Original Paper

Sensory Chunking and the Like: Testing a Pedagogical Treatment Applied to the Strengthening of the Third-Person Singular-s

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Abstract

Research into foreign language acquisition reports that learners of English as a foreign language are inconsistent with the suppliance of verbal morphology and tend to omit morphemes such as the third-person singular -s even at advanced instructional stages. Researchers rely on Generative linguistics and models such as the Minimalist Programme (Chomsky, 2000, 2015/1995) and the Feature Assembly Hypothesis (Lardiere, 2005, 2007, 2009) to account for such variability. The present study attempted to increase the accuracy rates of the -s. The author designed a treatment (©2018, 2019, Verónica Mendoza Fernández) that centered around sensory chunking (teaching with chunked sentences). Sixty-four learners of English as a foreign language from three different rural schools of primary education in Northern Spain participated in a classroom experiment that followed a pretest-postest procedure. Participants from school 1 constituted the control group and participants from schools 2 and 3, the experimental groups. The results of a grammaticality judgement task indicated a statistically significant increase in the accuracy rates of the -s for one of the experimental groups and a trend towards significance for the other experimental group. The treatment could promote the learning of linguistic items contained within blocks of language, as well as the learning of such blocks, and thus foster language automatisation.

Keywords

generativism, pedagogy, language teaching, language automatisation, neuroscience, psychology, motor chunk, sensory chunk

1. Introduction

Research on Foreign Language (FL) acquisition relies on Generative models such as *The Minimalist Programme* (Chomsky, 2000, 2015/1995) and the *Feature Assembly Hypothesis* (Lardiere, 2005, 2007, 2009) to explain why learners of English as an FL are inconsistent with the suppliance of verbal morphology and tend to produce utterances such as *she go* even at advanced instructional stages (Ionin & Wexler, 2002; White, 2003; Lázaro-Ibarrola & García-Mayo, 2012; Martínez-Adrián & Gutiérrez-Mangado, 2015).

In *Syntactic Structures* (1957) and *Aspects of The Theory of Syntax* (1965), the linguist Noam Chomsky propounds a *generative grammar* in the form of a system of rules that can be analysed into three major components: syntactic, semantic and phonological. The syntactic component contains a lexicon and yields sentences by organising "language blocks" (*phrases*) hierarchically. The phonological and semantic components determine, respectively, the meaning and sound of such sentences. Subsequently, in the *Minimalist Programme*, Chomsky (2015/1995, 2000, 2001, 2002, 2011) claims that, in the human mind/brain, the faculty of language comprises a cognitive system, as well as conceptual-intentional and sensor motor systems. The *Minimalist Programme* provides a theoretical description of the roles played by such systems in the structuration and production of language. Within the cognitive system, the computational system of human language (C_{HL}) is a procedure that generates hierarchical syntactic structures and interacts with the conceptual-intentional and sensorimotor systems in order to specify, respectively, the meaning and sound of sentences. Additionally, language consists of three types of elements: the semantic, phonetic and formal features that make up the lexical items of every language; the lexical items that are assembled from these features and the syntactic structures that are constructed from such lexical items (Chomsky, 2000). In acquiring his/her first language (L1), the child's faculty of language undergoes two relevant processes: feature selection (that is, the selection of language-specific features) and feature assembly (that is, the assembly of such features into language-specific lexical items) (Chomsky, 2001). Moreover, the *Minimalist Programme* describes L1 acquisition as a transition from the initial state of the faculty of language at birth to a mature state that involves the mastery and automatisation of an L1 generative procedure (Belletti and Rizzi, 2002, in Chomsky, 2002; see also Chomsky, 1965). Furthermore, generative researchers (Lardiere, 1998, 2009; Muroya, 2018) have examined the problem associated with the acquisition of formal features (i.e., [third person] and [singular]) in second language (L2) acquisition from the standpoint of the prominent *Feature Assembly Hypothesis* (Lardiere, 2005, 2007, 2008, 2009).

Likewise, in "The problem of serial order in behavior" (1951), the psychologist Karl Lashley postulates the need for a *syntax of action*, cerebral schemas that account for the planning (structuration) and production (expression) of action and language. The structuration of action, including language, is hierarchical insofar as action sequences and language sentences can be broken down into smaller groups or "blocks" (see also Miller, 1956). Moreover, research in neuroscience has examined the sensory and motor areas/systems of the brain and their specialisations in language and action planning,

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production, (over)learning and automatisation (Alexander et al., 1990; Graybiel et al., 1994; Fuster, 1995, 1997, 2015, 2019; Graybiel, 1998, 2008; Jog et al., 1999; Smith & Graybiel, 2016). Researchers have argued that the automatic planning and production of action and language could require the overlearning of subsets or "blocks" (*motor chunks*), a specialisation attributed to a particular motor area (Graybiel, 1998, 2008; Jin et al., 2014; Smith & Graybiel, 2014, 2016).

Since Generativism does not state how the problem of the variability in the omission/suppliance of the -*s* could be pedagogically addressed, the author resorted to evidence in neuroscience and psychology in order to design a treatment that made use of chunked sentences (*sensory chunking*) and pursued the improvement in the accuracy rates of the -*s*; that is, the strengthening (overlearning) of such a morpheme.

2. Literature Review

The present section conveys a brief overview of the literature on language planning (structuration), production, learning and automatisation from the perspective of psychology, neuroscience and Generative linguistics. The first part includes the theoretical contributions made by Lashley (1951) and Chomsky (1957, 1965) to neuroscience and linguistics, respectively. Lashley (1951) postulates the concept of *syntax of action*; that is, cerebral schemas that underlie the planning and production of action, including language. As for planning, he claims that the sequences of language and action are hierarchical and can be broken down into smaller groups (or "blocks"). Chomsky (1957, 1965), in turn, propounds a *generative grammar* that yields sentences which are composed of hierarchically organised "blocks" (*phrases*) and specifies the semantic and phonological interpretation of such sentences. The second part focuses, on the one hand, on the roles of the sensory and motor areas/systems of the brain in language planning, production, learning and automatisation from the standpoint of neuroscience. After an initial description of sensory and motor areas and their main specialisations by the neuroscientist Joaquín Fuster (1995, 1997, 2003, 2015, 2019), the second part compiles a series of studies on the specialisations of brain areas that have led researchers to conclude that the automatisation of language and action could involve the overlearning, planning and production of "blocks" (*motor chunks*) (Graybiel, 2008; Jin et al., 2014). The second part tackles, on the other hand, some aspects of the *Minimalist Programme* (Chomsky, 2015/1995, 2000, 2001, 2002, 2011), such as the theoretical description of the roles played by the systems of the human mind/brain in the structuration and production of language. L1 acquisition/learning, L1 automatisation (Chomsky, 2002) and the L2 acquisitional problem posed by L2 formal features (Lardiere, 2005, 2007, 2008, 2009) are also reviewed.

2.1 Language/Action Planning and Production (I): Syntax of Action and Generative Grammar

In "The problem of serial order in behavior," Lashley (1951) emphasises the need for a *syntax of action*, abstract cerebral schemas that control the planning (structuration) and production (expression) of skilled action (i.e., language and music). Lashley's contribution is considered the origin of the concept

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of *motor programme,* which is analogous to that of *action plan* (Fuster, 1995, 2015; Summers & Anson, 2009). According to Lashley (1951) and *Motor Programme Theory* (Schmidt & Wrisberg, 2000), an action is the product of a schema or *motor programme* that specifies, in advance, which elements are to occur and in what order (*motor planning*), as well as the details for the expression (*motor output*) of such elements (see also Fuster, 1995, 2015; Bermúdez, 2014).

The term *motor planning* relates to the organisation of words into a meaningful sentence or acts into a goal-directed structure of action (Lashley, 1951; Fuster, 1995, 2015). A sentence is a structure of action that derives its meaning from the choice and order of words, much as an action structure pursues its goal through the choice and order of individual acts (Fuster, 2015). Lashley (1951) claims that action is hierarchically and temporally organised. On the one hand, the brain exerts *syntax of action* by means of schemas of cerebral integration that combine groups or "blocks" of elements in a hierarchical fashion (Lashley, 1951; Miller, 1956; Miller et al., 1960; Fuster, 1995, 2015; Bermúdez, 2014; Fitch & Martins, 2014). For example, when reading the sentence "The boy who patted the dog chased the girl," an English speaker knows that *the boy*, and not *the dog*, chased the girl, despite the fact that this sentence contains the sequence "the dog chased the girl." (Fitch & Martins, 2014, p. 87).

On the other hand, action is also organised as temporal order, "as a temporal sequence, either as a succession of words or of acts" (Lashley, 1951, p. 122).

The term *motor output* refers to the specifications regarding the particular muscles needed to produce a particular action, i.e., the instructions concerning the oropharyngeal musculature engaged in the articulation of speech (00). With respect to rhythm, Lashley (1951) claims that rhythm spreads to almost every form Fuster, 1995). Specifications include the order in which these muscles are to be activated and contracted, as well as the timing (rhythm) and duration (speed) of such muscle contractions (Lashley, 1951; Schmidt & Wrisberg, 20 of skilled action. Even "The skilled extemporaneous speaker rounds his phrases and speaks with a definite though not regular rhythm" (Lashley, 1951, p. 127).

Chomsky (2006), in turn, claims that human language and action (i.e., walking) share the characteristic of being "syntactic." In particular, "Human language is "syntactic" in that an utterance is a performance with an internal organization, with structure and coherence." (Chomsky, 2006:60; see Lashley, 1951, in Chomsky, 2006). However, Chomsky begins the introduction of *Syntactic Structures* by focusing on language and defining syntax as "the study of the principles and processes by which sentences are constructed in particular languages" (Chomsky, 1957, p. 12). He provides a generative grammar that contains phrase-structure and transformational rules. Generative grammar is a phrase-structure grammar insofar as sentences consist of "language blocks" (*phrases*) that are arranged in a hierarchical fashion. For example, a sentence such as "*The man saw the apple*" contains a noun phrase (NP) and a Verb Phrase (VP). Both NP and VP comprise a head: a noun (N) and a Verb, respectively. The phrase-structure rules of such a sentence are described in (1i)-(1vi) and its corresponding tree diagram is presented in Figure 1.

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(1)

(i) Sentence → NP + VP

(ii) NP → T + N

(iii) VP → Verb + NP

(iv) T → the

(v) N → man, apple

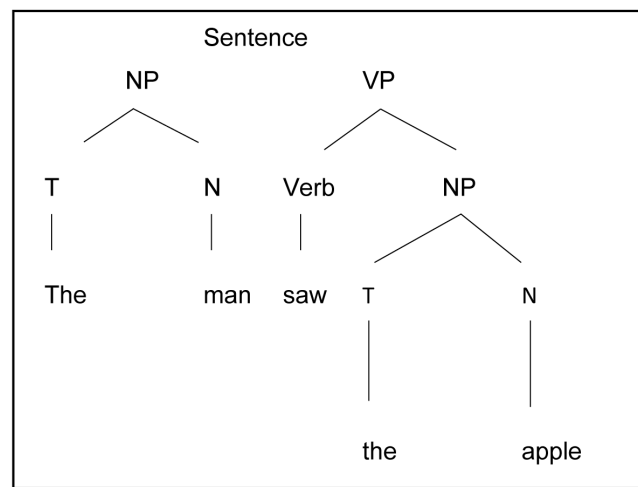(vi) Verb → saw, took, etc. (adapted from Chomsky, 1957:26)

Figure 1. Tree Diagram of the Sentence *"The Man Saw the Apple"* (Adapted from Chomsky, 1957, p. 27)

Moreover, generative grammar is also a transformational grammar. The structural description in Figure 1 constitutes the Phrase Marker (PM) of the sentence *"The man saw the apple."* Once the PM for the sentence has been described, transformational rules allow for the conversion of a simple declarative active sentence into the interrogative, the passive, etc.

Furthermore, generative grammar reflects the knowledge of language (L) that every speaker possesses and uses to produce (and understand) language. Generative grammar is a finite system of rules that can yield "all of the grammatical sequences of L and none of the ungrammatical ones" (Chomsky, 1957, p. 13). The system of rules can be analysed into three major components: syntactic, semantic and phonological. The syntactic component contains a lexicon and can generate the structural descriptions of the infinite number of sentences of a particular language. The semantic and phonological components specify, respectively, the meaning and sound of the sentences generated by the syntactic component (Chomsky, 1965). Generative grammar also reflects the creative aspect of language insofar as it can generate all the sentences of a language. Chomsky argues for the existence of a *Universal Grammar*, a linguistic theory on a richly structured system, an innate endowment that underlies the generative grammar of each particular language and accounts for the creativity displayed by all

languages (Chomsky, 1965, 2002).

In short, Lashley suggests the existence of *syntax of action*, abstract schemas that lie behind the planning and production of meaningful language and goal-directed action. In exerting *syntax of action*, the brain conveys hierarchical and temporal order, purpose/meaning, accuracy, rhythm and speed to all forms of skilled action, including language. Chomsky, in turn, postulates a *generative grammar* that can specify the hierarchical syntactic structure, as well as the meaning and sound of the sentences of each language. He adds that *Universal Grammar* lies behind the generative grammar of each language.

2.2 Language/Action Planning and Production (II), Learning and Automatisation

One of the fundamental interests of neuroscience is how action—including language—arises from the activity of different brain areas, mainly our sensory and motor areas/systems (Fuster, 1995, 1997, 2015; Miller & Cohen, 2001; see also Zillmer et al., 2008). Sensory and motor areas store information (memory) and use it in perception and action (Fuster, 1995, 2003, 2013, 2019). Sensory areas specialise in perception: sensory processing and the storage of perceptual memory. The term *sensory processing* refers to the analysis and interpretation of sensory information (*sensory input*). Perceptual memory comprises the networks that represent events, people, objects and substantive names, among others. For example, the network "apple," is one that agglutinates the neuronal representations of certain sensory qualities and lexical information, i.e., the colour (i.e., red) and the name of that object (Fuster, 1995, 1997, 2003, 2013). Motor areas in the frontal lobe (located in the cortex and comprising, among others, the prefrontal cortex) specialise in action: the storage of motor memory and motor processing. Motor memory encompasses the representations of the rules of language and action, the concepts of action (i.e., verbs) and the actions or movements produced by the different body parts (i.e., the patterns for the articulation of speech). The term *motor processing* refers to the structuration (*motor planning*) and production (*motor output*) of action (Fuster, 1995, 1997, 2003, 2013, 2015). The basal ganglia (a motor area harboured outside the cortex) also specialise in the storage of motor memory (i.e., rules) and motor processing (Fuster, 1995, 1997, 2015; Graybiel, 1995, 1998, 2008).

As for motor processing, research has shown that the prefrontal cortex and the basal ganglia are crucial to the planning and production of language and action (Damasio, 1983; Graybiel, 1995, 1998; Fuster, 1995, 1997, 2015, 2019). The prefrontal cortex is responsible for the motor programmes of novel action and language. By contrast, the basal ganglia are in charge of the action plans of routine action and language (Fuster, 1995, 1997, 2015; Graybiel, 1995, 1998, 2008). Some studies have implicated the prefrontal cortex in rule learning and implementation, as well as the planning and production of novel (not routine) sequences requiring sustained attention (Luria, 1966; Lieberman, 1991; Jenkins et al., 1994; Fuster 1997, 2003, 2015, 2019; Miller, 1999; Miller & Cohen, 2001). As for language, damage to prefrontal cortex results in the patient's inability to construct grammatically correct sentences and in a dearth of subordination, dependent clauses (Jackson, 1882, 1915; Fuster, 2015, 2019). Fuster (2003, 2013, 2015) suggests that, in syntactic construction, the prefrontal cortex interacts with perceptual and motor networks that provide the lexicon in order to plan sentences by combining

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single words hierarchically and temporally, i.e., "Cherries (word$_1$) turn (word $_2$) red (word$_3$) as they get ripe (word$_n$)." Furthermore, research has shown that the basal ganglia are involved in overlearned, routine action and language, as well as the implementation of familiar rules (Lieberman, 1992; Fuster, 1995, 1997, 2003, 2015; Graybiel, 1995, 1998, 2008; Tettamanti et al., 2005). Some experiments on animals have demonstrated that the basal ganglia plan action sequences by means of well-honed *motor chunks*, groups or "blocks" of acts that have start-end boundaries and can be produced in a particular temporal order, i.e., "chunk$_1$($_{START}$[act$_1$+act$_2$+act$_3$+act$_4$]$_{END}$) + chunk$_2$ … + chunk$_n$." The findings suggest that action sequences could be composed of hierarchically organised subsets or groups that are reused and recombined in subsequent sequences (Graybiel, 1998, 2008; Jog et al., 1999; Barnes et al., 2005; Graybiel & Grafton, 2015; Jin et al., 2014; Jin & Costa, 2010, 2015; Smith & Graybiel, 2013, 2014, 2016; see also Wymbs et al., 2012).

Furthermore, both the prefrontal cortex and the basal ganglia are also central to sensorimotor integration; that is, the conversion of *sensory input* (perception) into *motor output* (action) (Lashley, 1951; Fuster, 1995, 2003, 2015, 2019). Action is planned and produced in response to the available stimuli and in compliance with the rules of grammar or action (Fuster, 1995, 2003, 2013, 2015). Research has proved that the prefrontal cortex is capable of integrative sensory-motor operations. The sensory systems gather environmental signals; that is, sensory (i.e., visual and auditory) information. Such signals are forwarded to the prefrontal cortex in order for a person to plan and produce goal-directed action or meaningful language and interact with the environment, i.e., the interlocutor in a conversation. The basal ganglia, in turn, perform such operations on routine action and language (Alexander et al., 1990; Graybiel et al., 1994; Fuster, 1995, 2003, 2013, 2015; Fuster et al., 2000; Miller & Cohen, 2001; Haber, 2011, 2016). Research has also shown that the striatum (located in the basal ganglia) is highly context-dependent and formulates action plans in order to respond to highly processed sensory information (Graybiel, 1995; Fuster, 1995, 2003, 2013, 2015; Nagy et al., 2006; Haber, 2011, 2016; Graybiel & Grafton, 2015).

Moreover, action (i.e., a daily morning routine) is triggered not only by external stimuli (i.e., alarm clock) but also by internal urges (i.e., appetite) (Fuster, 2013; Graybiel & Grafton, 2015). The term *reward* refers to "the satisfaction of a biological need, pleasure, or the acquisition of something of value, in whatever manner measurable" (Fuster, 2013, p. 112). Experiments on humans and animals have shown that evaluative cortico-basal ganglia circuits that connect mainly the striatum and the prefrontal cortex are involved in reward processing and reward- or reinforcement-based learning (Alexander et al., 1990; Graybiel et al., 1994; Graybiel, 1995; Jog et al., 1999; Barnes et al., 2005; Fareri & Delgado, 2013; Graybiel & Grafton, 2015; Graybiel, 2016; Haber, 2016). Investigations on human learning have shown that cortico-basal ganglia circuits are activated by both primary reinforcers (i.e., food) and secondary reinforcers (i.e., approval from others) (Haber, 2011; Fareri & Delgado, 2013; Daniel & Pollmann, 2014; Graybiel & Grafton, 2015; see also Skinner, 1953; *Self-Determination Theory*, Deci & Ryan, 1985; Ryan & Deci, 2000; see also Dörnyei & Csizér, 1998, with respect to L2

teaching/learning). As for studies on animals, researchers have stated that striatal neurons respond mainly to pleasant stimuli and that cortico-basal ganglia circuits could determine which responses to reinforce or weaken in the course of learning (Barnes et al., 2005; Graybiel & Grafton, 2015; Smith & Graybiel, 2016). Additionally, studies on animals have repeatedly shown that, with practice (overlearning, overtraining), the striatum remaps bits of information into *motor chunks*. Bracketing patterns (start-end boundaries) are formed, as when we "chunk" a phone number in order to learn it (Graybiel, 1998, 2008; Jog et al., 1999; Barnes et al., 2005; Pennartz et al., 2009; Graybiel & Mink, 2009; Smith & Graybiel, 2013, 2014, 2016; Graybiel & Grafton, 2015). Furthermore, researchers suggest that *motor chunks* could be crucial to the automatic structuration and expression not only of action sequences but also of linguistic sequences that require accuracy and speed (Graybiel, 1998, 2008; Jin & Costa, 2010, 2015; Jin et al., 2014; Wymbs et al., 2012; Graybiel & Grafton, 2015; see also Lieberman et al., 2004).

By the same token, in the *Minimalist Programme*, Chomsky (2000, 2001, 2011, 2015/1995) assumes that the faculty of language comprises at least two components: a cognitive system (a computational system of human language—C_{HL}—and a lexicon) and performance systems (the sensorimotor and conceptual-intentional systems). The cognitive system "stores information in some manner" (Chomsky, 2000, p. 117) and performance systems "access that information and use it" (Chomsky, 2000, p. 117) "for articulation, perception, talking about the world (…), and so on." (Chomsky, 2015, p. 2) Chomsky also claims that

A particular expression generated by the language contains a phonetic representation that is legible to the sensorimotor systems, and a semantic representation that is legible to conceptual and other systems of thought and action. (Chomsky, 2000, p. 10).

In this respect, Chomsky adds that C_{HL} is a generative procedure that

yields an infinite array of structured expressions, each interpreted at two interfaces, the sensory-motor interface (sound, sign, or some other sensory modality) for externalization and the conceptual-intentional interface for thought and planning of action. (Chomsky, 2011, p. 263)

More precisely, C_{HL} interacts with the performance systems at two interface levels, Phonetic Form (PF) at the sensorimotor (or articulatory-perceptual) interface and Logical Form (LF) at the conceptual-intentional interface in order to determine, respectively, the sound and meaning of sentences (Chomsky, 2000, 2011, 2015).

Furthermore, language consists of three kinds of elements: the features that make up the lexical items of every language, the lexical items that are assembled from these features and the syntactic structures constructed from such items. The features assembled into lexical items can be classified into semantic, phonetic and uninterpretable formal. Additionally, features must satisfy the interface condition: semantic features are interpreted at LF; phonetic features, at PF and formal features are not interpreted at either interface (Chomsky, 2000, 2002). Lexical items, in turn, fall into two categories: lexical, i.e., nouns and verbs, and functional, i.e., (T) ense and (AGR) eement. Lexical categories convey

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descriptive meaning. By contrast, functional categories carry grammatical information (Roberts & Roussou, 2003). Morphemes (that is, morpholexical items such as the third-person singular -*s*) express functional categories. In order to organise and produce a sentence, the computational system of the human faculty of language, C_{HL}, forms an abstract object, a structural description that specifies the meaning (semantics) and sound (phonology) of such a sentence. More precisely, the computation starts with a set of lexical items. Different operations combine the lexical items in order to form a syntactic object. Then, the computation splits at Spell-Out, sending the syntactic object to the conceptual-intentional systems (LF level) for semantic interpretation and the sensorimotor systems (PF level) for linearisation (that is, the conversion of the syntactic structure into a string of words) and pronunciation (Yang, 1999; Chomsky, 2006, 2015). Syntax links LF and PF by means of syntactic operations such as Merge and Agree. Merge combines two syntactic objects α and β to form a larger one, the set {α, β}, and applies iteratively to its own output (see (2i)-(2iii)) to build phrase structure (Chomsky, 2000, 2001, 2015/1995; Roberts & Roussou, 2003; Bolhuis et al., 2014).

(2)

(i) {the, apple}

(ii) {saw, {the, apple}}

Agree is the operation that relates lexical items within a syntactic space (Roberts & Roussou, 2003). Chomsky (2000, 2002) states that, for example, in the sentence "Clinton seems to have been elected," the agreement -*s* on "seems" is the morphological expression of the relation between the subject and the main verb. The subject and the main verb agree in inflectional features, but have no semantic relation. Instead, the semantic relation of the subject is to the remote verb "elect." "Seems" has inflectional features (i.e., third person, singular) that are uninterpretable and add nothing to the meaning of the sentence, since they are already expressed in the subject. In particular, formal features have no interpretation at the semantic interface, need not be expressed at the sound level and hence must be erased to satisfy the interface condition. Slabakova (2013), in turn, claims that formal features fall into two categories: interpretable and uninterpretable. Interpretable formal features are legible to the semantic system and contribute to the meaning, so they cannot be eliminated. By contrast, uninterpretable formal features should be eliminated before Spell-Out, since they do not contribute to the interpretation. For example, in the sentence "Peter often takes the bus," the interpretable formal feature [singular] of the subject survives into the semantic system while the uninterpretable formal feature on the verb (that is, the agreement -*s*) is eliminated by the meaning interface, but survives in the sound system to be pronounced as /-s/.

In what follows, the faculty of language is addressed in terms of acquisition and automaticity. *Universal Grammar* is the theory of the initial state initial (S_0) of the faculty of language, the knowledge that the child is endowed with before exposure to the so-called *primary linguistic data* (PLD) (Chomsky, 2000, 2001, 2002; White, 2003). S_0 specifies the set of features (F) available for languages. Features are the elemental units that make up the lexical items of every language. L1

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acquisition involves two relevant processes: feature selection (the selection of a subset $[F_{L1}]$ of F) and feature assembly (the assembly of features of $[F_{L1}]$ into particular lexical items $[Lex_{L1}]$) (Chomsky, 2001; Lardiere, 2009; Domínguez et al., 2011). Furthermore, particular grammars constitute direct expressions of *Universal Grammar* under particular sets of parametric values. For example, the position of heads in phrases is determined by a parameter. Languages are either "head-first" (with the verb preceding the object) or "head-last" (with the object preceding the verb). At S_0, all parameters are set with unmarked values. The child analyses the PLD, guided by *Universal Grammar*, and "fixes" that parameter (Chomsky, 1981, 2001, 2002, 2006). Belletti and Rizzi (2002) claim that, whereas initial versions of generative grammar consisted of phrase-structure and transformational rules −a view inherited from traditional grammar—, subsequent versions are characterised by the proposal of parameters (Belletti & Rizzi, 2002, in Chomsky, 2002). Slabakova (2013, p. 8), in turn, asserts that language-specific parameters lead to different grammatical rules in every language. Moreover, L1 acquisition can be seen as the transition from the initial state of the faculty of language at birth to a mature state in which every speaker/hearer masters and uses a generative procedure in an automatised, unconscious manner. This procedure can generate the infinite array of hierarchically structured L1 expressions (Chomsky, 2000, 2002, 2011, 2015/1995; Belletti and Rizzi, 2002, in Chomsky, 2002; see also Chomsky, 1965). As for L2 acquisition, Chomsky (2000) asserts that formal features with no semantic interpretation give rise to learning problems.

In the *Feature Assembly Hypothesis*—FAH—(or *Feature Reassembly Hypothesis*—FRH—), Lardiere (2005, 2007, 2008, 2009) reports that, L2 learners tend to omit L2 morpholexical items in oral production, a problem that cannot be explained in terms of the failure to reset parameters from the L1 values to those of the L2. Lardiere (1998) collected data from Patty, a Mandarin and Hokkien Chinese speaker who came to the United States at age 22. The first recording was taped when Patty was 32. The second and third recordings were taped about two months apart when Patty was 41. Patty was educated in U.S. universities, had been exposed to the same everyday English for many years and showed native-like syntactic competence in many respects. Although Patty's L1 Chinese has no overt case-marking nor overt agreement, subjects are raised, at least over modals, implicating the presence of an Extended Projection Principle (EPP) feature and hence that of abstract agreement. Nevertheless, Patty rarely marked regular third-person singular *-s* agreement. According to Lardiere (2005), the acquisition of nominative case marking in English by a Chinese speaker does not involve resetting a parameter but learning how to assemble formal features in the L2. Lardiere (2009) also asserts that the L2 learner brings to the task of L2 acquisition an already-assembled set of L1 morpholexical items and is exposed to an already-assembled set of L2 morpholexical items. L2 learners seek the equivalents of L1 already-assembled morpholexical items in the L2. Lardiere (2005, 2007, 2009) also underscores that, although any feature that is detectable can be acquired, L1/L2 differences in morpholexical combinations can pose a problem for L2 acquirers, who must learn how to bundle L2 formal features into new configurations in the L2 or repackage formal features already assembled in their L1 into different

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configurations in the L2. Moreover, the learning problem argued by FAH/FRH has been supported by numerous studies that have examined the acquisition of different formal features, such as verbal morphology in L2 Spanish by L1 English speakers (Domínguez et al., 2011), number marking on nouns in L2 Swahili by L1 English speakers (Spinner, 2013) and verbal morphology in L2 English by L1 Japanese speakers (Muroya, 2018).

As stated, neuroscientists have examined the specialisations of the areas/systems of the brain. Sensory and motor areas store information (memory) and use it in perception and action, respectively (Fuster, 1995, 2003, 2013, 2019). For example, motor areas store and use motor memory, i.e., rules (Fuster, 2015). Recall also that, according to Lashley's (1951) *syntax of action* and *Motor Programme Theory* (Schmidt & Wrisberg, 2000), abstract cerebral schemas or *motor programmes* specify, ahead of time, the structuration (*motor planning*) and expression (*motor output*) of purposeful action or meaningful language. According to some neuroscientists, the prefrontal cortex specialises in rule learning and implementation, as well as the building of the motor programmes of novel language and action, while sustained attention is involved (i.e., Fuster, 1995, 1997, 2003, 2015; Miller, 1999; Miller & Cohen, 2001). The basal ganglia store and implement familiar rules and are involved in the formulation of the schemas of overlearned action and language (i.e., Fuster, 1995, 2015; Graybiel, 1995, 2008). Both the prefrontal cortex and the basal ganglia are also responsible for sensorimotor integration, a process during which such motor areas transform *sensory input* (perception) into *motor output* (action). As a result of this process, both motor areas plan and produce meaningful language or goal-directed action in response to the available information (context-related stimuli) and, also, in accordance with rules (Fuster, 1995, 2003, 2015; Miller, 1999; Miller & Cohen, 2001; Haber, 2016). In addition, the basal ganglia learn *motor chunks* ("blocks") when positive emotion (rewarding stimuli) and thorough practice are involved. Some neuroscientists suggest that the basal ganglia could learn to organise, (re)combine and express *motor chunks* in an automatic manner. Such chunks could underlie not only the automatic structuration and expression of skilled action but also of skilled speech (i.e., Graybiel, 1998, 2008; Jin & Costa, 2015; Graybiel & Grafton, 2015; see also Lashley, 1951; Miller, 1956). Moroever, in exerting syntax "at expert level," the brain is also said to impart accuracy, rhythm and fluency to the sequences of action and language (Lashley, 1951; Schmidt & Wrisberg, 2000; Jin et al., 2014). By contrast, in the *Minimalist Programme*, Chomsky assumes that language comprises a cognitive system that "stores information in some manner" (Chomsky, 2000, p. 117) and performance systems that "access that information and use it" (Chomsky, 2000:117) "for articulation, perception (…), and so on" (Chomsky, 2015, p. 2). He also asserts that C_{HL} (located within the cognitive system) generates abstract structural descriptions that provide the performance systems (that is, the conceptual-intentional and sensorimotor systems) with specifications concerning the meaning and sound of sentences (Chomsky, 2000). On the other hand, Generativism thoroughly describes language in syntactic terms (i.e., *features*, *phrases* or "blocks" and operations) and shows that L2 formal features (such as the third-person singular -*s*) are difficult to acquire (i.e., Lardiere, 2009). Therefore, some

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neuroscientists (and some psychologists) provide guidelines as to how the brain could acquire and automatically plan and produce language—and all forms of skilled action—. Generative linguists do not. For the current study, a treatment that drew on neuroscience and psychology was implemented in an attempt to improve the accuracy rates of the third-person singular -*s*. A research question guided the study: Will the treatment increase the accuracy rates of the -*s* in a grammaticality judgement task?

3. Method

3.1 Participants

The learners participating in the present study pertained to three rural schools of primary education in Northern Spain: the Basque Autonomous Country (BAC) and Navarre (Note 1). The study encompassed 64 EFL learners, aged 8-11. No intact classes were available for the study since some parents did not allow their children to take part in it. Accordingly, twenty-five students (12 males, 13 females) from a school in the BAC formed the control group (group 1). Additionally, 12 students (7 males, 5 females) from another school in the BAC constituted the first experimental group (group 2). Finally, 27 students (12 males and 15 females) from a school in Navarre formed the second experimental group (group 3). Moreover, in order for the researcher to apply the treatment, the study involved access to the participants' classes. Thus, before collecting the data and carrying out the study, the participants' parents and legal guardians signed a consent form. The participants' characteristics were gathered by means of a background questionnaire (see Table 1).

Table 1. Participant Characteristics

Group	N	Age at testing	Age average	Years of exposure	Age of first exposure	Percentage of learners receiving extracurricular English lessons	Percentage of learners speaking Basque at home
1	25	8-11	9.52	6.18 (SD 2.27)	3.34 (SD 2.05)	56.00%	84%
2	12	8-11	9.75	6.83 (SD 1.86)	2.92 (SD 0.97)	41.67%	75%
3	27	8-11	9.78	6.96 (SD 1.83)	2.81 (SD 1.38)	44.44%	18%

The three groups presented differences in several aspects, i.e., the percentage of learners speaking Basque at home. The groups also differed in the number of hours of instruction received in English per week/year. The participants from the BAC (groups 1 and 2) were attending schools where Basque was the medium of instruction, which means that all the participants were Basque/Spanish bilinguals. In addition, in group 1, the 3rd and 4th grade participants received 3 hours of English class per week, while the 5th and 6th grade participants received 4 hours. In group 2, the 3rd and 4th grade participants received 1 hour of English class per week, while the 5th and 6th grade participants received 2 hours. In group 3, the 3rd and 4th grade participants were enrolled in PAI (*Programa de Aprendizaje en Inglés*, "English Learning Programme"), a variant of Content and Language Integrated Learning (CLIL). Such 3rd and 4th grade participants received instruction predominantly in Spanish, as well as 10 hours of English per week that involved English lessons and two additional subjects (Sciences and Art). The 5th and 6th grade participants from group 3 were enrolled in an older programme in which Spanish was the medium of instruction. Such participants received 5 hours of English class per week. Moreover, out of the total of participants in group 3, 81.5% had Basque as a subject. The total number of English hours per week/year is summarised in Table 2.

Table 2. Total Number of English Hours Per Week/Year

Total number of hours of exposure	N	3 primary (8 years old)	4 primary (9 years old)	5 primary (10 years old)	6 primary (11 years old)
GROUP 1	25	3/120	3/120	4/160	4/160
GROUP 2	12	1/40	1/40	2/80	2/80
GROUP 3	27	10/400*	10/400*	5/200	5/200

* Number of English hours per week/year received by the participants enrolled in PAI.

Despite the aforementioned differences, all the participants had the same level of proficiency in English, as established by the Quick Placement Test (Oxford University Press, © UCLES 2001, source: https://www.vhs-aschaffenburg.de/page_/Serve/download/ID/766/f/oxford-test.pdf).

3.2 Materials

The materials used in the present study comprised an Oxford placement test, four pretest-postest tasks and the instruction on the third-person singular –*s* that was administered after the pretest. All participants were given the placement test and four pretest-postest tasks. Here, the author transmits the results of a Grammaticality Judgment Test (GJT). This task was specifically designed to investigate the accuracy rates of the -*s* by means of two experimental items: "He + VERB $_{\text{[Present simple tense]}}$" and "She + VERB$_{\text{[Present simple tense]}}$." Participants were provided with correct and incorrect sentences in the present simple tense (3a-3b):

(3)

(a) He lives in Germany.

(b) * He sing when he ride his horse.

Additionally, the distractors contained both correct and incorrect sentences in the past simple.

Group 1 (control group) received its own school instruction. Groups 2 and 3 (experimental groups) received the treatment discussed in the present paper. Moreover, the teachers from the experimental groups were also given an informal interview in which they were asked about the participants' reaction to the treatment (see below).

The treatment applied to the experimental groups comprised a set of pedagogical strategies (©2018, 2019, Verónica Mendoza Fernández): *sensory chunking*, the structuration of linguistic input on the basis of processing demands and *sensorimotor drilling*.

First, *sensory chunking* consisted in teaching with sentences that were made up of *sensory chunks* (that is, language blocks that can be perceived through the senses). *Sensory chunking* was based on the claim that the brain acquires *motor chunks* in order to automatically plan and produce action and, probably, language (i.e., Graybiel, 1998, 2008). The treatment involved predominantly chunked sentences. Such sentences contained one of the following *sensory chunks*: [He + VERB$_{\text{Present\_simple\_tense}}$], [She + VERB$_{\text{Present\_simple\_tense}}$] and [They + VERB$_{\text{Present\_simple\_tense}}$] (see Figure 2).

Figure 2. *Illustration of a Sentence Consisting of 5 Sensory Chunks*

A five-minute cartoon was also played.

Second, the structuration of linguistic input on the basis of processing demands involved the presentation of chunked sentences whose length was gradually increased. The *sensory chunks* presented in initially short sentences (i.e., [He sleeps] [on a tree]) were subsequently reused and recombined in longer ones (i.e., [He sleeps] [a lot] [when] [he travels] [a lot]). Such structuration was predicated on several claims. On the one hand, the brain—in particular, the prefrontal cortex—can be overloaded when paying attention to each of the items (i.e., words) in a sequence. The higher the number of items demanding sustained attention, the heavier the burden imposed on that particular brain area (Fuster, 2009; Baars & Gage, 2010). On the other hand, the strategy of chunking mitigates the processing load and facilitates the learning of the information processed (Miller, 1956; Howard, 1983; for the contribution of *motor chunks* to brain efficiency, see Graybiel, 1998; Ramkumar et al., 2016). What is more, the motor programmes of the basal ganglia could reuse and recombine *motor chunks*. Action sequences could consist of "blocks" that are reused and recombined in subsequent sequences (Jin & Costa, 2015).

Third, *sensorimotor drilling* rehearsed learners' linguistic action when exposed to (non-)linguistic stimuli associated with contexts expressed in the present simple tense (i.e., routines and states). The strategy comprised two components: perceptual and motor. The perceptual (or sensory) component encompassed predominantly learners' exposure to (a) context-related non-linguistic input (i.e., the visual imagery from an illustrated tale; see APPENDIX A); (b) matching linguistic input (chunked sentences whose accuracy, rhythm and speed was emphasised) and (c) rewarding stimuli (positive emotion). The motor (or action-related) component involved the production of the sentences that learners perceived, as well as the planning/structuration and output/production of the sentences generated by the learners themselves to describe a person's habits and states (see Figure 3).

Sensorimotor drilling

Perceptual component
sensory input

Motor component
motor planning and motor output

Context-related non-linguistic stimuli: visual imagery

Matching linguistic stimuli: *sensory chunking*

    Order of *sensory chunks*
    Combinatorial properties of *sensory chunks*
    Morphological accuracy (*sensory chunks* displaying
        the 3rd-pers sing -*s*)
    Rhythm (stress patterns)
    Fluency (increasing speed)

Contextualised (non-)linguistic stimuli: a cartoon

Rewarding stimuli (positive emotion)

Linguistic planning and output:

    Order
    Combinatorial properties
    Morphological accuracy
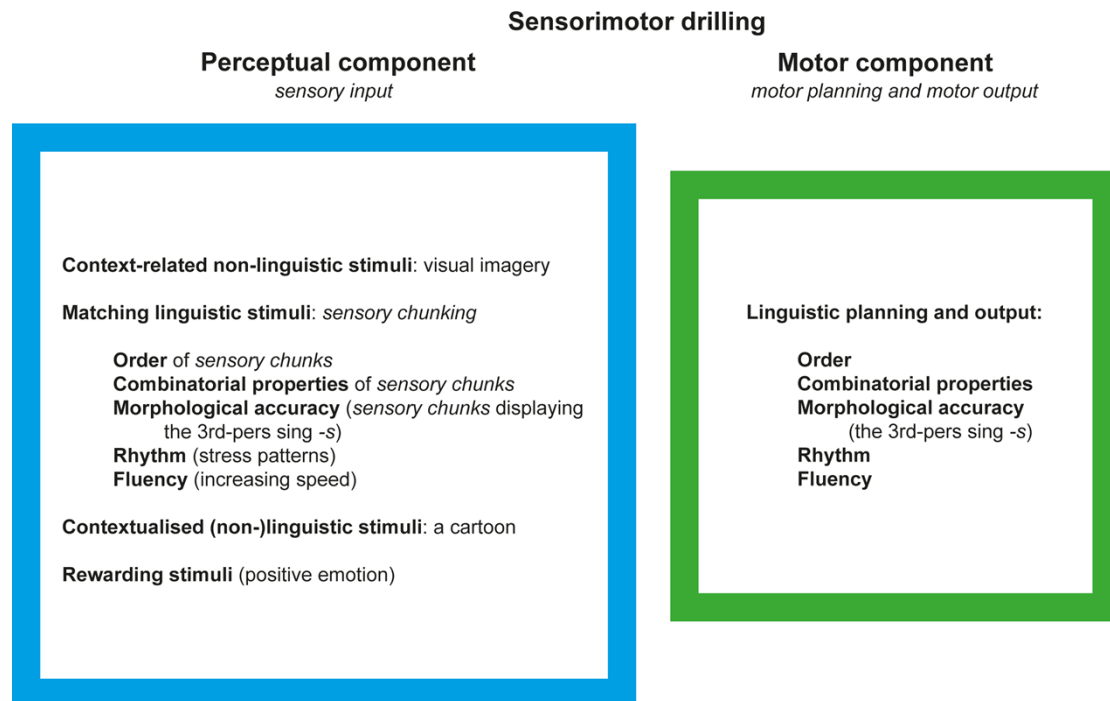   (the 3rd-pers sing -*s*)
    Rhythm
    Fluency

Figure 3. Schematic Illustration of the Perceptual and Motor Components of Sensorimotor Drilling: the (non-)Linguistic Input Provided by the Teacher and the Linguistic Planning and Output Expected from the Learners

Rehearsal involved drilling series in which chunked sentences were presented together with matching, context-related visual imagery (an illustrated tale and photographs). A sentence in the present simple was extracted from a cartoon and presented in a chunked fashion together with the cartoon.

Most input sentences provided learners with information on chunk-based order, chunk-based combination and chunk-based rules (in particular, morphological accuracy relating to the third-person singular -*s*). Learners read and listened to the chunked sentences, which were displayed on a large screen and produced orally by the teacher. Both teacher and learners engaged in choral drilling series with emphasis on accuracy, rhythm and stress patterns (see APPENDIX A), increasing speed and increasing voice volume. As for rhythm and pace, the teacher clapped and learners banged their hands on their desks.

Rehearsal also involved drilling series only with previously presented images. In this case, learners recalled and uttered the chunked sentences associated with such images. In addition, rehearsal comprised a chunk-based fishing game (*Fish the Words!*) that was interspersed with the aforementioned drilling series. During the game, learners caught fish that read previously rehearsed words. Learners were asked to (re)construct a *sensory chunk* expressed in the present simple tense (i.e., [She travels], [He travels] or [They travel]) and were told to add and combine further *sensory chunks* in order to complete a sentence (see APPENDIX B). Learners organised and combined *sensory chunks* (*motor planning*) and expressed sentences orally (*motor output*).

After each drilling series, the teacher praised learners. Both teacher and learners clapped their hands and celebrated their performance. The treatment pursued fun and, overall, a rewarding learning experience. To that aim, instruction included what could constitute pleasant classroom stimuli: an illustrated tale (*Tim's story*), a cartoon, a game, playful drilling series, praise, clapping and celebration. Sensorimotor drilling was grounded in aspects related to the process of sensorimotor integration and the overlearning of motor chunks. Recall that, according to some researchers, two motor areas exert syntax during sensorimotor integration: the prefrontal cortex and the basal ganglia. Both motor areas produce motor output (i.e., meaningful speech) in response to sensory input (i.a., visual and auditory stimuli). Moreover, the basal ganglia acquire motor chunks by means of reward and thorough practice and learn to formulate the chunk-based motor programmes of skilled action and, arguably, skilled language (for the reutilisation and recombination of motor chunks, see above). In exerting syntax of action "at expert level," motor chunks could underlie the automatic planning and production of the sequences of action and language that are characterised by their accuracy, rhythm and speed (i.e., Lashley, 1951; Graybiel, 1998, 2008; Jin & Costa, 2010, 2015; Jin et al., 2014; Wymbs et al., 2012; Graybiel & Grafton, 2015).

3.3 Procedure

In week 1, the participants were given the pretest tasks. In week 2, learners in the three groups received three classes that lasted 45 minutes each and focused on the -*s*. The control group received its own school instruction. The experimental groups received the treatment analysed in the current paper. In week 3, learners carried out the postest tasks.

3.4 Analyses

Statistical analyses were carried out using SPSS (version 25). Though the experiment consisted of four tasks, only the results of GJT are transmitted here. Each of the four tasks comprised a different number of experimental items. To even the results, the scores of all tasks were calculated over 100, which yielded the percentages of accuracy rates of the -*s*. Then, the mean, median, standard deviation (SD) and confidence intervals (CI) were obtained. Given the differences between the three groups and the fact that the data did not meet the required normal distribution and homoscedasticity, the Wilcoxon Test was run to measure the accuracy rates of the -*s* at the pretest and postest within groups. The percentages of accuracy rates were also grouped into four intervals that had the same width (25%) and thus conveyed the information corresponding to the quartiles.

4. Result

The research question enquired into the comparative results on the accuracy rates of the -*s* obtained by the control group (group 1) and the experimental groups (groups 2 and 3) before and after instruction. The mean, median, SD and CI scores were calculated on the basis of the accuracy rates of the -*s*. Both the mean and the median increased significantly for both experimental groups in the postest (see Table 3).

Table 3. Mean, Median, SD and CI of the Accuracy Rates in GJT

Group	N	Pretest				Postest			
		Mean	Median	SD	CI	Mean	Median	SD	CI
1	25	31.33	29.167	18.36	[23.75/38.91]	32.83	25.00	23.70	[23.05/42.62]
2	12	49.65	52.08	19.74	[37.11/62.19]	69.10	62.50	26.85	[52.03/86.16]
3	27	40.89	37.50	19.37	[33.23/48.56]	76.70	83.33	23.09	[67.56/85.83]

The Wilcoxon Test was run to compute the accuracy rates within groups in GJT. Group 1 showed no statistical significance between the pretest and postest. Group 2 did not reach statistical significance, though it did show a certain trend toward it in the postest (Z=-1.736, p=0.083, d Cohen=1.158, which showed a large magnitude of effect sizes). Further, group 3 reached statistical significance in the postest (Z=-4.242, p<0.001, dCohen=2.827, which also showed a large magnitude of effect sizes). Furthermore, the accuracy rates of the -*s* were also measured in terms of quartiles. Group 1 showed no improvement in the postest. By contrast, the experimental groups showed a decrease in the number of participants obtaining results <50.00%, as well as a significant increase in the percentage of learners scoring results ≥75.00% in the postest (see Table 4).

Table 4. Intervals of the Accuracy Rates in GJT

Accuracy rates	Group 1		Group 2		Group 3	
	PRETEST Number/ Percentage of learners	POSTEST Number/ Percentage of learners	PRETEST Number/ Percentage of learners	POSTEST Number/ Percentage of learners	PRETEST Number/ Percentage of learners	POSTEST Number/ Percentage of learners
<25.00%	7 (28.0%)	8 (32.0%)	1 (8.3%)	-	2 (7.4%)	1 (3.7%)
25.00-49.99%	12 (48.0%)	11 (44.0%)	3 (25.0%)	3 (25.0%)	17 (63.0%)	1 (3.7%)
50.00-74.99%	6 (24.0%)	4 (16.0%)	7 (58.3%)	4 (33.3%)	6 (22.2%)	8 (29.6%)
≥75.00%	-	2 (8.0%)	1 (8.3%)	5 (41.7%)	2 (7.4%)	17 (63.0%)

4. Discussion

The current study was aimed at testing a pedagogical treatment which sought to tackle the pervasive problem of the variability in the omission/suppliance of the third-person singular –*s* by increasing the accuracy rates—and hence the strength—of such a morpheme. In the *Minimalist Programme*, the

linguist Chomsky (2000) has pointed out that L2 formal features with no semantic interpretation pose a learning problem. Furthermore, numerous studies conducted by Lardiere (i.e., 1998, 2009), Spinner (2013) and Muroya (2018), among other linguists, have demonstrated that L2 formal features are difficult to acquire. However, researchers do not explain how such linguistic items could be taught, learned and automatised. In order to fill this gap, the author built on neuroscience and psychology and designed a pedagogical treatment that pivoted around *sensory chunking* (teaching with chunked sentences).

A research question was set: Will the treatment yield an increase in the accuracy rates of the –s in GJT? The results evidenced that the control group did not reach statistical significance. By contrast, group 2 (12 participants) showed a trend towards statistical significance (Z=-1.736, p=0.083) and group 3 (27 participants) reached statistical significance (Z=-4.242, p<0.001). In addition, the author also extracted information on quartiles and interpreted it on the basis of memory processes: encoding (learning), consolidation/strengthening (overlearning), retrieval (accessibility) and use of a memory. Consolidation is the process by which memories are strengthened. In order to be retrieved for use, a memory must have a degree of strength. The greater the strength of the memory, the greater the accessibility to that piece of stored information (Fuster, 2003). The author assigned the following labels (see Table 5) for the analysis of the intervals presented in Table 4.

Table 5. Percentages and Degrees of Retrieval and Use of the *-s*

Percentage of retrieval and use	Degree of retrieval and use
<25.00%	Very low
25.00-49.99%	Low
50.00-74.99%	Moderate
≥75.00%	High

After the brief implementation of the treatment, there was a decrease in the percentage of learners scoring percentages of retrieval and use <50.00% and an increase in the percentage of learners obtaining percentages of retrieval and use ≥75.00%. The increase in the degree of retrieval and use of the *-s* in both experimental groups was interpreted as an increase in the degree of strength of this morpheme. The treatment thus seemed to promote the overlearning, retrieval and use of the required item. The hypothesis seemed to be confirmed.

It should also be noted that, although the participants from groups 1 and 3 carried out GJT in silent classrooms, those from group 2 did the task in their regular classroom while instruction was taking place, which may have negatively affected their performance. Moreover, the participants in the study had the same level of proficiency in English and similar average age. However, participants presented significant differences in the total number of English hours received and their linguistic background.

Despite the lack of homogeneity of the groups formed in each of the rural schools, the results obtained after the treatment seemed to improve only for the two experimental groups.

Furthermore, according to Lardiere's (2005, 2007, 2008, 2009) FAH/FRH, L1/L2 differences in morpholexical combinations can pose a learning problem for L2 acquirers. Both Spanish and Basque have the formal features [3rd person] [+singular]. 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, subjective and imperative). Basque verbs agree with the subject, direct object and indirect object. 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). English does not allow null subjects and lexical verbs agree only with the third-person singular subject in the present tense (Villarreal-Olaizola, 2011). Table 6 conveys an example that compares the first-, second-, third-person singular of the present tense in English, Spanish and Basque.

Table 6. The verb *"live"* (1st, 2nd and 3rd-Person Singular of the Present Tense) in English, Spanish (*"vivir"*) and Basque (*"bizi izan"*)

	Spanish	Basque	English
First-person singular	Yo viv**o**	Ni bizi **naiz**	I live
Second-person singular	Tú viv**es**	Zu bizi **zara**	You live
Third-person singular	Él viv**e**	Hura bizi **da**	He live**s**

The results obtained in the present study seemed to contradict Lardiere's claim that the assembly of formal features in an L2 (here, the assembly of formal features into the morpholexical item -*s* in English as an FL) can pose a learning problem.

Moreover, an informal interview in which teachers were asked about learners' impressions on the treatment, was also carried out. The teacher from group 2 reported on the high level of attention and involvement of the learners throughout the treatment. Also, learners from group 2 who had not agreed to take part in the experiment, but had heard of it from other learners who had already received part of the treatment, came voluntarily to the treatment class "to have fun." Additionally, the teachers from group 3 commented on the high level of motivation of learners, who had a completely different attitude from the one observed in their regular lessons.

In sum, the improvement observed in the experimental groups could be attributed to an effective translation of the evidence stemming from neuroscience and psychology into the pedagogical treatment. Drawing on such disciplines and the characteristics of the treatment, the author suggests that the

extended implementation of the pedagogical ensemble, *sensory chunks*, could constitute a form of "gymnastics" that could pave the way for language overlearning and automatisation. Prolonged instruction could promote the encoding (learning), strengthening (overlearning) and retrieval (accessibility) of linguistic items, language blocks (i.e., [He + VERB$_{Present\_simple\_tense}$]) and, possibly, *motor chunks*, which, according to some neuroscientists, could underlie the automatic, extemporaneous planning and production not only of purposeful action but also of meaningful language. Protracted instruction could also foster the automatic organisation, (re)combination and expression of language blocks in response to context-related stimuli. When expressed, chunked sentences could display accuracy, rhythm and fluency. In other words, further automatisms could be strongly established in the brain.

Nevertheless, the results need to be taken cautiously since the study displayed several limitations, such as the absence of brain-specific measurements obtained in a laboratory, the scarcity of subjects, the absence of homogeneous groups, the briefness of the intervention and the lack of subsequent post-test measurements. Future research should tackle such limitations and, additionally, test the treatment on additional linguistic items (i.e., possessives and relative clauses).

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Note

Note 1. In the BAC, there are two official languages: Spanish, the majority language, and Basque (source:

https://www.euskadi.eus/contenidos/informacion/ikerketa_soziolinguistikoak/es_def/adjuntos/VI%20_I NK_SOZLG_EAE_Presentacion_publica_20161014.pdf). The same is true for Navarre (source:

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https://gobiernoabierto.navarra.es/sites/default/files/estudio_soiolinguistico_2018.pdf).

Appendix A

Examples of *sensory chunking* included in the illustrated tale (*Tim's story*) that was used in the aforementioned experiment. Fuchsia dots in (Figure A) and (Figure B) were used for rhythm and fluency.
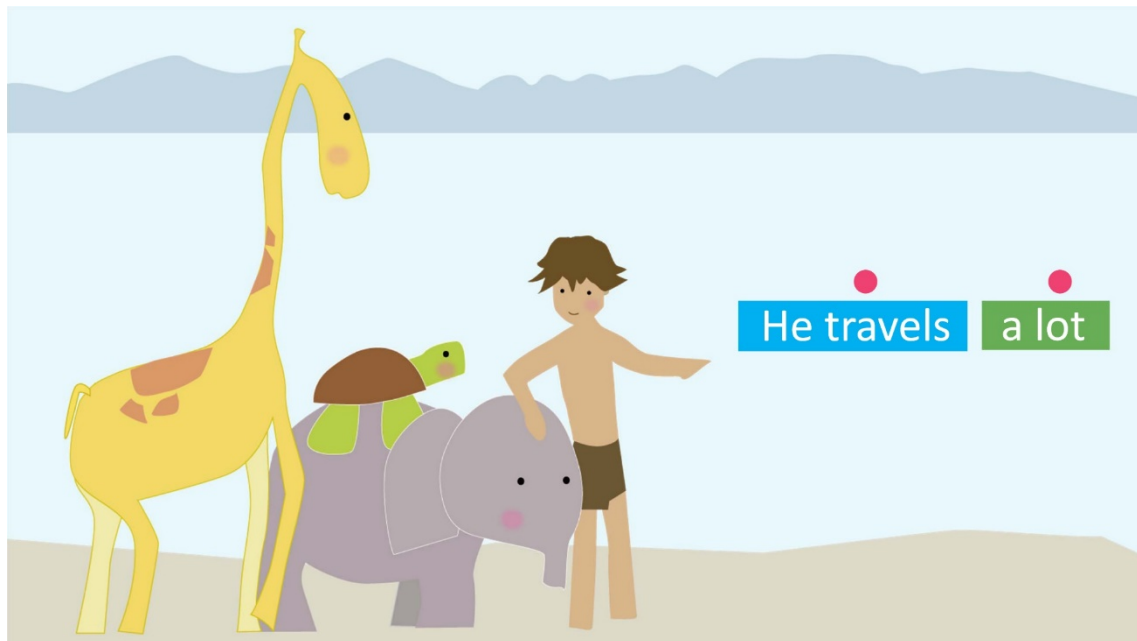

Figure A. [He travels] [a lot]

Figure B. [He sleeps] [on a tree]

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Appendix B

Reconstruction of the first *sensory chunk* ([She travels]) and integration of a second *sensory chunk* ([to France)], as part of the structuration of a sentence (see Figure C).
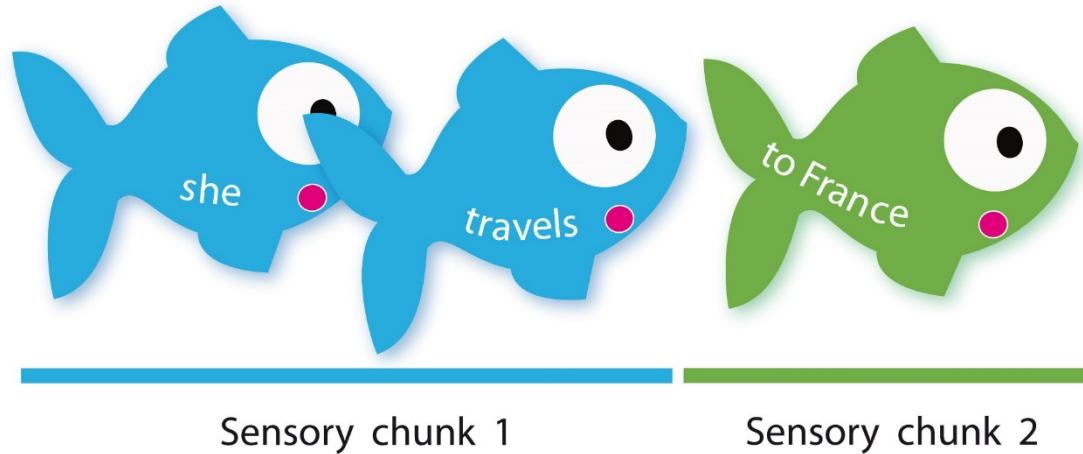

Figure C. [She travels] [to France] …