
| 40–49.99 |          |           |          | 16.7%     | 3.7%     | 11.1%     |
| 50–59.99 |          | 8.0%      |          |           | 3.7%     | 7.4%      |
| 60–69.99 |          |           |          |           |          |           |
| 70–79.99 |          |           |          | 8.3%      |          | 18.5%     |
| 80–89.99 |          |           |          | 16.7%     |          | 7.4%      |
| 90–100%  |          |           |          | 16.7%     | 3.7%     | 25.9%     |

The minimum and maximum values were also obtained (see Table 10).

**Table 10.** Oral sentence transformation task. Minimum and maximum scores (0% and 100%) based on learner percentage.

| Deciles | Group 1  | Group 2   | Group 3  | Deciles | Group 1  | Group 2   |
|---------|----------|-----------|----------|---------|----------|-----------|
|         | Pre-Test | Post-Test | Pre-Test |         | Pre-Test | Post-Test |
| 0.00%   | 96.0%    | 84.0%     | 75%      | 16.7%   | 40.7%    |           |
| 100.00% |          |           |          | 8.3%    |          | 14.8%     |



As explained in the previous section, oral chunk-based training is a brain-informed pedagogy that considers “essential brain matters,” including the cognitive function of memory. As a preliminary step, quartiles were analysed in relation to memory processes. Fuster (1995, 2003, 2013) claims that, for a memory to be retrievable for use, its network must have a certain degree of strength. Building on this perspective, the authors assumed that the accuracy rates of the target items could serve as indicators of retrieval (accessibility) and, by extension, of the degree of strength (or robustness) of sentence segments containing the third-person singular –s ([He VERB+s] and [She VERB+s]) at the two testing times (see Table 11).

**Table 11.** Quartiles showing the degree of retrieval (accessibility) and strength (or robustness) of sentence segments containing the third-person singular –s in the oral sentence transformation task.

| Degree of Retrieval and Strength | Group 1  |           | Group 2  |           | Group 3  |           |
|----------------------------------|----------|-----------|----------|-----------|----------|-----------|
|                                  | Pre-Test | Post-Test | Pre-Test | Post-Test | Pre-Test | Post-Test |
| <25%                             | 96.0%    | 92.0%     | 91.7%    | 33.3%     | 77.8%    | 18.5%     |
| 25.00–49.99%                     | 4.0%     |           | 8.3%     | 25.0%     | 14.8%    | 22.2%     |
| 50.00–74.99%                     |          | 8.0%      |          | 8.3%      | 3.7%     | 18.5%     |
| 75–100%                          |          |           |          | 33.3%     | 3.7%     | 40.7%     |

A preliminary interpretation of the results suggests that oral chunk-based training may enhance the retrieval and strengthening of sentence segments containing the third-person singular –s in both experimental groups at the second testing time.

Note also that the first author conducted informal interviews with the teachers of the experimental groups, asking them about learners’ impressions of the treatment. Group 2’s teacher reported that the learners maintained a high level of attention and task engagement throughout the treatment. Furthermore, Group 2’s teacher reported that the learners maintained a high level of attention and task engagement throughout the treatment. Furthermore, learners in Group 2 who had not agreed to participate in the experiment but had heard about it from other learners who had already received part of the treatment came voluntarily to the treatment class “to have fun.” Additionally, Group 3’s teacher commented on the high level of motivation among learners, who displayed a completely different attitude compared with their regular lessons. However, these interviews lack the scientific rigour of well-established questionnaires.

## 5. Discussion

The present study aimed to investigate chunk and morpheme production, as well as the effects of oral chunk-based training on this production. An oral sentence transformation task was used to assess the accuracy rates of two target sentence segments containing the third-person singular –s: “he VERB+s” and “she VERB+s.” Sixty-four children learning English as a foreign language participated in this study. The control group ( $n = 25$ ) followed regular classroom instruction, while the first experimental group ( $n = 12$ ) and the second experimental group ( $n = 27$ ) received oral chunk-based training (see Supplementary Materials). All three groups completed an oral sentence transformation task, which yielded statistically significant  $p$ -values only for the experimental groups (Group 2:  $p = 0.006$ ; Group 3:  $p < 0.001$ ). Furthermore, the intervals with equal width indicated that, following the treatment, low accuracy rates decreased and high accuracy rates increased in both experimental groups.

As previously noted, all participants completed four tasks: an oral production task, a written production task, an oral sentence transformation task, and a grammaticality judgment test. In the oral production task, statistically significant improvements in accuracy rates were observed only for Group 2 ( $p = 0.017$ ) and Group 3 ( $p = 0.021$ ). In the written production task, Group 2 narrowly missed statistical significance ( $p = 0.059$ ), while Group 3 achieved a significant improvement ( $p = 0.005$ ). In the grammaticality judgment test, Group 2 again failed to reach statistical significance ( $p = 0.083$ ), whereas Group 3 achieved statistical significance ( $p < 0.001$ ).

Group 2 completed both the written production task ( $p = 0.059$ ) and the grammaticality judgment test ( $p = 0.083$ ) while regular classroom instruction was being conducted with the children who did not participate in the experiment. This testing context may have influenced the results for this group. Furthermore, unlike Groups 1 and 3, Group 2 consisted of a small number of participants ( $n = 12$ ), which likely contributed to inconsistencies in statistical significance. The limited sample size may also explain discrepancies between the  $p$ -value analysis and the quartile analysis, the latter of which divides raw accuracy scores into intervals of equal width.

Nonetheless, quartile analysis revealed substantial improvement in both experimental groups across all four tasks, suggesting a relatively consistent effect of oral chunk-based training. Notably, the minimum scores (0% accuracy) and first quartile scores (0–24.99% accuracy), which were relatively high in the pre-test phase for nearly all tasks and all groups, decreased after the treatment in the experimental groups. This indicates that learners initially had considerable difficulty acquiring verbal morphology. Conversely, the fourth quartile showed the opposite trend, increasing after treatment. Additionally, while some participants in the experimental groups reached the maximum score after receiving instruction, others continued to perform at the minimum level.

Significantly, the groups varied in several aspects, including input quantity, instructional quality, curriculum design, language environment, and medium of instruction.

Regarding input quantity, Group 3 received 10 hours of instruction per week in the early grades, while Group 2 received only 1 hour per week (see Table 2). This represents a tenfold difference in input. Goldschneider and DeKeyser (2001) argue that grammatical items that appear more frequently in the input are expected to be acquired earlier than those that occur less often. Ellis (2006) maintains that grammatical functors must be perceived as cues before being acquired. However, second-language learners fail to acquire these linguistic forms despite thousands of occurrences in the input (input fails to become intake). Ellis and Wulff (2019) define salience as the characteristic of a stimulus that makes it stand out from others, making it more likely to be noticed, attended to, and subsequently processed cognitively and learned. However, morphemes such as the third-person singular *-s*, have low salience within the language stream. These tend to be short and unstressed, making them difficult to perceive from the input. This contributes to the challenges that second-language learners face while acquiring them (Ellis, 2006; Goldschneider & DeKeyser, 2001).

As for instructional quality and curriculum design, Group 3 used a textbook and CLIL-based programme, while Groups 1 and 2 did not. CLIL is known to enhance language acquisition. Nonetheless, the mere use of a textbook within a CLIL framework does in itself constitute a unified pedagogical experience. Coyle et al. (2010) assert that the quality and effectiveness of CLIL instruction depend on how content and language are integrated, how tasks are designed, and the extent to which learners are actively engaged. Moreover, CLIL's effectiveness is not uniform across linguistic features. Martínez-Adrián and Gutiérrez-Mangado (2015) studied the general proficiency and specific linguistic features (verbal morphology, including the third-person singular *-s*) of 44 Basque/Spanish bilingual learners of English as a third language. The participants were divided into

three groups: a group of learners enrolled in a Content-and-Language-Integrated-Learning programme and two groups receiving instruction in English as a foreign language. The results confirmed that the benefits of CLIL in general competence do not extend to the acquisition of specific linguistic features, demonstrating how these learners struggle with the acquisition of verbal morphology.

The groups also differed in language environment and medium of instruction.

Concerning linguistic background, the percentage of learners speaking Basque at home differed dramatically: 84% (G1), 75% (G2), 18% (G3) (Table 1). Importantly, verbs in Spanish agree with their subjects and are inflected for person (1st, 2nd, and 3rd), number (singular and plural), tense (present, past, future, and conditional), aspect (perfective and imperfective), and mood (indicative, subjunctive, and imperative). For further details, see [Montrul \(2004\)](#). In turn, Basque verbs agree with the subject, direct object, and indirect object. Additionally, due to this rich agreement system, all arguments (subjects, direct and indirect objects) can be dropped. Verbs in Basque are inflected for person (1st, 2nd, and 3rd), number (singular and plural), agreement (absolutive, ergative, and dative), tense (present, past, future, and conditional), aspect (perfective and imperfective), and mood (indicative, subjunctive, potential, and imperative). For further details, see [Ezeizabarrena \(1996\)](#) and [Arregi \(2000\)](#). Research has shown that speakers of pro-drop languages may encounter challenges when acquiring obligatory subject marking and tense morphology in English, which could offset any advantage conferred by morphological richness. For further details, see [Licerias et al. \(2008\)](#) and [Montrul \(2010\)](#). Although the difference in Basque use at home was statistically significant ( $p = 0.001$ ), it is not always feasible to control for all background variables statistically; rather, their potential influence should be discussed transparently, which the authors have done.

As for medium of instruction, Groups 1 and 2 attended Basque-medium schools; Group 3 was in a Spanish-medium context with partial English immersion. Research on bilingual education has shown that students in both Basque-medium and Spanish-medium programmes develop comparable levels of academic and cognitive proficiency when provided with balanced and sustained exposure to both languages. ([Cenoz, 2009](#); [Cummins, 2000](#)). However, researchers such as [Lardiere \(2008, 2009\)](#) highlight that, unlike native English speakers, learners of English as a second language may not achieve morphological competence. In adopting [Chomsky's \(2000, 2001, 2002\) Minimalist Program](#), [Lardiere \(2009\)](#) stated that the child is endowed with primary linguistic data at birth, a set of properties ("features") that form the lexical items of each language. [Chomsky's \(2000, 2001, 2002\) Universal Grammar](#) is the theory of the initial state ( $S_0$ ) of the faculty of language, representing the knowledge the child is endowed with at birth, prior to exposure to the so-called primary linguistic data. At  $S_0$ , a set  $\{F\}$  of properties ("features") is accessible to all languages. Features can be classified into semantic, phonetic, and formal. In turn, formal features can be divided into interpretable and uninterpretable. Whereas the former add meaning to the sentence, the latter involve grammatical specifications such as person and number, which do not contribute to sentence meaning. The universal set or inventory of linguistic features available to the child as part of the human genetic endowment is accompanied by a computational mechanism that combines and interprets these features. First language acquisition involves the processes of feature selection and assembly. The child assembles the selected features into language-specific lexical items, which enter computations that derive hierarchically structured representations. This suggests that features originate from a universal set or inventory for all languages but are selected and assembled in language-specific ways, yielding language variation. Significantly, first and second-language differences in morpho-lexical combinations can pose a learning problem for second-language acquirers, who will struggle to learn how to reconfigure (reassemble) uninterpretable formal features

from how these are represented in their first language into new formal configurations of morpho-lexical items in the second language. Significantly, first- and second-language learners strive to acquire verbal morphology. However, native speakers overcome this difficulty in early childhood, while second-language learners often do not. For further details, see Domínguez et al. (2011, 2017), García Mayo and Villarreal Olaizola (2011), Guo (2022), and Muroya (2018). Under Lardiere's (2009) Feature Reassembly Hypothesis, the authors predicted that the participants involved in the current study, who were acquiring English as a foreign language, would also have difficulty reassembling the uninterpretable formal features of [-past], [3rd person], and [+singular] into the new, language-specific morpheme: the third-person singular -s. Consequently, utterances such as *\*he play* would be produced. This pattern was observed in pre-test tasks across all three groups. However, this pattern changed for the experimental groups after they received oral chunk-based instruction.

While the groups differed in input quantity, instructional quality, curriculum design, language environment, and medium of instruction—factors that undeniably influence morphosyntactic development—these variations were addressed with transparency and treated as part of the study's ecological validity rather than as uncontrolled confounds. Crucially, the treatment itself had a relatively unifying effect on both experimental groups, despite their heterogeneous learning contexts. By contrast, the control group showed no significant improvement in producing sentence segments that included the third-person singular marker.

## 6. Conclusions

Researchers note that in formal settings, learners of English as a second or foreign language often strive to acquire verbal morphemes such as the third-person singular -s, producing utterances such as *\*he play* (Calzada & García Mayo, 2021; Ionin & Wexler, 2002; Lardiere, 2009; Martínez-Adrián & Gutiérrez-Mangado, 2015; Muroya, 2018). However, current linguistic theories do not offer practical solutions to this issue.

Oral chunk-based training is an interdisciplinary pedagogy that combines insights from neuroscience, psychology, linguistics, and biolinguistics. This instruction employs various techniques, including sensory chunking and its related techniques: incremental sentence length, chunk reutilisation and recombination, and sentence pattern iteration. Oral chunk-based training incorporates these and other techniques into three phases or task types (imitation, retrieval practice, and linguistic creativity) for oral rehearsal ("speech gymnastics"). Among these pedagogical components, sensory chunking and its related techniques may enhance brain efficiency by offsetting cognitive load in information processing. As a result, this pedagogy may foster language acquisition (including chunks and formal features such as the third-person singular -s) and promote speech automatisation.

Sensory chunking recodes input sentences into language blocks perceptible and recognisable through the senses—sensory chunks—as in [He lives] [in Africa], for oral rehearsal. This technique builds on foundational research by G. A. Miller (1956), Graybiel (1998, 2008), and Zeliadt (2013) to support language acquisition and speech automatisation through the oral rehearsal of chunk-based input sentences. According to G. A. Miller (1956), language acquisition is a clear example of chunking. In turn, Graybiel's (1998, 2008) experimental evidence shows that, through repetition, the basal ganglia initially exert motor chunking—recode action sequences into chunks—thereby acquiring motor chunks, and chunk-based motor programmes as motor (procedural) memory. Subsequently, the basal ganglia use motor chunks to plan and produce action sequences via chunk-based motor programmes automatically. Building on G. A. Miller (1956), Graybiel (1998) underscores that brain efficiency "can be gained by recoding bits of information to form packages (chunks of information) that, once learned, can be treated as entities in memory" (p. 129) (Zeliadt,

2013). Consequently, motor chunking enhances brain efficiency by offsetting “the problem of cognitive overload” during information processing in learning, which facilitates acquisition, and in planning and producing action sequences, which enables automaticity.

Moreover, the basal ganglia can recode both motor and cognitive sequences into chunks, thereby enabling “information compression” (p. 119). Specifically, through chunking, the basal ganglia segment action sequences and form motor chunks, such as when we group digits to remember a telephone number, e.g., 714–362–958 (Graybiel, 1998, 2008; Smith & Graybiel, 2013, 2014, 2016; Zeliadt, 2013).

In an attempt to aid the brain’s natural ability to segment sequences, sensory chunking recodes sentences into recognisable, perceptual language blocks. This technique is complemented with three additional strategies: incremental sentence length, chunk reutilisation and recombination, and sentence pattern iteration. Drawing on G. A. Miller (1956) and Howard (1983) (see Figure 2), the technique of incremental sentence length involves the systematic increase in the length of chunk-based input sentences. Relatedly, the technique of chunk reutilisation and recombination integrates sensory chunks previously rehearsed in shorter sentences into longer sentences in an attempt to further alleviate “the problem of cognitive overload.” In turn, sentence pattern iteration involves practising a set of sentences that share (iterate) the same syntactic structure but include some word variation.

Note that while the technique of chunk reutilisation and recombination aims to rehearse the integrative properties of language between sensory chunks, sentence pattern iteration focuses on practising the combinatorial properties of language within these chunks. These two techniques rely on Lashley’s syntax of action (1951), Chomsky’s generative grammar (1957, 1965, 2007, 2015); and the contributions of Chomsky and Miller (1963), Fuster (2003, 2013), and Berwick et al. (2011). Both Lashley (1951) and Chomsky (1957, 1965, 2007, 2015) underscore that language is not a linear chain of words, nor can it be acquired through rote memorisation. Instead, language requires knowledge of its combinatorial properties. Additionally, both Lashley (1951) and Chomsky (2015) converge on the idea that language is planned hierarchically and produced linearly.

However, unlike Lashley (1951), Chomsky (1995, 2000, 2011, 2015) argues that the brain is endowed with a generative procedure that *recursively* builds larger syntactic objects, yielding the hierarchical structure of phrases. These syntactic structures are subsequently linearised into word strings for production. Chomsky (2015) adds that “In learning a language, the real problem is mastering externalization” (p. xi)—the linearisation (concatenation) of hierarchically organised phrases (groups of words) for sentence production. Regarding recursion, Berwick et al. (2011) further emphasise that, for example, Bengalese finches can “‘remember’ an entire sequence encapsulated as a single phrase or a ‘state’ of an automaton, and (...) reuse that encapsulation elsewhere, just as human syntax reuses Noun Phrases and Verb Phrases. However, Bengalese finches do not seem to be able to manipulate chunks with the full flexibility of dependent nesting found in human syntax.” (p. 8). However, birds lack the capacity for hierarchical recursion, specifically dependent nesting. The authors propose that, in alignment with Chomsky’s (2015) assertion that “In learning a language, the real problem is mastering externalization” (p. xi), the authors examine how brain-informed practices can support learners of English as a second or foreign language in developing more automatic and fluent linearisation of word groups—particularly those involving morphosyntactic forms such as the third-person singular –s in speech.

Through sensory chunking and its associated techniques, oral chunk-based training may be beneficial for overcoming the learning challenges associated with acquiring verbal morphemes and subordination. Although Chomsky rejects teaching methods like audiolingualism that aim for habit formation through the rote memorisation of sentences (Richards & Rodgers, 2014), oral chunk-based training involves the oral rehearsal of the



combinatorial properties of language, both between and within chunks. Future research should explore whether oral chunk-based training helps learners acquire, for example, embedded object relative clauses, such as “The rat [the cat killed] ate the malt” (Chomsky & Miller, 1963, pp. 286–287). By segmenting input sentences into recognisable language blocks, sensory chunking may help reduce cognitive load during information processing, thereby supporting efficient learning. Sensory chunking could be used for the oral rehearsal of chunked sentences such as “[The rat ate] [the malt]” and “[The cat killed] [the rat]” alongside incremental sentence length and chunk reutilisation and recombination (e.g., “[The rat] [the cat killed] [ate] [the malt]”), as well as sentence pattern iteration (e.g., “[The turtle] [the shark injured] [ate] [the shrimp]”). Through sensory chunking and its related techniques, oral chunk-based training may facilitate hierarchical recursion—that is, compositional or linguistic creativity—rather than suppress it.

Furthermore, Belletti and Rizzi (2002) emphasise that a native speaker can use the generative procedure in an automatic, unconscious fashion: “This system is constantly used, in an automatized and unconscious manner, to produce and understand novel sentences, a normal characteristic of ordinary language use.” (p. 5) (Chomsky, 2006). In contrast, Lashley (1951) asserts that the brain controls automatic, extemporaneous action sequences, including speech sentences, through integrative schemas. These *action schemas* are built from hierarchically organised chunks (groups of words or acts) that are always produced in linear order, yielding the sequences of automatic actions, such as routine speech, refined birdsong, expert musical performance, and locomotion.

On the one hand, Lashley’s (1951) action schemata are widely regarded as the foundation of motor programmes (Summers & Anson, 2009). A motor programme refers to a cerebral schema that governs learned actions, such as language production and birdsong. By contrast, the terms central pattern generator and fixed-action pattern denote schemas that regulate innate behaviours, including respiration and locomotion in humans, as well as species-specific actions such as self-grooming in rodents (Aldridge & Berridge, 1998; Kalueff et al., 2016; Schmidt & Wrisberg, 2000). The basal ganglia regulate sequences of learned, automatic actions—such as routine speech, perfected birdsong, and skilled musical performance—through motor programmes (Fuster, 1997, 2015; Grillner, 2013; Smith & Graybiel, 2016; Zatorre et al., 2007). This motor region also governs innate automatic actions, including respiration and locomotion via central pattern generators, and self-grooming in rodents via fixed-action patterns (Duysens & Van de Crommert, 1998; Grillner & El Manira, 2020; Kalueff et al., 2016; Schmidt & Wrisberg, 2000). Learned automatic actions are grouped into motor chunks, while innate automatic actions are organised into cycles (central pattern generators) or phases (fixed-action patterns) (Aldridge & Berridge, 1998; Graybiel, 1998, 2008; Grillner et al., 2005; Grillner & El Manira, 2020; Kalueff et al., 2016; Smith & Graybiel, 2016).

However, as Martins et al. (2016) emphasise, iteration—the repetition of an operation a given number of times—does not necessarily produce hierarchical structures or establish dependencies between constituents. Walking, for example, is hierarchical but not recursive. In addition, Berwick et al. (2011) highlight that birds do not possess the ability for hierarchical recursion, particularly when it comes to dependent nesting. Human syntax allows for phrases to be embedded within other phrases, as in “The turtle [the shark injured] ate the shrimp.” Human language requires both hierarchical and symbolic processing, which birdsong does not seem to support. In fact, human language is characterised by “how words are combined into larger structures with distinct meanings” (p. 6). This “compositional creativity” (p. 6) is absent in birdsong. Conversely, Asano (2022) and Asano and Boeckx (2015) assert that Lashley’s (1951) syntax of action enables a productive cross-domain comparison regarding the hierarchical planning of groups and their linearisation for expression. In

turn, [G. A. Miller \(1956\)](#) and usage-based proponents, such as [Tomasello \(2003\)](#) and [Bybee \(2010\)](#), emphasise that language acquisition relies on domain-general cognitive processes, such as chunking, rather than on an innate, universal grammar. In this context, the authors suggest that locomotion and birdsong serve as valuable examples for examining how the brain manages automatic sequences of actions through groups or “chunks.” This does not imply an equivalence between these activities and human language. Crucially, chunks are natural and intrinsic to brain function; they can be either innate or learned, and are neither domain-specific nor species-specific. As the building blocks of automaticity, chunks are assembled into chunk-based action schemas and are executed quickly and accurately, with minimal cognitive effort. As mentioned earlier, [Graybiel \(1998\)](#) notes that chunking facilitates “information compression” (p. 119). Consequently, chunks *per se* contribute to brain efficiency by reducing cognitive load not only in planning and producing actions, which supports automaticity, but also in learning, which aids acquisition. Recall that [G. A. Miller \(1956\)](#) suggested long ago that chunking reduces cognitive load during input processing, making learning—particularly language acquisition—easier.

On the other hand, [Lashley \(1951\)](#) asserts that action schemas determine the muscular specifications required to express a sequence, including the order, timing, and duration of contractions. Automatic, extemporaneous actions—speech among them—are characterised by rhythm, accuracy, and speed. Through oral rehearsal that involves chunks, rhythm, and speed, the proposed pedagogy may provide a structured way to align cognitive processes with language teaching, stressing the importance of chunking as both a natural learning mechanism and a pathway to natural, native-like, and fluent communication ([Hu, 2024](#); [Khalil, 2018](#); [Mohammadi & Enayati, 2018](#); [Zafarghandi et al., 2015](#)).

Furthermore, the design of oral chunk-based training considers various “essential brain matters” derived from neuroscience and psychology. These include brain area specialisations, neuronal networks, cognitive functions (such as sensation, attention, perception, memory, and language), and reward. Specifically, oral chunk-based training suggests that the process of language acquisition and speech automatization requires the ability to sense efficient sensory input, attend to it, perceive it (interpret and assign meaning to it), and then learn it. Repetition—characterised as repeated exposure to context-related stimuli paired with efficient speech practice—may improve memory processes, thereby aiding language acquisition and speech automatization. Moreover, motivation and emotion (seeking and achieving reward) play a crucial role in this process.

Rooted in these principles, oral chunk-based training aims to enhance brain efficiency in language acquisition and promote automatic speech through its phases and techniques (see Section 3.3 for details). In this context, this instruction suggests that chunk-by-chunk structuration may be more efficient than word-by-word construction, particularly in language teaching environments centred on speech automatization. Furthermore, this pedagogy advocates for a gradual progression from shorter to longer chunked sentences. Shorter chunked sentences might impose fewer cognitive demands, while longer sentences could become manageable when they contain familiar, previously practised chunks. Additionally, this instruction highlights the integrative and creative aspects of language by working on the combinatorial properties of language, both within and between sensory chunks.

Oral chunk-based training also assumes that information that cannot be retrieved cannot be used. Consequently, this pedagogy capitalises on elements such as repetition and retrieval (see changing stimuli and rehearsed information testing in Section 3.3). [Fuster \(2003\)](#) argues that for a memory to be retrieved (accessed), its network needs a certain degree of strength (robustness). Repetition, understood as repeated exposure to sensory configurations and repeated practice, can aid in forming and strengthening memories. Empirical evidence ([Graybiel, 1998, 2008](#); [Jin et al., 2014](#); [G. A. Miller, 1956](#); [Zeliadt, 2013](#))

supports the idea that chunking mitigates cognitive load, thereby facilitating attention and further information processing, including learning, memory, and its associated processes—encoding, storage, and retrieval. Verbal morphology is a common challenge for English as a foreign language learners, especially in Expanding Circle countries (Kachru, 2015), where the reassembly of uninterpretable formal features onto new, language-specific markers, such as the third-person singular –s, often hinders accurate speech production. Preliminary analyses suggest that oral chunk-based training may enhance the acquisition of morphemes and chunks, thereby improving both the robustness and accessibility of sentence segments that include the third-person singular –s (e.g., “he VERB+s”). However, these findings must be interpreted cautiously due to various limitations, including a narrow focus on specific linguistic elements and short intervention durations. Longitudinal research is necessary to assess long-term retention and transfer effects.

Additionally, Fuster (1997, 2003, 2015) reports that motor areas, primarily the prefrontal cortex and the basal ganglia, are responsible for purposeful, meaningful actions such as speech. These areas acquire motor (procedural, action-related) memory, which includes rules and motor programmes, through repeated practice. The motor programmes controlled by the prefrontal cortex are composed of single-item units. This motor area is engaged at the initial stages of learning and whenever deliberation and attention to every item (word or act) in an action sequence are required. Conversely, with extended repetition, overlearned actions, such as routine and unimaginative speech, activate the basal ganglia. Graybiel (1998, 2008) specifies that, unlike the prefrontal cortex, the basal ganglia regulate motor programmes involving multi-item units or “chunks.” Graybiel (1998) explains that brain efficiency can be gained by recoding bits of information into chunks that, once acquired through repetition, can be treated as units of procedural memory. Jin et al. (2014) add that chunks enable reliable retrieval and efficient performance. Graybiel (1998, 2008, 2016), Jin et al. (2014), Jin and Costa (2015), and Smith and Graybiel (2014, 2016) highlight that chunks allow the basal ganglia to plan and produce action sequences automatically (without attentional demands), accurately, and fast. Thibault et al. (2021) add that the basal ganglia organise sequences into distinct groups and manage the dependencies between these groups within complex hierarchical structures. Although further empirical research may be needed to specify the neural substrates of recursive linguistic operations, oral chunk-based training may enhance the efficient storage, retrieval, and production of chunks—particularly those involving markers such as the third-person singular –s—, thereby contributing to speech automatization. Thus, this pedagogy may promote cognitively efficient processes mediated by the basal ganglia, rather than the more demanding processing typically associated with the prefrontal cortex.

Further studies should examine whether, through protracted oral practice, this pedagogy can support the development of automaticity and motor (procedural) memories, including rules, motor chunks, and chunk-based programmes, without resorting to explicit formal instruction. Specifically, additional research could clarify whether sensory chunking and its complementary techniques can facilitate motor chunking—the process of reorganising action sequences into motor chunks. Further research may explore whether sensory chunks, which are manageable multi-item units that are easy to process perceptually and cognitively, can aid the acquisition of motor chunks as speech micro-automatisms aligned with Chomskyan phrases. Additionally, future studies might investigate whether chunk-based sentences, which represent cognitively manageable sentence patterns, can support the learning of chunk-based motor programmes as speech macro-automatisms that correspond with Chomskyan syntactic frameworks. Moreover, incremental sentence length, including chunk reutilisation and recombination, might provide a cognitively manageable learning process.

This pedagogy requires further research to determine whether it can improve other “essential brain matters,” such as attention, perception, additional memory types (specifically perceptual memory), and reward. For example, future research may establish whether oral chunk-based training can help alleviate attentional constraints—“the problem of cognitive overload” (Graybiel, 1998, 2008; G. A. Miller, 1956; Zeliadt, 2013), “the problem of inattention blindness” (Simons & Chabris, 1999), and “the problem of habituation” (Gross, 2020; Santrock, 2011)—and thereby promote attention to sensory input, awareness, and further information processing (e.g., perception and memory).

Additional research could benefit from tools such as eye tracking, acoustic phonetics (Praat), N-back tasks adapted to sensory chunks, neuroimaging, and reward-related questionnaires, among others. The potential advantages of incorporating explicit formal instruction also need to be explored. Furthermore, this pedagogy could be tailored for different languages. Future investigations might also assess the feasibility of using a Large Language Model (LLM) as a “model student.” This idea holds considerable potential, as it would enable researchers to thoroughly evaluate their educational proposals.

## 7. Patents

The teaching materials used in this research are copyrighted as NA-0395/18 and NA-0354/19 under the name of Veronica Mendoza Fernandez. The authors allow the use of the Supplementary Materials for research purposes rather than commercial ones, provided that this article is properly cited.

**Supplementary Materials:** The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/educsci15111494/s1>. The teaching materials used in this study are included in the Supplementary Materials.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in this study. Before the experiment began, the school and the children’s parents and legal guardians signed a consent form approved by the Ethics Committee of the University of the Basque Country.

**Data Availability Statement:** The original contributions presented in this study are included in the Supplementary Materials. Further inquiries can be directed to the corresponding author.

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