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L2 Acquisition of English by Persian L1 Speakers. Comparing Morphology, Syntax and Semantics

The Bottleneck Hypothesis in L2 acquisition

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Dedication

To my adorable husband and my lovely son for their endless love and support

Abstract

In this thesis, I test the Bottleneck Hypothesis (Slabakova, 2008, 2013, 2016) in L2 acquisition of English by Persian L1 speakers. The Bottleneck Hypothesis (BH) examines what is difficult and what is easy to acquire in a second language. According to this hypothesis, functional morphology is the most challenging part for second language learners to acquire, while narrow syntax and semantics are easier to acquire.

In the current study, I test four linguistic conditions within three linguistic modules (morphology, syntax and semantics): Subject-verb agreement, Past tense *-ed*, Adjective-Noun (Adj-N) word order and Pronominal gender. Subject-verb agreement and Past tense *-ed* represent knowledge of functional morphology, Adj-N word order and Pronominal gender represent knowledge of syntax and semantics respectively.

The study consisted of a timed acceptability judgement task with 50 test items, a background questionnaire, and a proficiency test with 29 multiple choice test items, which were administered to Persian learners in two age groups of 10 (n=129) and 12 (n=123).

The results of the statistical analysis indicate that the participants struggle more with identifying Pronominal gender than they do with Subject-verb agreement, Past tense *-ed* and Adj-N word order. Moreover, the results show that Pronominal gender is a more persistent problem and is not acquired well with either of the groups. Furthermore, the findings demonstrate that Past tense *-ed* is not only easier to acquire than Subject-verb agreement, but also it is easier than Pronominal gender and Adj-N word order. I conclude that the findings do not support the BH.

Keywords: Agreement, Functional morphology, L1 Persian, L2 English, Past tense, Pronominal gender, Semantics, Syntax, The Bottleneck Hypothesis, Word order

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List of Abbreviations

3sg/Pl: Third person singular/Plural

Adj-N word order: Adjective-Noun word order

AJT: Acceptability Judgement Task

BH: Bottleneck Hypothesis

CA: Contrastive Analysis

CAH: Contrastive Analysis Hypothesis

CLI: Cross Linguistic Influence

EFL: English as a Foreign Language

FT/FA: Full Transfer Full Access Hypothesis

IL: interlanguage

L1: First language

L2: Second language

L2A: Second Language Acquisition

NSD: Norwegian Centre for Research Data

RQ: Research question

SLA: Second Language Acquisition

SVA: Subject-Verb-Agreement

SVO: Subject-Verb-Object word order

SOV: Subject- Object -Verb word order

TL: Target Language

UG: Universal Grammar

V2: Verb second

1. Introduction

In recent years, numerous second language researchers have been interested in examining and explaining why some linguistic features and constructions are difficult or easy in second language. In line with this interest, the current thesis aims to test the Bottleneck Hypothesis (Slabakova, 2008, 2013, 2016) in second language (L2) acquisition of English by Persian L1 speakers. This hypothesis argues that functional morphology is the bottleneck of Second Language Acquisition (SLA), while acquisition of syntax, semantics and pragmatics flows smoothly (Slabakova, 2006, 2008, 2013).

Many studies have explored L2 acquisition which have laid the foundation of the BH (Ionin & Wexler, 2002; Haznedar, 2001; Lardiere, 1998a, b). These studies found that knowledge of syntax comes before the accurate knowledge of functional morphology in L2 acquisition. In contrast, other studies argued that acquisition of functional morphology drives acquisition of syntax (see e.g. Clahsen, Penke & Perodi 1993/1994; Radford, 1990). However, these studies did not specifically test the BH as this hypothesis did not exist then. In recent years, there have been two studies (M. Jensen, 2017; Jensen et al, 2020) investigating the BH on Norwegian learners of L2 English. The findings of Jensen et al. (2020) revealed that Norwegian learners of L2 English have problems with Subject-verb agreement, which supports what the BH claims. In contrast, the findings of M. Jensen (2017) lend some support to the BH. In this study, M. Jensen (2017) argued that although Subject-verb agreement is more difficult to acquire than syntax, Past tense *-ed* is easier to acquire than both Subject-verb agreement and one of the syntactic conditions (see section 2.4.2 for further discussion). In addition, Dehghani et al. (2016) investigated the order of difficulty of twelve English grammar features in Persian speakers including: Causatives, Reported speech, Articles, Conditionals, Passives, Verbals, Prepositions, Tag questions, Conjunctions, Tenses, Determiners, and Relative clauses. The results indicated that Persian L2 learners of English do not have problems in acquiring tense. These studies are further discussed in sections 2.3 and 2.4).

Although some studies have been done on difficulties of English as a second language for L1 Persian speakers (Dehghani et al., 2016; Kafipour & Khojasteh, 2012), no study has been tested the BH on Persian L1 students of L2 English. I find it interesting to test the BH in order to examine the difficulty of different areas of L2 acquisition by L1 Persian speakers. Furthermore, the results of this study may help teachers to recognize students' problems in L2 classroom better and try to

solve them in a way that the students can acquire the problematic constructions without difficulty (this is discussed in section 6).

In order to test the Bottleneck Hypothesis, four conditions are included in the current study: Subject-verb agreement, Past tense *-ed*, Adj-N word order and Pronominal gender. Subject-verb agreement and Past tense *-ed* represent functional morphology, while Adjective-noun word order represents syntax, and Pronominal gender relates to semantics. The reason for choosing these conditions is that there is considerable mismatch between Persian and English.

Regarding Subject-verb agreement, the agreement system of English and Persian differs in the use of inflections. Persian is a pro-drop language, in which “inflectional suffixes appear on the verb to mark subject-verb agreement” (Rasekh, 2014, p. 16). In Persian, the present tense is made by adding the tense marker *mi-* to the present stem of the verb and conjugating it depending on the subject (Lotfi, 2006). In English, the verb in the present tense is marked with the suffix *-(e)s* when the subject is 3rd person singular (see section 2.5.2 in detail).

Regarding Past tense, Persian does not have any tense marker on the verb, and L1 Persian speakers create Past tense with the infinitive stem and personal endings. Nevertheless, there is no personal ending for the third-person singular and it is the past stem alone (Lotfi, 2006), while in English, Past tense is made by adding *-ed* or *-d* to the base form of the verb. Examples of the two morphological conditions are provided in (1) to (4):

(1) *Subject-verb agreement in English*

- a. Jason plays basketball. [3sg]
- b. Jason and Jack play basketball. [Pl]

(2) *Subject-verb agreement in Persian*

- c. Jason [3sg] bæskɛtbal bazi **mikonæd** [mi-Present-3sg]
Jason basketbal plays
'Jason plays basketball.'

d. Jason [3sg] va [C] Jack [3sg] bæsketbal bazi **mikonænd** [Past-3Pl]

Jason and Jack basketball play

‘Jason and Jack play basketball.’

(3) *Past tense in English*

a. Jason played basketball.

(4) *Past tense in Persian*

b. Jason [3sg] bæsketbal bazi **kærdφ** [Past-3sg]

Jason basketball played

‘Jason played basketball.’

Regarding word order, the basic order in Persian is Noun + Adjective. This means that in Persian an adjective follows a noun, and a short vowel /e/ that is called *ezafe* in Persian, comes after the noun. In contrast, adjectives in English are pronominal and they come before the noun. Thus, the basic order in English is Adjective + Noun. In this regard, the Adj-N word order patterns between these two languages show contrast in relation to the placement of the adjective, which is illustrated as follows:

(5) *adjective-noun word order in English*

Those books with **new covers** are expensive.

[Adj] [N]

(6) *adjective-noun word order in Persian*

An ketabha ba **jeldha -e** [N-pl] [e] **jædid** [Adj] geran hastænd.

Those books with covers new expensive are

‘Those books with new covers are expensive.’

With reference to Pronominal gender, Persian does not have Pronominal gender, while English has Pronominal gender (see section 2.5.5 in detail). Example (7) illustrates the differences in Pronominal gender:

(7) U [3sg] xane daræd [Present-3sg]

He/She house has

‘He/she has a house.’

In the current thesis, I will focus on the comparison of functional morphology, syntax and semantics to investigate which linguistic module is more difficult to acquire in L2 acquisition of English. In order to test the Bottleneck Hypothesis, the study addresses the following research questions:

RQ 1: Do Persian learners of English have more difficulty acquiring functional morphology compared to syntax and semantics?

RQ 2: Is English functional morphology a more persistent problem than its syntax and semantics for L1 Persian speakers?

RQ 3: Are the two morphological conditions equally difficult in L2 acquisition for L1 Persian speakers?

RQ 4: Are the two syntax-semantics conditions in English equally difficult in L2 acquisition by L1 Persian?

In order to find answers to the research questions, the experiment was carried out through an online survey method, on *Gorilla*, which included a timed Acceptability Judgement Task (henceforth, AJT), a background questionnaire and a subset of a Standardized Oxford Proficiency test (see sections 3.7.1 and 3.6). A total of 252 students in two age groups of 10 and 12 years old participated in this study. They all were native speakers of Persian who acquired English as their L2. The participants are further discussed in section 3.5.

As the following chapters indicate, the current study does not support the claims of the BH. I therefore argue that access to UG, interpretability vs uninterpretability features and transfer from the L1 cause the difference in the results.

This thesis is divided into the following sections: chapter 1 presents the general overview of the overall thesis. Chapter 2 describes the theoretical background based on the research objectives. Then it provides related studies on the BH, and presents conditions that are going to be tested in this study and discusses the differences of these conditions in English and Persian. Chapter 3

discusses the methodology, research questions and the predictions. Chapter 4 describes the results from the experiment and how data has been analyzed, chapter 5 presents the discussion of the results, and finally, a summary of the findings, implications, and suggestions for further research are provided in chapter 6.

2. Literature

In this chapter of the thesis, I first present the field of Second Language Acquisition (SLA, henceforth) based on generative linguistics. Moreover, in the sub-chapters 2.1.1, and 2.1.2 I describe transfer, the Full Transfer/Full Access Theory, and the interpretability vs uninterpretability features. In section 2.2, I define the Bottleneck Hypothesis (Slabakova 2008; 2013; 2016) and discuss morphology and syntax in SLA. Furthermore, in section 2.3, I address previous studies on L2 acquisition of functional morphology, and semantics. In addition, in section 2.4, I present previous studies on the acquisition of morphology and syntax in English by ESL learners. Finally, in section 2.5, I present the linguistic conditions of interest for this study both in English and Persian.

2.1 Second Language Acquisition

Second language acquisition is “the study of how learners create a new language system with only limited exposure to a second language” (Gass, Selinker, & Polinsky, 2013, p. 1). It is the study of what learners learn from L2 and what they do not learn. Moreover, Gass et al., (2013) declared that SLA is the study of why most L2 learners do not have the same level of proficiency as they have in their L1, while some learners “achieve native-like proficiency in more than one language” (p. 1). Furthermore, Gass et al., (2013, p. 2) stated that SLA is a part of linguistic study, and its aim is to study the nature of the human mind. Likewise, Slabakova (2016) stated that the study of SLA is about the processes in the human brain considering the language architecture and how this is put together when learners acquire a second language.

Numerous researchers used the term *second language* to refer to any language acquired after L1 (e.g. Berggreen & Tenfjord 1999; Gass et al., 2013), while Rothman, Amaro and de Bot (2013) stated that languages acquired after the L1 should be discriminated since their initial states differ. Thus, the second acquired language should be considered as L2, and the third acquired language should be referred to as L3. In this thesis, I use the term *second language* to refer to learners who acquire their second language, and not their third, fourth, or fifth language, since the main focus of the current thesis is to examine L1 Persian speakers’ knowledge of L2 English functional morphology, syntax and semantics.

The BH is set within the generative linguistic framework (Chomsky 1957; 1965). Generative linguistics argues that “the linguistic competence of speakers can be described as a highly abstract unconscious grammatical system, which allows them to produce and comprehend language” (Slabakova, 2013, p. 6). Syntax, phonology and semantics are components of the unconscious system, or Universal Grammar (UG). Some properties related to syntax, semantics, and pragmatics are universal (principles) and common among all languages, while some others are language specific (Parameters) and vary among languages. Moreover, Principles of UG are transferrable from L1, while parameters that are different from the L1 need to be reset to the target value which creates difficulty in the acquisition of second language (Slabakova, 2013).

According to Chomsky (1995), UG is considered as “the theory of languages and the expressions they generate. UG is a theory of the initial state *S0* of the relevant component of the language faculty” (p. 167). Moreover, White (2003) stated that “the term *initial state* is variously used to mean the kind of unconscious linguistic knowledge that the L2 learner starts out with in advance of L2 input and/or to refer to characteristics of the earliest grammar” (p. 58). This means that learners have unconscious linguistic knowledge about their L1. Thus, in this thesis, I use White’s (2003) definition when referring to *S0*. Following Chomsky’s point of view, who declared that the linguistic competence of native speakers can be considered as an abstract and unconscious linguistic system, White (2003, p. 1) stated that “native-speaker grammars are constrained by built in universal linguistic principles, known as Universal Grammar (UG)”.

Following Selinker (1972) who coined the term *interlanguage*, White (2003) stated that the term *interlanguage* refers to non-native grammars. Additionally, White (2003) argued that interlanguage grammars are constrained by principles and parameters of UG (p. 16). In this thesis, I use White’s (2003) definition when referring to interlanguage.

According to generative linguistics, UG contains a blueprint of all the rules that a speaker will need to generate all and only acceptable sentences in a language (Slabakova 2016, p. 9). In other words, in first language acquisition, UG is the genetic endowment (Slabakova 2016, p. 6) and determines what a grammar can be like (White 2003, p.2). Moreover, Slabakova (2016), declared that language acquisition is comprehended by UG, and the process of SLA is fundamentally similar

to natural process of native language development and “the difficulties can be overcome with the exposure to rich and diverse L2 input and language practice” (p. 415).

Throughout this thesis, following Chomsky (1995), Slabakova (2016) and White (2003), I assume that both L1 and UG are involved in SLA. To exemplify, Gass (2013) and Slabakova (2016) argued that although some parts of L2 linguistic knowledge may be innate, other parts are sensitive to the influences from the L1 and the frequencies of the L2 input. In other words, SLA is constrained by UG and L1.

2.1.1 Transfer

Fries (1945), a structuralist linguist proposed Contrastive Analysis (CA) as “a pedagogical technique that focused attention on structural differences between a learner’s L1 and L2” (Foley & Flynn, 2013, p. 30). Moreover, Weinreich (1953) introduced the notions of transfer and interference in L2 acquisition. The former means the use of the L1 that leads to “correct” usage in the L2. The latter means the use of the L1 that leads to “incorrect” language use (Foley & Flynn, 2013, p. 98). Then, Fries’ student Lado (1957) assumed a broad notion of learners’ extension of the “properties of L1” to L2, and he further developed CA. Moreover, under the Contrastive Analysis Hypothesis (CAH), researchers investigated similarities and differences between the L1 and the L2. It was found that if properties of the L1 resembles properties of the L2, acquisition of the L2 can be easier, while the differences between properties of the L1 and the L2 makes the L2 acquisition harder. Thus, it was concluded that if they pay attention to the contrasts between the L1 and the L2, SLA can be eased. In sum, in the 1950s and 1960s, studies investigated mistakes made by L2 speakers and assumed all were the result of negative transfer.

In the late 1960s and early 1970s, L2 researchers paid attention to the systematic errors made by learners. Selinker (1972) was one of these researchers who introduced the term *interlanguage (IL)*. Selinker (1972) focused on the process between the L1 and the L2. Selinker (1972) found that the IL has a systematic set of rules that differs in describable ways from the Target Language (TL) rule system.

Moreover, in the 1970s and 1980s researchers examined under what conditions L1 knowledge transfers to the L2. Many studies examined surface forms (e.g. Gilbert 1983 & Zobl 1982), while others investigated the knowledge underlying the use of surface forms (e.g. Kellerman 1979).

According to Westergaard (2021), in the late 1980s and 1990s, the focus of L2 acquisition research was on defining the initial state, and various models of transfer ranging from complete to no transfer were developed: Full Transfer Full Access (Schwartz and Sprouse, 1996) which proposed complete transfer, Minimal Trees (Vainikka and Young-Scholten, 1996) which declared transfer of just lexical categories and not of functional categories (partial transfer), Weak Transfer (Eubank, 1993/94) and the Initial Hypothesis of Syntax (Platzack, 1996). In the current study, I focus on the *Full Transfer / Full Access Hypothesis*, since the BH assumes it.

Schwartz and Sprouse (1996) defined the Full Transfer / Full Access hypothesis (FT/FA) as “the initial state of L2 acquisition is the final state of L1 acquisition” (pp. 40-41). According to FT/FA hypothesis, the initial state of the L2 is the L1 plus UG for language acquisition. Moreover, when learners are exposed to L2 input, they make a copy of the L1 grammar and consider it as L2. However, if the L2 input differs from the L1, learners have to restructure the L2 grammar with exposure to L2 input. In this process, when inter-language is needed to restructure, L2 learners access UG to make their interlanguage more target-like (Schwartz and Sprouse, 1996). This process can occur immediately after exposure to the L2. Accordingly, Gass (2013) stated that “the L2 learner is predicted to use the L1 grammar as a basis but to have full access to UG in cases where the L1 is insufficient for the learning task at hand” (p. 168). To exemplify, English and Persian do not have the same word order in main clauses. Therefore, their underlying word order is not the same, as English is an SVO language, and Persian is an SOV language. This is illustrated in the sentences in (8). In other words, Persian learners of English should be exposed to the structures in which the differences in word order is seen to change their L2 grammar immediately after exposure to the structure.

(8) Persian L1: Man be madrese mi-ravam.

English L2: *I to school go

Intended: “I go to school”

However, if differences between the L1 and the L2 grammar are not illustrated in the surface representations, “the learners may assume that the two grammars are the same, and for that reason, not change their interlanguage” (White, 2000, p. 132). In other words, it is not possible to identify when the restructuring happens. Therefore, “the sooner the learners are exposed to the mismatch, the sooner they are able to acquire the English word order” (White, 2000, p. 132).

Moreover, Slabakova (2016) declared that in SLA, L1 transfer refers to the “grammatical knowledge that can be reasonably traced back to the influence of the native language” (p. 422). This means that L1 has the influence on the process of L2 acquisition. Further, Slabakova (2016) stated that “Principles transfer from UG or from L1, while parameter values transfer from the native language, at the initial stage of L2 acquisition” (p. 422).

2.1.2 Interpretable vs uninterpretable features

Slabakova (2016) presented an example that showed the way interpretable and uninterpretable features pose different issues in L2 acquisition. Example below, provides an example of interpretable and uninterpretable features.

(9) He often take-s the bus.

Agree

[3rd person, singular subject]

[Tense: present]

[Aspect: habitual]

But also

Overt Subject obligatory

Nominative Subject

Verb stays in Verbal Phrase (Slabakova, 2016, p. 182)

In the example above, interpretable features contribute to the interpretation of the sentences; they cannot be excluded from the sentence as they make changes to the interpretation of the sentence. In other words, if we change or omit them, they will change the information that is carried by the sentence. In contrast, uninterpretable features can be excluded from the sentence as they do not

make any changes to the interpretation of the sentence. They specify whether the sentence is grammatical or not. According to the sentence presented above, features of [masculine], [3rd person], and [singular] are interpretable. These features contribute to the semantic meaning of the sentence. The verb *take-s* shows both subject-verb agreement (uninterpretable feature) and present tense (interpretable features). Therefore, if we remove uninterpretable feature (subject-verb agreement) the sentence will be ungrammatical and the meaning will not change. Whereas, if we remove interpretable feature (present tense), the information cannot be conveyed in the sentence. As interpretable and uninterpretable features change across languages from language to language, "... this attribution is predicted to pose problems for L2 learners" (Slabakova, 2013, p.8).

In the current thesis, the two conditions of Agreement *-s* and Past tense *-ed* within functional morphology are predicted to be the most problematic conditions (see sections 2.2). Moreover, according to the interpretability, these two conditions are different. Past tense is an interpretable feature while Agreement is an uninterpretable feature. This means that the past tense marker *-ed* is essential to keep the meaning in a sentence, while the Agreement *-s* is not necessary to maintain the meaning in a sentence. In other words, if we omit Agreement *-s*, the sentence will be just ungrammatical and the meaning of the sentence will not change.

2.2 The Bottleneck Hypothesis

In recent years, researchers have been trying to explain and investigate which linguistic features and conditions are easy or challenging to acquire in second language. With this respect, in her textbook on second language acquisition and universal grammar, Lydia White (2003) points out two different views with reference to syntax-morphology interface: known as *morphology-before syntax* and *syntax-before-morphology* (pp. 182-184).

In some studies, it has been argued that the acquisition of overt morphology drives the acquisition of syntax (e.g. Clahsen, Penke and Parodi 1993/1994; Radford 1990; Vainikka and Young Scholten, 1994). The claim in L1 was that children had to learn the morphology in the tense domain which would trigger verb movement. In other words, children had to learn the morphology in order to realize that it triggered verb movement to that position. Therefore, the claim was morphology-before- syntax in L1.

Furthermore, researchers started examining morphology and syntax in L2. They found that in contrast to L1, there was a dissociation between verb movement and inflectional morphology and L2 learners knew where to put the verb and acquired it before verbal inflection (Clahsen 1988; Meisel 1991), but they had problems with the agreement morphology; thus in L2 acquisition it was claimed that syntax is acquired before morphology. In support of this approach, numerous studies have been carried out in child and adult L2 acquisition (see e.g. Ionin and Wexler 2002; Haznedar 2001; Lardiere 1998a, b; Li 2012; White 2003). These studies examined morphological variability in production data drawn from child and adult L2 learners, which look for the evidence of abstract syntactic knowledge associated with morphosyntactic features (White 2003, p. 188). White (2003) summarized the data of the three studies in terms of the percentage of suppliance, in obligatory contexts, of verbal inflection such as, 3sg agreement and Past tense and associated syntactic properties like overt subjects, nominative case on the subject, and verb staying in VP. Table 1 illustrates the L2 English suppliance in obligatory contexts in percentage.

Haznedar (2001) investigated a Turkish child learning L2 English. Ionin and Wexler (2002) examined twenty children acquiring L2 English with Russian as their L1, and Lardiere (1998b) looked at Patty, a Hokkien and Mandarin bilingual adult learner of English.

Table 1. L2 English: suppliance in obligatory contexts (in %)

	3sg agreement on lexical verbs	Past tense	Suppletive forms of <i>Be</i> (aux/cop)	Overt subjects	Nominative case (no raising)	V in VP
Haznedar (2001)	46.5%	25.5%	89%	99%	99.9%	-
Ionin&Wexler (2002)	22%	42%	80.5%	98%	-	100%
Lardiere (1998a,b)	4.5%	34.5%	90%	98%	100%	100%

According to the table 1, there is a dissociation between verbal inflection and various syntactic phenomena in production data. Based on the data in the table, it is apparent that the accuracy rate of verbal inflection is lower than the accuracy rate of syntactic phenomena. In other words, the accuracy rate of verbal inflection like 3sg agreement, Past tense and suppletive forms ranges from 4.5% to 90% while the accuracy rate of syntactic phenomena like overt subjects, nominative case and verb staying in VP is above 98%. Although all phenomena are all related to the same functional category (IP), the accuracy rates are higher and more consistent with syntax (Slabakova 2013, p. 10). Thus these results support the view of *syntax before morphology* arguing against the view of *morphology before syntax*.

Following White (2003) and Lardiere (1998a, b), Slabakova (2006) claimed that there is no critical period for the acquisition of semantics. This means that meaning comes for free if the functional morpho-syntactic competence is already in place. Moreover, Slabakova (2008, 2013, 2016) proposed the BH to find the answer to what is easy and what is hard to acquire in a second language. Slabakova (2013) stated that functional morphology is language specific and must be lexically learned, therefore functional morphology is the bottleneck of L2 acquisition, while syntax and semantics are easy to acquire because they are processed by the means of universal operations, and are thus transferable. Thus, according to Slabakova (2013), the knowledge about narrow syntax comes before accurate knowledge of functional morphology (p. 23) which supports the view of *syntax-before-morphology* and is one of the main predictions in the Bottleneck Hypothesis.

According to Slabakova (2016), the rationale of the Bottleneck Hypothesis is presented hereunder:

- Functional morphology is the locus of variation because it is where differences among languages are located. Thus, functional morphology is language specific and must be lexically learned.
- Without enough experience and exposure to morphology, both L2 learners and native speakers have difficulty in processing.
- Narrow syntax and meaning calculation are putatively universal.
- To acquire syntax and meaning in an L2, the learner cannot bypass the bottleneck of the functional morphology (Slabakova, 2016, p. 402).

In sum, Slabakova (2013) claimed that functional morphemes and their features are the bottleneck of SLA. Moreover, she declared that functional morphology has to be lexically learned for each individual language, while acquisition of universal syntax, semantics and pragmatics flows smoothly, i.e. they are universal (Slabakova 2006, 2008, 2013). This means that, through the knowledge of languages that have been acquired previously, the features associated with narrow syntax can be facilitated with positive transfer or access to UG, while functional morphology cannot be transferred from the previously acquired languages. In other words, the reason why acquisition of functional morphology is challenging is that it encodes all of the grammar's non-transferable formal features.

2.3 Previous research on the acquisition of morphology and Pronominal gender in L2 English

2.3.1 Felzien (2011)

Felzien (2011) investigated the English Pronominal gender in native Mandarin speaking learners. According to Felzien (2011), native speakers of Mandarin have challenges in using the L2 English nominal agreement paradigm that marks 3rd-person pronouns for gender, number, and case. Their problems in maintaining control over the use of English 3rd-person pronoun can be due to the system of personal pronouns in Mandarin, which is morphologically simpler than that of English. Mandarin Chinese is a language which lacks Pronominal gender in the oral form, and the singular pronoun *tā* is used to represent *he, she, and it*. In contrast, English has Pronominal gender and mark pronouns that carry information on number, and subjective, objective or possessive case (p. 70).

The aim of this study was to investigate “why errors within Pronominal gender sometimes occur in even the most proficient of Mandarin-English adult bilinguals” (Felzien, 2011, p. 71). More specifically, the purpose of this study was to determine whether these errors are due to the “transfer of properties of the Mandarin nominal agreement paradigm, or whether the errors are attributed to issues in lexical access or other non-transfer-related factors” (ibidem, p.71). To this end, the study employed a simple 5-minute recorded conversation a topic of which was restricted to the participants’ favorite actors/actresses, bands, movies and singers. A total of 4 undergraduate students at Eastern Michigan University participated in this study. The age of the participants ranged from 21 to 23 and they were all born in China and spoke Mandarin Chinese.

In pilot versions of the study, Felzien used two different elicitation tests, one grammaticality judgment task, and one picture-description task. However, she stated that the constrained domain conversation proved to be the most fruitful in eliciting pronoun usage as she put the participants in a discursal situation in which 3rd-person pronoun usage would become necessary to properly describe different celebrities or musicians (p.72). She transcribed a simple 5-minute recorded conversation and elicited 3rd-person English pronouns. As the study did not have a control group comprised of native speakers of other L1s (including native-learning English children), Felzien (2011) used one of the pilot studies drawing from both conversational interviews and the CHILDES database. It is worth noting that none of the L1s contained epicene pronouns and all of them marked pronouns for gender in the same way.

The results indicated that just native speakers of Mandarin accepted or produced sentences with the errors in question, no matter how proficient they were. In contrast, neither native-learning English children, nor adult native speakers whose L1 did not contain epicene pronouns accepted the sentences with errors as grammatical. Felzien (2011) argued that the reason can be due to the mappings between multiple pronominal reference situations and the single Mandarin pronoun. Further, following Jarvis’ (2000) criteria (see more in Felzien, 2011, p.77), Felzien declared that the overuse or disorganized use of English Pronominal gender by native speakers of Mandarin is due to the influence of L1 in L2 production.

Moreover, Felzien (2011) stated that if she had examined a property like surface word order, where the L1 had an SVO ordering but the L2 an SOV, and the results indicated that the learners produced

L2 sentences with SVO orderings, she could have identified the source of the error. However, in her study, Felzien found “disorganized patterns of control over gender agreement in the subject data, which appeared to be due to *ta*’s multi-way mapping, in contrast to something more straightforward, like surface word order (p. 80).

Given the above observation, the current thesis becomes interesting. Persian like Mandarin, lacks Pronominal gender. Moreover, it is different from English, since English has two personal pronouns for third person singular. Nevertheless, little is known about how speakers of Persian will perform in their acquisition of L2 English Pronominal gender. In section 2.5, I present the two languages under study.

2.3.2 Dehghani, Bagheri, Sadighi, Tayyebi (2016)

Dehghani, et al., (2016) carried out an experimental study to investigate which English grammatical features are difficult for Persian learners of English. Moreover, they intended to see whether there is any difference between the instructors’ perceptions and participants’ performances on the difficulty order of the twelve English grammar features (p. 210). These grammar features were as follows: Causative, Reported speech, Article, Conditional, Passive, Verbal, Preposition, Tag question, Conjunction, Tense, Determiner, and Relative clause. To this end, 125 undergraduate senior EFL learners from various universities and higher education institutions participated in this study. Their age ranged from 22 to 25. Furthermore, in order to investigate the second research question, 12 experienced English teachers participated in the study to express their opinions about the difficulty level of the English grammar features. In order to ensure that participants were in an intermediate level, an Oxford Placement Test (2007) was administered as a proficiency test, and a researcher-developed test of English grammar was used as the main test. They asked some experienced teachers to identify the difficulty of the given grammatical features on a Likert scale from very easy to very difficult. 5 questions were allocated to each grammatical feature, a total of 60 items.

Regarding the first question, grammatical features were split up into two groups or two halves; more difficult features include causatives, reported speech, articles, conditional sentences, passive structures, and verbals, and less difficult features include Prepositions, tag questions, conjunctions, tenses, determiners, and relative clauses. Based on the above classification, it is apparent that

tenses are in the group of less difficult features and it is not difficult for Persian learners to acquire it. The results revealed that causative with the mean score of 1.96 was the most difficult feature in the first rank and relative clause with the mean score of 3.94 was the least difficult feature.

Regarding the second question, some similarities and differences were found in the first and the second half of the Table. Causative, reported speech, and passive features were in the first half of the Table, as more difficult features, and determiner, tense, and tag question features were in the second half, as less difficult ones (p. 217). Other features had variation in the rank order. Here, expert instructors also classified “*tense*” in the less difficult category. The reason can be due to their order of presentation in the textbooks. This means that the features that were taught earlier, assumed to be learned easier and those features that were taught later, may be considered as more difficult as they have to be practiced more. In this thesis, I will investigate Past tense *-ed* to see how difficult its acquisition is, and to see whether it is the bottleneck of SLA or not.

2.4 Previous research on the acquisition of morphology and syntax in English by ESL learners

2.4.1 Slabakova and Gajdos (2008)

Slabakova and Gajdos (2008) investigated the acquisition of functional morphology among English L2 learners of German. They examined how beginning learners of German (with English as their L1) calculate the uninterpretable features of agreement, as reflected in the copula verb *sein* ‘be’ in the present tense (p. 38).

(a) 1. sg. Ich bin 1. pl. wir sind

2. sg. du bist 2. pl. ihr seid

3. sg. er/sie ist 3. pl. sie sind

To this end, 42 L2 learners of German at a US university participated in this study. Their proficiency level was identified based on the number of class hours of exposure to German instruction. 24 of them were considered as beginners as they were exposed to roughly 40 hours of German classroom instruction and 18 of them considered as intermediate learners as they were exposed to 140 hours. Additionally, Slabakova and Gajdos (2008) tested 17 native German

speakers in Germany. The main test was a written pen-and-paper task consisted of simple sentences with missing subjects and participants had to choose which subject matched with the provided sentence. Participants could choose more than one option. An example from the test is illustrated as follows:

(a) _____ bist ein guter Freund.

are a good friend

- Moritz
- du ‘you’
- die Schüler ‘the students’
- er ‘he’

They predicted that participants would make more errors in using the copula form *sind*. According to (Slabakova and Gajdos 2008):

If L2 learners are guided by the same universal feature evaluation metric as German acquiring children are, then we expect English learners of German to demonstrate evidence of overusing sind in the process of learning the target agreement morphology, and hence, making more errors with it (p. 39).

The result supported their hypothesis and they found that although the intermediate learners had longer exposure to German, they did not perform well on *sind*. Moreover, the intermediate learners demonstrated even worse accuracy than the beginners when they had to combine a DP subject with the copula (p. 41). This means that knowledge of subject-verb agreement with full DPs did not improve much. Table 2 illustrates the result of Slabakova and Gajdos (2008, p.41).

Table 2. Percentage errors in all forms of sein depending on type of subject

Type of errors	Beginners	Intermediate learners
Errors in choosing correct pronoun subjects	7.50	4.50
Errors in choosing correct DP subjects	20.18	29.80

Furthermore, they declared that the Combinatorial Variability Hypothesis explained the error rate discrepancies. This hypothesis explains intra-personal morphosyntactic variation as arising from the combinatorial mechanisms of language itself (p. 42). In sum, they asserted that there can be various sources for variable L2 morphosyntactic performance (Slabakova and Gajdos 2008, p.42). It is worth noting that the findings of Slabakova and Gajdos (2008) reveals that acquisition of functional morphology is challenging especially with sentences that have full DP subjects.

2.4.2 M. Jensen (2017)

Another study was conducted by M. Jensen (2017) with the purpose of testing functional morphology against narrow syntax. She tested Norwegian L1 speakers acquiring English as L2 by carrying out an acceptability judgement task (AJT). She proposed two research questions in order to examine whether “functional morphology is more difficult to acquire than narrow syntax and to see whether two morphologically conditions are equally difficult in L2 acquisition or not” (p. 18). To this end, she examined two functional morphemes; subject-verb agreement and Past tense *-ed* and two conditions within syntax; verb movement across an adverb in subject-initial clauses and verb movement across the subject in non-subject initial clauses. Participants of her study were 4th (9 and 10 years) and 8th graders (12 and 13 years) who went to Norwegian schools in Tromsø, where they had English instructions from 1st grade. M. Jensen (2017) used a proficiency test and a background questionnaire about their languages and age. Then, in order to gather the data about their judgement of the different conditions, an acceptability judgement task (AJT) was utilized in this study. The AJT consisted of 45 test sentences. These 45 sentences entailed 20 sentence pairs and five ungrammatical fillers. In addition, Four different types of sentences were used in AJT: “subject-initial and non-subject-initial declarative clauses with lexical verbs, subject-initial

declaratives with 3rd person singular subjects and subject-initial declaratives with the Past tense marking *-ed*" (M. Jensen, 2017, p. 26).

Findings of this study revealed that functional morphology is more difficult to acquire than narrow syntax, but two morphological conditions are not equally difficult in L2 acquisition and one of the morphological conditions was easier than one of the syntactic conditions. Participants of her study acquired functional morpheme of Past tense *-ed* easier than subject-verb agreement and verb movement in subject-initial clauses. Based on the BH, Past tense should be more challenging than narrow syntax. Therefore, the results of M. Jensen (2017) does not solely support the claim posed by the BH. In contrast, another condition of functional morphology which was subject-verb agreement was more difficult to acquire than verb movement and supports the Bottleneck Hypothesis.

M. Jensen (2017) found that there can be two possible reasons why Past tense is acquired easier than another morphological condition; subject verb agreement. These reasons can be transfer from L1 and interpretability of the conditions.

Regarding the FT/FA hypothesis (Schwartz and Sprouse 1994, 1996), the initial state of second language grammar is the final state of first language grammar. English Past tense is similar to the Norwegian Past tense as both mark it by adding suffix to the regular verbs. Therefore, participants transferred this condition from Norwegian to English. In addition, based on the Contrastive Analysis, when there are similarities between two languages, acquisition of second language will be easier. Therefore, based on both FT/FA and CA, acquiring Past tense marker is easy and the acquisition of agreement *-s* is difficult as it does not exist in Norwegian language.

Regarding interpretability conditions, Past tense marker *-ed* as an interpretable feature was acquired easily. It is worth noting that both languages of English and Norwegian have Past tense marker; while the agreement marker as an uninterpretable feature does not exist in the Norwegian language and it was acquired with more difficulty. Therefore, learners have to learn it which is challenging for them.

In sum, M. Jensen (2017) found a significant difference in difficulty between tense and agreement and different types of syntactic conditions, even though the BH at least at the outset would predict both to be the same.

2.4.3 Jensen, Slabakova, Westergaard, Lundquist (2020)

In a study conducted by Jensen et al. (2020), which is based on the data in Jensen (2016), the Bottleneck Hypothesis was tested in English as a second language of Norwegian native speakers. They proposed three research questions. The first question was to figure out whether functional morphology is more difficult than narrow syntax in L2 acquisition or not. The second question was to see whether morphology is a more persistent problem than narrow syntax or not. And the latter was to investigate which of syntactic and morphological sub-conditions are more difficult? They examined two conditions that did not match in languages of English and Norwegian: The first one included functional morphology, Subject–verb agreement, which is obligatory in the English but does not exist in Norwegian language, and another condition verb-second (V2) word order involved syntax, which is obligatory in the Norwegian, but restricted to specific contexts in English. Regarding the previous research that revealed the influence of sentence structure in the difficulty of a condition, they tested various structures of subject-verb agreement and verb movement. They predicted that if frequency and instruction are vital issues in acquiring a second language; then, Norwegian learners “at the same level of proficiency should make fewer errors with subject-verb agreement than with non-V2 syntax” (p. 10). On the contrary, if the results reveal that functional morphology is the bottleneck of acquisition, then learners should make more errors with SV agreement. In other words, identifying ungrammatical word order should be easier than identifying ungrammatical agreement. Moreover, they predicted that the participants’ ability to find ungrammatical word order should be faster than their ability to identify ungrammatical agreement. Finally, they predicted that

- a. If sentences have an auxiliary verb, non- V2 syntax is problematic. To this end they added other variables to their research design. As auxiliary verbs move in English like in questions, while lexical verbs never move, they used them in the non- subject-initial declarative clauses (see more on Jensen et al., 2020, p. 11).

b. “Long distance agreement is more challenging than local agreement” (Jensen et al., 2020, p. 13). It is worth noting that they added a prepositional phrase between the subject and the verb and increased the distance.

c. participants should make errors of over-suppliance and underuse of the –s.

They made various conditions to test SV agreement and word order. Non-subject-initial declarative main clauses with auxiliaries and lexical verbs, represented core syntax (see examples a, b). Long-distance and local agreement in present tense subject-initial declarative main clauses with singular and plural subjects, tested functional morphology (see examples c to f). Examples are as follows (Jensen et al., 2020, p. 14):

(a) Non-subject-initial declaratives with lexical verbs

- a. * Yesterday went the teacher to the shop.
- b. Yesterday the teacher went to the shop.

(b) Non-subject-initial declaratives with auxiliary verbs

- a. * Every day should the students bring their books to school.
- b. Every day the students should bring their books to school.

(c) Long-distance agreement with plural subjects

- a. * The kids with the red bike plays in the garden.
- b. The kids with the red bike play in the garden.

(d) Long-distance agreement with singular subjects

- a. * The teacher with black shoes walk to work every day.
- b. The teacher with black shoes walks to work every day.

(e) Local agreement with plural subjects

- a. * The teachers gives their students a lot of homework.
- b. The teachers give their students a lot of homework.

(f) Local agreement with singular subjects

- a. * The brown dog play with the yellow football.
- b. The brown dog plays with the yellow football.

In order to examine the above mentioned conditions, Jensen et al. (2020) utilized an acceptability judgement test. In addition, they used a proficiency test and a background questionnaire. The number of 60 participants whose age ranged from 11-12 and 15-18 participated in this study. They were divided into four proficiency groups of low intermediate, intermediate, high intermediate and advanced speakers. Then, their performance was considered both across and within each proficiency level.

Regarding the first research question, based on Jensen et al.'s (2020) predictions that relied on learnability, frequency, and instruction, they asserted that as participants are provided by comprehensible input, they can accept more grammatical sentences. The findings showed that participants made errors with ungrammatical agreement more than ungrammatical word order. It can be implied that subject-verb agreement is difficult for all of the participants in all proficiency groups. Consequently, Subject-verb agreement is more difficult than core syntax. They also assessed participants' performance and found that there is a development with both word order and agreement conditions. On the other hand, they realized that the participants identified ungrammatical word order more than ungrammatical agreement. In other words, as participants level of proficiency increased, they made more correct judgements with grammatical sentences which means that Bottleneck hypothesis is supported and "L2 learners improve their accuracy for verb movement faster than for agreement" (p. 18).

According to the second research question, they found that functional morphology (Subject-verb agreement in their study) is a more persistent problem than core syntax (verb movement in their study).

Regarding the third research question, they found that local agreement with singular subjects is attested to be the easiest agreement sub-condition. Moreover, they found a pattern specific to Norwegian L2 learners of English that was not predicted by the Bottleneck Hypothesis. Furthermore, their findings indicated that long-distance agreement with singular subjects and local

agreement with plural subjects, seem to be developing in tandem (p. 20), and long-distance agreement with plural subjects is the hardest sub-condition. Therefore, plural subjects make more problems for learners than singular ones, and learners struggle with ignoring “an overt morpheme next to a singular noun (e.g. *The kids with the red bike **plays** in the garden*) than a null one next to a plural noun (e.g. *The teacher with black shoes **walk** to work every day*) (p. 21). The preference of using *-s* was seen in plural subjects in local agreement. Based on syntactic conditions, it was realized that sentences with lexical verbs were less problematic than sentences with auxiliary verbs. Lexical verbs stay in verb phrase, while auxiliaries move in specific contexts; hence, in non-subject- initial declaratives, learners will not pay more attention to ungrammatical auxiliary verb movement which can provide conflicting information for learners. In sum, the findings in Jensen et al. (2020) lend tentative support to the Bottleneck Hypothesis.

2.5 Conditions

The aim of this study is to test the Bottleneck Hypothesis. The BH claims that functional morphology is more difficult to acquire than narrow syntax and other linguistics domains. To this end, in order to test the bottleneck hypothesis, Subject-verb agreement and Past tense *-ed* were chosen to test functional morphology, and Adj-N word order and Pronominal gender were chosen to test syntax and semantics respectively. In the following sections, I explain the mismatches between English and Persian with respect to conditions of: Subject-verb agreement, Past tense *-ed*, Adj-N word order and Pronominal gender.

2.5.1 Subject-verb agreement

Agreement is one of the most significant grammatical properties in most languages (Vigliocco, Butterworth, Garrett, 1996). Many languages demonstrate agreements of one sort or another; as an example, special elements in a sentence need to agree in terms of a specific feature, such as number, gender, and/or animacy. Typically, one element controls agreement on a later-occurring one (Nicol, Forster, Veres, 1997, p. 569). English has overt agreement morphology, which primarily means that the verb and the subject in a sentence must agree in person and number.

Moreover, verb in present tense receives the suffix –s, if the subject is third-person singular¹. And if the subject is not third-person singular, verb appears in its bare form (see example 10).

(10) Jack goes to school (Third-person singular)

They go to school (Third-person plural)

I go to school (First-person singular)

Persian belongs to the Indo-Iranian subdivision of the Indo-European languages. It is the official language of Iran which is also spoken in Afghanistan and Tajikistan (Family and Allen, 2015). Although there are many dialects in Iran, Modern Persian is spoken in most of the cities (Payesteh, 2015) and it is the medium of instruction at schools. Persian is a pro-drop language in which person and number agree with the referent on the verb. Although the use of subject is optional, use of personal suffixes on the verb are necessary in both formal and informal language. As verb inflections are used differently in formal and informal language, this study focuses on the formal language. The verb inflection and agreement are introduced and exemplified in the next section.

2.5.2 Verb inflection in English and Persian

According to Carter and McCarthy (2006), English has overt agreement morphology, which means that all verbs agree with the subject in person and number. Only third person singular requires singular verb ending –s in simple present tense; otherwise, other singular and plural subjects have no verb endings (Johansson, 2018), see example (11).

(11) a. She sleep-s

3SG verb-verb ending

b. The lion roars

3SG verb- verb ending

c. The lions roar

3PL verb

¹ There are two exceptions that do not take the agreement –s (3SG -s), the verb *be* and modal auxiliaries. “(1) the verb *be* has three forms in the present tense – *am, are, is* - and two in the Past tense – *was, were*; and (2) the modal auxiliaries have no *s*-form (*I must leave – he must leave*)” (Dypedahl et.al, 2012, p.103)

From the examples above, it can be understood that in English, whenever the subject is not third person singular, the verb is used in its uninflected form in present tense sentences, which means that a verb is finite with a zero morpheme (Johansson, 2018).

Moreover, unlike Persian, English is not a pro-drop language and personal pronouns are obligatory. Table 3 illustrates the verb conjugation with personal pronouns in English.

Table 3. Verb conjugation in English

Number	1st person	2nd person	3rd person
Singular	I sleep	You sleep	He/she sleep -s
Plural	We sleep	You sleep	They sleep

In Persian, verbs are comprised of a root and inflectional morphemes. Roots have two types, past and present. Moreover, the inflectional morphemes consist of numerous patterns of participle, voice (two terms: active and passive), infinitive (adding -an to the Past tense verb root), tense (three terms: past, present, and future), mood (three terms: indicative, subjunctive, and imperative), aspect (four terms: simple/continuous, perfective/imperfective), and person plus number (six terms: three persons each singular or plural) (Haghshenas, 1996). According to Natel-Khanlari (1972), among these patterns, some of them like tense, mood and aspect work together. Therefore, totally there are nine grammatical tenses in Persian. Five of them are in the past (simple past, past continuous, past perfect, present perfect, and past subjunctive), three of them are in the present (present indicative, present subjunctive, and present continuous) and one of them is in the future.

The past and non-past stems of some Persian verbs are represented in the following table. This table (4) is taken from Farahani (1990, p. 19).

Table 4. The past and non-past stems

	Infinitive	Past stem	Non-past stem	Gloss
1	Shekaf.t.æn	Shekaf.t	Shekaf	To unsew
2	Xan.d.æn	Xan.d	Xan	To read
3	Xænd.id.æn	Xænd.id	Xænd	To smile
4	Ræf.t.æn	Ræf.t	Ræv	To go
5	Amæ.d.æn	Amæ.d	A	To come
6	di.d.æn	di.d	Bin	To see

According to table 4, it is clear that there is a relationship between past and non-past stems. In the examples of 1 to 3, we see regular verbs. As is apparent, the past and non-past stem of the verbs are similar and the only difference is in their Past tense morpheme. (In the first example, it is shown as /t/, in the second example it is shown as /d/ and in the third one it is represented as /id/). On the other hand, we see irregular verbs in the examples 4 to 6. According to the table, there is no similarity between the past and non-past stem of the verbs. According to Farahani (1990), in the examples of 4 to 6, if we omit Past tense morphemes, the phonological similarity between the past and non-past stem decreases (p. 19). Although there is a formal affinity between the past and non-past stems in examples of 4 and 5, there is no phonological similarity between the past and non-past stems in the last example (6).

To recap, in Persian, each verb has two stems, past and non-past (Natel-Khanlari, 1976). All the forms which refer to the past time are constructed from the past stem, and the form which refers to the present or future time is derived from the non-past stem (Natel-Khanlari, 1976, p. 27). Tables 5, and 6 illustrate the difference between suffixes added to the past and non-past roots.

Table 5. Suffixes added to the past stem

Number	1st Person	2nd person	3rd person
Singular	-æm	-i	- Ø
Plural	-im	-id	-ænd

Table 6. Suffixes added to the non-past root

Number	1st Person	2nd person	3rd person
Singular	-æm	-i	- æd
Plural	-im	-id	-ænd

Based on the tables above, verb endings are similar in the past and non-Past tense, except for the third-person singular. In the Past tense, the third person singular is – Ø, while it is – æd in the non-Past tense.

As Persian is a pro-drop language, verbs play a vital role in sentences. In this language, verbs are marked for both plural and singular (Lotfi, 2006, p. 125). Subject specifies the selection of the right suffix, and third person singular is considered as the bare form. Table 7, illustrates Persian verb inflections in the present tense.

Table 7. Verb inflection for "xabidan" (to sleep) (Forms between parentheses are informal variants)

Number	1st person	2nd person	3rd person
Singular	Mi (tense marker)- xab-æm "I sleep"	Mi(tense marker)- xab -i "you sleep "	Mi (tense marker)- xab -æd "s/he sleeps "
Plural	Mi (tense marker)- xab -im "we sleep "	Mi (tense marker)- xab -id (/in) "you sleep "	Mi (tense marker)- xab -ænd (/an) "they sleep "

Both singular and plural verbs are indicated in the above table. Moreover, the present tense is created by adding the prefix (mi-) to the present stem of the verb.

To reiterate, table 8 demonstrates the full conjugation endings of verbs in both present and Past tenses.

Table 8. Verb endings in Persian

Person	Formal verb ending
1 SG	/-æm/
2 SG	/-i/
3SG	/-æd/, Ø
1 PL	/-im/
2PL	/-id/
3PL	/-ænd/

Sentences containing third-person singular are exemplified in (12)-(13):

(12) Sarah lebas mi-xar- æd.

3SG clothes buys

“Sarah buys clothes”.

(13) Faghr hanooz dar bazi keshvarha hast-Ø.

Poverty still in some countries exists.

“Poverty still exists in some countries”.

It is worthy to note that if there are plural animate subjects, the verb will be marked as plural, and if there are plural inanimate subjects, the verb can be marked as both singular and plural (Lotfi, 2006). Examples are provided as follows:

(14) Pesara raftan madrese. Boys go- PAST-PL school.

“The boys went to school”.

(15) a. Lebasha bad forush raft. Clothes bad sale go-PAST-SG

“The clothes sold badly”.

b. Lebasha bad forush raft-ænd. Clothes bad sale go-PAST-PL

“The clothes sold badly”.

2.5.3 Past tense *-ed* in English and Persian

In English, Past tense has two forms, regular (e.g., kick/kicked; play/played) and irregular (e.g., keep/kept; steal/stole). In the former, the suffix *-ed* is added to the stem of the verb, in the latter, there is not a specific pattern and irregular verbs should be memorized. Then, the focus of this thesis is on regular Past tense verbs. Table 9 illustrates verb inflection of the Past tense in English grammar.

Table 9. Verb inflection for the verb “walk” in English (Past tense)

Number	1st Person	2 nd person	3 rd person
Singular	I walked	You walked	She/he walked
Plural	We walked	You walked	They walked

In Persian, simple past is created by deleting the infinitive suffix /æɪn/, and adding personal endings to the stem. Moreover, third-person singular has no personal ending and it is just the past stem.

Table 10 illustrates conjugations of the simple Past tense of the infinitive /raftæn/ (to go), and the suffix added to the stem indicates the person.

Table 10. Verb inflection for the Past tense of "raftan" (to go), (Lotfi, 2006, p. 125)

Number	1st person	2nd person	3rd person
Singular	Raft- Ø - æm "I went"	raft- Ø -i "you went"	Raft- Ø- Ø "she/he went"
Plural	Raft- Ø -im "we went"	raft- Ø -id "you went"	raft- Ø -ænd "they went"

In summary, conditions of subject-verb agreement and Past tense –ed were represented as functional morphology in both English and Persian. In the case of subject-verb agreement, both English and Persian have affixes and represent the number and tense. It is worth noting that Persian has two morphemes that represent the third-person singular (see table 8). Moreover, Persian is richer in morphology than English. In the following section, two conditions are selected to test syntax-semantics conditions in the Bottleneck Hypothesis, adjective-noun word order and Pronominal gender.

2.5.4 Adjective-noun word order

In English, adjectives precede the noun. This means that the basic order is Adj+N. (see example 16).

(16) Beautiful flower

(Adj) (N)

However, there are a few exceptions that adjectives can follow the noun; see (17a, b).

(17a) The people present

(N) (Adj)

(17b) All matters financial

(N) (Adj)

In Persian, adjectives follow a noun, and a short vowel /e/ that is called *ezafe* in Persian comes after the noun, see examples (18a, b).

(18a) gol(N)-e ziba(Adj)

Flower beautiful

“beautiful flower”

(18b) An dokhtar(N)-e (Ez) ziba(Adj)

A girl-e (Ez) beautiful

“A beautiful girl”

Furthermore, adjectives in a subdivision of compound adjectives “adjective phrases” can either precede or follow a noun; see (19a, b).

(19a) bozorg(Adj) mard (N)

great man

“Great man”

(19b) sær (N) bolænd (Adj)

Head tall

“prideful”

In general, the Adj-N word order patterns between these two languages show contrast in relation to the placement of the adjective, i.e., English has pronominal adjectives and Persian has postnominal adjectives.

2.5.5 Pronominal gender

English has Pronominal gender and only third person pronouns show gender distinctions (he, she, it). In English, there are two subject pronouns for third person singular *he* and *she*. See examples (20a, b).

(20a) *He* has a bag (N)

(20b) *She* has a bag (N)

In contrast, Persian has no Pronominal gender. This means that there is just one form *U* for third person singular. See example (21).

(21) U ketâb dêræd.

He/She book has

“He/She has a book”

Table 11. The conjugation of personal pronouns in both Persian and English.

Number	Singular	Plural
First Person	Mæn “I”	Mâ “We”
Second Person	To “You”	Shomâ “You”
Third Person	U “He/She/It”	Eishân “They”

In sum, the reason I chose to analyze Pronominal gender is that Persian does not have this category. English has two subject pronouns for third person singular, while Persian has just one subject pronoun *U* for third person singular.

3 Research questions and Methodology

In the following section, I describe the research questions, hypothesis and predictions for the current study. Moreover, I present the methods and procedures used in this study. In section 3.1, I present the research questions that the current study is aiming to find answers to. In section 3.2, I describe the hypothesis and predictions based on the Bottleneck Hypothesis and the previous research. Finally, in section 3.3, I present methodology.

3.1 Research questions

The study addresses the following main research questions:

1. Do Persian learners of English have more difficulty in acquiring functional morphology compared to syntax and semantics?
2. Is English functional morphology a more persistent problem than its syntax and semantics for L1 Persian speakers?
3. Are the two morphological conditions equally difficult in L2 acquisition for L1 Persian speakers?
4. Are the two syntax-semantics conditions in English equally difficult in L2 acquisition by L1 Persian?

Research question 1 and 2 are raised based on the predictions of the Bottleneck Hypothesis that functional morphology is more difficult to acquire than syntax and semantics in L2 acquisition (see section 2.2). Research question 3 is also raised to test whether the two morphological conditions of Subject-verb agreement and Past tense –ed have the same level of difficulty. The reason why research question 3 is raised is that the two morphological conditions behave differently. Finally, research question 4 is raised to test whether the two syntax-semantics conditions of adjective-noun word order and Pronominal gender are equally difficult to acquire by L1 Persian speakers. Research question 4 is also included as the two conditions within syntax and semantics behave differently. Overall, this study aims to investigate whether there is a hierarchy of difficulty within morphological and syntax-semantics in learning English by L1 Persian speakers.

3.2 Hypothesis and Predictions

According to the Bottleneck Hypothesis and the previous research (see sections 2.2, 2.3 and 2.4), acquisition of functional morphology is more difficult than syntax and semantics in L2 acquisition. Accordingly, the current thesis hypothesized that for Persian L1 speakers acquiring English as their L2, functional morphology is harder to acquire compared to syntax and semantics. Subject-verb agreement and the Past tense *-ed* represent functional morphology, and Adj-N word order and Pronominal gender represent syntax and semantics respectively.

Prediction 1: Based on the BH, Persian learners of English have more difficulty acquiring functional morphology compared to syntax and semantics in English.

Prediction 2: Based on the BH, functional morphology is a more persistent problem than syntax and semantics for L1 Persian L2 English learners.

Prediction 3: Based on the previous research, the two morphological conditions in English are not equally difficult for L1 Persian speakers.

Prediction 4: Based on the previous research, the two syntax-semantics conditions in English are not equally difficult in L2 acquisition for L1 Persian speakers.

Prediction 1 and 2 build upon the major claim of the BH that functional morphology is more difficult to acquire than syntax and semantics, and knowledge of syntax comes before knowledge of functional morphology (Slabakova 2013, p. 23). In other words, knowledge of Adjective-N word order and Pronominal gender seem to have fallen in place before accurate knowledge of Subject-verb agreement and Past tense *-ed*. Thus, both morphological conditions of Subject-verb agreement and Past tense *-ed* should be more problematic than two syntax-semantics conditions of Adjective-N word order and Pronominal gender.

Prediction 3 is based on the findings from Dehghani et al. (2016) and M. Jensen (2017). Dehghani et al (2016) examined 12 grammatical features including: Causatives, Reported speech, Articles, Conditional sentences, Passives, Verbals, Prepositions, Tag questions, Conjunctions, Tenses, Determiners, and Relative clauses. The findings of Dehghani et al (2016) indicated that tense is in the classification of less difficult features, thus it is not difficult to acquire by Persian learners of English. Moreover, the findings of M. Jensen (2017) indicated that Past tense *-ed* is easier to acquire than both Subject-verb agreement and one of the syntactic constructions. Therefore, it is

predicted that the two morphological conditions are not equally difficult to acquire for Persian speakers learning English.

Regarding prediction 4, due to the differences between Adj-N word order and Pronominal gender, as discussed in sections 2.5.4 and 2.5.5, they may not be equally difficult to acquire for L1 Persian speakers. Moreover, Felzien (2011) investigated Pronominal gender on Mandarin learners of L2 English and argued that acquisition of Pronominal gender for learners whose L1 lacks Pronominal gender is difficult. Therefore, it is predicted that Persian speakers may find Pronominal gender difficult due to the lack of this grammatical category in their L1s.

Furthermore, based on the BH, both of the syntax-semantics conditions are expected to be easier than both of the morphological conditions. In sum, research question 3 and 4 address the differences in difficulty between both conditions within functional morphology and both conditions within syntax and semantics in Persian speakers learning English.

3.3 Methodology

The methodology in the current study is inspired by M. Jensen's (2017) and Jensen et al.'s (2020) studies. These two studies aimed to test the Bottleneck Hypothesis on the acquisition of morphology and syntax in Norwegian speakers learning English as L2. In addition to M. Jensen's (2017) and Jensen et al.'s (2020) conditions which were within morphology and syntax, I added another condition within semantics to test the morphological conditions against other domains than narrow syntax. Thus the present study is different as it investigates functional morphology in direct comparison to syntax and semantics. Moreover, this study includes an on-line experimental technique, viz. a timed Acceptability Judgement Task (AJT), which collects data about the participants' judgement of the various conditions within a limited time frame. Section 3.4 presents the pilot study which was carried out prior to the main test. Section 3.5 discusses the participants in the present study. Section 3.6 discusses the general proficiency test and a background questionnaire regarding the participants' age and language use. Section 3.7 presents the main experiment which is a timed AJT. The timed AJT is discussed in detail in section 3.7.1.

3.4 The pilot study

Prior to the main experiment, I conducted a pilot study to test the format and content of the AJT. Seven participants with the age range of 9 to 12 years took part in the piloting. They were all students at non-governmental schools and acquired Persian as L1 and English as L2. Moreover, I carried out the pilot study to see whether the participants understood how to do the experiment and to find out whether the test was too easy or too difficult for them. Furthermore, I wanted to check the time for each sentence. I wanted to ensure that the participants had enough time to make a judgment on grammaticality of each sentence, or if they should be given more or less time. Therefore, I set the time for each sentence at 15 seconds. In addition, sentences were randomized in order to ensure that a pair of grammatical/ungrammatical sentences do not follow each other from one page to the next. After conducting the pilot study, I discussed the test with the participants. All participants understood how to carry out the experiment and reported no errors concerning the layout, and the test sentences. Moreover, the participants found the amount of time spent on each sentence to be appropriate. Thus, no changes were made to the AJT after the pilot study. It is worth noting that two English native speakers judged and confirmed the AJT based on its wording. They checked whether the test items are related to the conditions I aimed to examine

or not. Moreover, the background questionnaire and the proficiency test were conducted in the pilot study to ensure that they were understandable for the participants' level of English. After they completed the test, no one reported any difficulty with the background questionnaire. However, based on the comments from the participants, I had to make some minor changes in the proficiency test.

One of the changes that was made concerned the vocabulary. The proficiency test included a sentence with an unfamiliar word. Therefore, I decided to change it to make the content more familiar to the participants (see section 3.6). Example (12) illustrates the sentence that was changed.

(12) Change in the Oxford Proficiency Test

7. Places near the *Equator* have _____ weather even in the cold season.
a. a warm b. the warm c. warm

The participants reported difficulty with the word *Equator*, thus I changed it with a country that is located near the Equator to make it more familiar to the participants. Thus, I replaced the word *Brazil* with *Equator*, and the new sentence is as follows:

7. Places near *Brazil* have _____ weather even in the cold season.

Another change that was made in the proficiency test was in regards to some sentences concerning the history of airplanes and the life of the famous boxer Muhamad Ali which could be unfamiliar to the participants due to their young age. Thus I added the information in Persian in order to avoid any confusion. Prior to the passage about airplanes, some information about airplanes was added, and prior to the passage about Muhammad Ali, some information about him was added. None of the participants reported any difficulties with the layout of the proficiency test, and the layout seemed familiar to them. The pilot study showed that it seems that the participants seemed to have difficulty in subject-verb agreement (see appendix 1).

3.5 The participants

A total of 252 students in two different age groups (10 and 12 years old) participated in this study. The younger students attended 4th grade in primary school in Iran (n= 129) and the older students were in their last (n=123) year of schooling (6th grade). All participants were native speakers of

Persian, with Persian as their native language and English as their L2. In Iran, there are two types of schools, governmental and non-governmental. In governmental schools, students are introduced to English as a second language in their first year of upper secondary school (7th grade), while in non-governmental schools (private schools), students have English as a subject from the first year of primary school (1st grade) and they attend 108 hours in the English subject per year, in which the teaching hours are presented in 90-minutes. In the current study, the focus is on students who go to non-governmental schools. I contacted the schools and distributed consent forms and information sheets to get permission to conduct the research (see appendix 2). I was given the opportunity to attend some classes to ask the students to participate in the experiment during school hours.

According to Norwegian Centre for Research Data (NSD), the participants who are under the age of 15, need their parents' approval in order to participate in the study. In the current study, the participants are 4th and 6th graders, which means that they are between 10 years old and 12 years old. Thus, they had to have their parents' approval to participate. Participants were informed about the test and each participant was given the information sheet and the consent form to be signed by their parents (see appendix 3). The letters were handed back to me at the school before conducting the experiment.

As this study is focused only on Persian L1 speakers learning English as their L2, multilinguals or speakers who did not have Persian as their native language were not included in the dataset². Therefore, 23 participants were excluded, resulting in a total of 252 speakers in the dataset, of which 129 were at 4th grade and 123 were at 6th grade. Table 12 indicates demographic information regarding the participants in the present study.

²There exist numerous ethnic groups in Iran living in different parts of the country such as Azeri (Turks), Kurds, Lors, and Baluchis, whose L1 is not Persian (Sharifian, 2007). Therefore, the focus of this study is on the learners that acquired Persian as their L1.

Table 12. Demographic information regarding the participants in the present study

	Age		Sex	
	10 years old	12 years old	Female	Male
Number	129 (51.2%)	123 (48.8%)	243 (96.4%)	9 (3.6%)
Total	252		252	

According to table 12, 129 (51.2%) of the participants were 10 years old and 123 (48.8%) were 12 years old. Moreover, 243 (96.4%) of the participants were female and 9 (3.6%) were male.

3.6 The proficiency test and the background questionnaire

A proficiency test was used in this study to see whether the participants' general proficiency had any correlation with the conditions I wanted to test and to see whether the participants of the study should be in the same age groups or they should be divided. That is, although the age of the participants indicates their general proficiency in English, no one can ensure that the proficiency of each participant correlates with the expected level of proficiency. To this end, I used a subset of the standardized Oxford proficiency test with 29 questions (see appendix 4). This test has commonly been used (e.g., Jensen, 2016; M. Jensen, 2017; Slabakova & Garcia Mayo, 2015). The standardized Oxford proficiency test is a multiple-choice task, i.e. sentences with a blank space and three options to choose from. All blanks should have been filled out, the participants have to choose one of the three choices to make the sentence acceptable, and they score one point for each correct answer. As illustrated in examples (13) and (14), the proficiency test has two parts, and in the second part, the sentences are from a continuous story.

(13) Example: Multiple choice with individual sentences

1. Water _____ at a temperature of 100° C.
 a. is to boil b. is boiling c. boils

(14) Example: Multiple choice with a continuous story

11. Mohammed Ali _____ his first world title fight in 1960.
 a. has won b. won c. is winning

12. After he _____ an Olympic gold medal, he became a professional boxer.
- a. had won b. have won c. was winning

Some changes were made to the proficiency test compared to how it was used in Jensen et al. (2020) and M. Jensen (2017). One change concerned the length of the test. In Jensen et al.'s study (2020), the proficiency test had 40 questions, while in the current study the proficiency test was shortened and it contained 29 questions as the participants were young and it could be tiring for them to fill out the proficiency test with 40 questions. Moreover, the number of the questions was the same with the proficiency test that was used in M. Jensen (2017). However, M. Jensen (2017) made some changes regarding the lexical content, while I just made one change (see section 3.4). Therefore, the second change that was made concerned the lexical content in one of the sentences. After carrying out the pilot, I discussed the test with the participants. Based on the participants' feedback in the pilot study, one lexical item was unfamiliar to them, therefore, I changed it to make the lexical item more familiar and understandable without changing the grammatical structure of the sentence. Then, the last change that was made was adding some background information to the second part of the test. In order to avoid any misunderstandings or confusion, the written information were added in Persian.

A background questionnaire was added to the main test in order to see that participants acquired Persian as their L1 and English as their L2, and also to associate each answer to the correct age group. Thus, the participants replied on how old they were, which class they were in, which languages they spoke at home, with which language they spoke to their family members, and friends. They were also asked how many years they have been exposed to English (see appendix 5). In order to avoid any confusion about these questions, the background questionnaire was prepared in Persian.

3.7 The main experiment

In the following sections, I describe a timed acceptability judgement task (AJT) in section 3.7.1. Moreover, I discuss the test sentences in section 3.7.2., and the procedures of data collection in section 3.7.3.

3.7.1 The acceptability judgement task

The main part of the experiment was a timed acceptability judgement task (see appendix 6). The timed AJT was an electronic test, carried out through the web based survey program *Gorilla*. *Gorilla* is an online experiment builder that hosts behavioral experiments or tasks for use on computers, tablets or phones, where the participants can take part in experiments anonymously. Moreover, on *Gorilla*, all participants can complete the test simultaneously, which makes it possible to gather data from several participants at the same time.

The AJT is one of the quantitative research methods which is also referred to as *grammaticality judgement task*. “Although certain scholars have argued that acceptability and grammaticality are two separable notions that refer to different concepts, there are contexts in which the two terms are used interchangeably” (Evelina & Westergaard, 2020, p. 1). According to Evelina and Westergaard (2020), these two terms are not similar: some sentences are acceptable while they are not grammatical (ungrammatical), and some sentences are unacceptable, while they are grammatical. With respect to grammaticality, a sentence follows the rules of grammar in a language. With regard to acceptability, “the focus moves from the stimulus to a speaker’s perception” (ibidem, p. 2). To exemplify, a sentence in (13) is grammatical, while it is unacceptable. And a sentence in (14) is ungrammatical but it is acceptable.

(13) Colorless green ideas sleep furiously. (Chomsky, 1957 as cited in Evelina and Westergaard (2020, p. 4)

(14) Fewer people have been to Tromsø than I have.

Following Evelina and Westergaard (2020), I choose to use the term acceptability judgement task in this study. Moreover, according to Ionin and Zyzik (2014), an AJT is a task in which the participants are asked to judge the sentences with regard to its grammatical acceptability” (p. 38). Furthermore, Ionin and Zyzik (2014) stated that the sentences should not belong to the same context and they have to be presented in isolation. In addition, they declared that the sentences should be presented one sentence at a time.

In the current study, the timed AJT was presented with 15 seconds for each sentence. The sentences were presented one sentence at a time, and they were randomized. The participants were asked to

judge the sentences on a 4-point Likert scale, as well as the option “I do not know”. Rating scales were numerically coded. 1 means very bad, and 4 means very good. Due to the participants’ young age, emoticons were added to the options on a Likert scale to make it interesting and understandable. Moreover, the information was given in Persian orally and the participants judged the sentences from very good to very bad.

3.7.2 Sentences

The AJT contained 20 sentence pairs and ten ungrammatical fillers, which means that the AJT contained a total of 50 test sentences (see appendix 7). There were four conditions: Subject-verb agreement, Past tense *-ed*, Adj-N word order, and Pronominal gender. In addition, there were ten ungrammatical fillers. I added the ungrammatical fillers for two reasons. One was to distract the participants’ attention from understanding what conditions they were being tested in. Another reason was to give motivation to the participants especially the youngest ones to recognize ungrammatical sentences relatively easily. Moreover, each condition had five sentence pairs. This means that the participants had to judge ten sentences from which five were grammatical and the other five were ungrammatical.

In order to ensure that the sentence pairs did not follow one another from one page to the next and to avoid comparison of the sentences, the sentence pairs and ungrammatical fillers were randomized.

Moreover, there were some common features about all the sentences. According to Dabrowska (2010: 5),

... [R]esearchers must take care to either neutralize [extra-grammatical factors] (by balancing stimuli for length, lexical content, processing difficulty, plausibility, etc., whenever possible) or to control for them (by setting up control conditions which will allow them to assess the extent to which the confounding factors affect speakers’ judgments.

Accordingly, I tried to make the sentences with the same length and frequent vocabulary, as the acceptability of a sentence may be influenced by these factors (Dabrowska, 2010).

To do this, all the sentences consisted of 10 syllables. Secondly, the lexical words used when constructing the sentences were taken from the books *Family and friends 3 and 4*, as these are the books used in English education in most private schools for 10- to 12-year-olds. Therefore, the words were familiar to the participants and they could understand the context well.

Regarding Subject-verb agreement, the sentences contained lexical verbs which received the suffix *-s* when the subject was 3rd person singular. These are exemplified in (15). (All of the sentences are listed in appendix 7)

(15) *Subject-verb agreement*

- a. David **reads** a story book every week.
- b. *David **read** a story book every week.

With respect to the Past tense *-ed*, the sentences contained lexical verbs that were all in the regular past form, i.e. there were no Past tense irregular verbs, and the subjects were all plural in order to avoid judgments based on Subject-verb agreement. These are exemplified in (16).

(16) *Past tense*

- a. Sarah and Emma **fixed** a car last month.
- b. * Sarah and Emma **fix** a car last month.

Regarding the adjective-noun word order, the sentences contained plural *to be* verb “*are*”, and the nouns were plural in order to avoid any mismatches with the Past tense *-ed*, and the Subject-verb agreement respectively. These are exemplified in (17).

(17) *Adjective-noun word order*

- a. Those boys with **heavy suitcases** are tired.
- b. * Those boys with **suitcases heavy** are tired.

The reason that I chose Adj-N word order to test syntax is because of the mismatch in English and Persian with respect to the word order. In English, adjectives are prenominal, while in Persian, they are post nominal (see chapter 2, section 2.5.4).

Regarding the Pronominal gender of personal pronouns, all sentences contained third person singular subjects, and in order to avoid any confounding factor with Subject-verb agreement and Past tense *-ed*, all lexical verbs were in the irregular form. These are exemplified in (18).

(18) *Pronominal gender*

- a. Mina bought a house and **she** was happy.
- b. * Mina bought a house and **he** was happy.

The main reason why subjective pronoun was used to test semantics is based on the fact that there is no Pronominal gender in Persian, i.e. there is just one equivalent for *he* and *she*. In contrast, English has Pronominal gender, which is expressed by the pronouns *he* and *she*

Lastly, there were 10 ungrammatical fillers in the task. As exemplified in (19), these sentences contained verb second word order (V2) which is unacceptable neither in English nor in Persian.

(19) *Ungrammatical filler*

At a hotel **took** Emily a bath.

If the participants judge the ungrammatical fillers as ungrammatical, it may indicate that they understand the task and confirms that the test and its results are reliable.

3.7.3 Procedure

The web based survey program *Gorilla* was used to carry out the data collection procedures. It was an online experiment including the AJT, the background questionnaire, and the proficiency test. The main experiment took place during school hours, and the participants spent approximately 30 minutes to complete the experiment. Before the test started, participants were given instructions about what they were asked to do. This information was given in Persian orally. Then I asked them whether they have any questions regarding the experiment. They declared that they felt confident about the experiment. Moreover, by clicking on the link, the written information about the experiment was shown once more in Persian, then on the next page a 33 second video was presented to them about the AJT. After watching the video, they practiced a sentence and then they

were informed that by clicking on the “next” button, they would start the main test (see appendix 6). All the information was given in Persian to ensure that the participants understood what to do.

The first part of the experiment was the timed AJT. In this test, the participants saw one sentence on a page, and they were asked to rank it on a Likert scale from very good to very bad within 15 seconds. It was obligatory to rank each sentence and they could not go back to the previous pages and change their judgements. As discussed in section 3.7.2, every grammatical sentence had an ungrammatical equivalent. By providing one sentence on each page and setting time to the AJT, the participants could not go backwards, and they were unable to compare the sentences. Therefore, they had to judge every sentence individually. Example (20) shows how the sentences were presented to the participants.

(20)

Joe and Max answer two questions last Tuesday.



Very good 😊 Good 😊 Bad 😞 Very bad 😞

I do not know

As noted earlier, the test was randomized. The purpose of randomizing was to make sure that the sentences in a pair did not follow one another from one page to the next. After completing the AJT, the participants pressed the “next” button to proceed to the second part of the experiment, which was the background questionnaire. In this part, the participants answered questions about their age, grade and linguistic background (see appendix 5). In order to avoid any misunderstandings, the

background questionnaire was in Persian. Finally, after finishing the background questionnaire, they pressed the “next” button to move on to the last part of the experiment, which was the proficiency test. As mentioned, this test was a subset of a standardized Oxford Proficiency test with 29 questions. In this test, the participants had to choose one of the three options to make the sentence acceptable and it was obligatory to answer all the questions (see appendix 4).

4 Results

The data were retrieved from Gorilla and analyzed in R, using the *lme4* package (Bates et al., 2015). The main aim of the study is to see whether there are statistically significant differences between the ways in which Subject-verb agreement, Past tense, Adj-N word order and Pronominal gender are judged in the timed acceptability judgement task, and also, if the results support the Bottleneck hypothesis as discussed in chapter 3. In the analysis, the dependent variable is accuracy, and the independent variables are age, proficiency scores, conditions (the four linguistic properties), the interaction between conditions and age, and the interaction between conditions and proficiency scores. Furthermore, I analyzed accuracy by using a mixed effects logistic model.

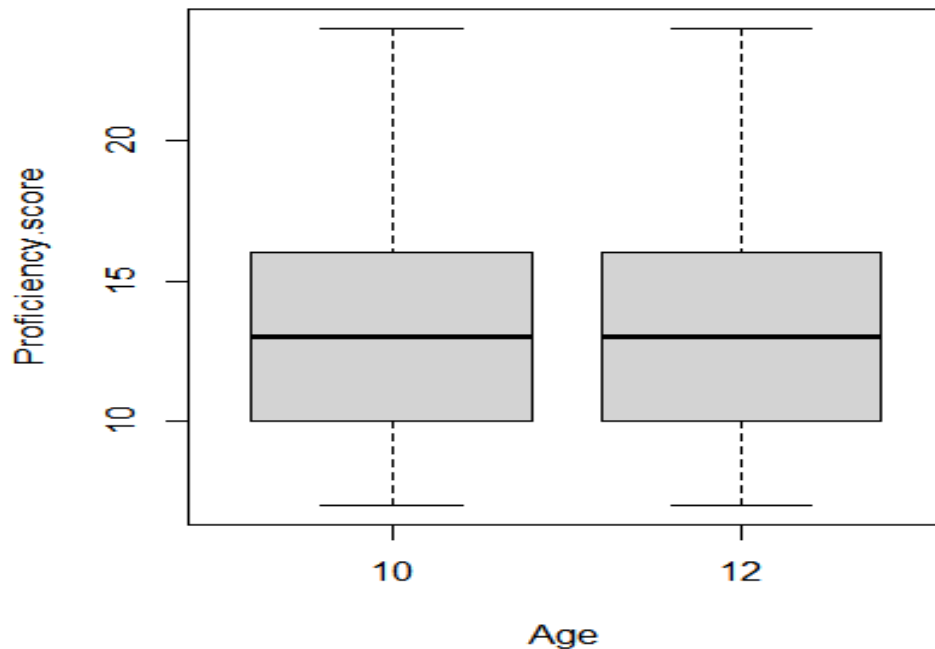
In the following sections, I discuss the participants' proficiency scores in comparison to their age. Secondly, I discuss the results of the acceptability judgement task. The fillers are excluded from the analyses. As discussed in section 3.7.2, there were 10 ungrammatical filler sentences in the AJT. The participants judged the ungrammatical fillers as ungrammatical, which shows that the participants understood the task and confirms that the test and the results of the test are reliable.

4.1 Data analysis: The proficiency test

As discussed in section 3.6, the students' proficiency is measured with a multiple-choice task. This test is a subset of the Standardized Oxford Proficiency test with 29 items. Each correct answer gives one point, i.e. the highest score is 29. In this study, the assigned proficiency score for all the participants' ranged between 7 and 24 points (mean =13.52, median =13.00). Based on this data, figure 1 shows the correlation between participants' age and their proficiency scores.

Figure 1

Figure 1. Correlation between proficiency scores and age



The adjusted r^2 -value for the correlation between age and proficiency scores is less than 0.01 (see appendix 8), which suggests that less than 1% of the proficiency scores can be explained by the participants' age. This indicates that there is no significant correlation between proficiency scores and age.

4.2 Data Analysis: The acceptability judgement task

As presented in chapter 3, the experiment consists of 20 sentence pairs. Each pair has a grammatical and an ungrammatical version of the same sentence. The participants were asked to judge all sentences on a Likert scale from very bad to very good, where very bad means completely unacceptable, and very good means completely acceptable. In the analysis, the scores on the Likert scale are treated as a binary variable with the categories *unacceptable* and *acceptable*, *i.e.* levels 1 and 2 on the Likert scale indicate unacceptable and levels 3 and 4 indicate acceptable. For that reason, I added an accuracy variable. Accuracy would be 1 if the response is 1 for a grammatical sentence or 0 for an ungrammatical sentence, and accuracy would be 0 if the response is 0 for a grammatical sentence or 1 for an ungrammatical sentences. In essence, accuracy is the 'distance

from the correct answer' but for binary responses, thus the distance can only be 0 or 1. Moreover, the dependent variable was the 'accuracy' in the acceptability judgement task, and the independent variables were the conditions (discussed in section 2.5), age, the proficiency scores and the interaction between age and conditions, and the interaction between proficiency scores and conditions. Participants and items were included as random intercepts.

Furthermore, I fitted three mixed effects logistic regression models: the first one was to model accuracy by conditions (appendix 9). Then, a pairwise comparison between the conditions was performed. The second one was to model accuracy by the interaction between conditions and age (appendix 12), next I performed a pairwise comparison between age groups by condition. In this model, conditions, age, and the interaction between conditions and age were considered as fixed effects, while the participants' ID, and item were regarded as random effects. The third one was to model accuracy by the interaction between conditions and proficiency scores (appendix 14). In this model, conditions, proficiency scores, and the interaction between conditions and proficiency scores were considered as fixed effects, while the participants' ID and item were considered as random effects. Then I performed a pairwise comparison between proficiency scores by condition.

Table 13 illustrates the raw and marginal accuracy means from the defined model (see appendix 10). Asymp.LCL is the lower boundary of a 95% confidence interval, asymp.UCL is the higher boundary of a 95% confidence interval, which means that if I repeat the sampling method again, approximately 95% of the intervals constructed would show the mean of the true population. According to table 13, in the first model, conditions were considered as fixed effects and the participants' ID, and items (the sentence pairs) as random effects.

Table 13. Raw and marginal means of accuracy by condition, for all participants

Conditions	Mean	SE	Df	asymp.LCL	asymp.UCL
Adj-N	0.958	0.0813	Inf	0.799	1.11
Pronominal gender	0.570	0.079	Inf	0.414	0.726
Past	0.986	0.080	Inf	0.827	1.144
Subject-verb agreement	0.640	0.079	Inf	0.484	0.795

According to table 13, accuracy in conditions Past tense (0.98), Adj-N (0.95), Subject-verb agreement (0.64), and Pronominal gender (0.57) is observed. These findings show that Past tense seems to be less problematic for the Persian learners of English, as they have high accuracy in judging the sentences in this condition, while Pronominal gender seems to be more problematic for them as they obtained the lowest accuracy in judging the sentences in this condition.

Moreover, accuracy of Past tense (0.98) is higher than Subject-verb agreement (0.64). In other words, the participants performed better in Past tense than in Agreement. Furthermore, the accuracy of Adj-N (0.95) is higher than Pronominal gender (0.57) which means that the participants performed better in Adj-N word order than in Pronominal gender.

4.2.1 Comparison of conditions

To examine the accuracy of the participants by conditions together, marginal scores in logistic mixed-effect regression are compared (see appendix 11). The results in table 14 indicate that there is a significant difference in accuracy between Adj-N word order and Pronominal gender ($p < 0.05$), Adj-N word order and Subject-verb agreement ($p < 0.05$), and Past tense and Subject-verb agreement ($p < 0.05$).

Table 14. Compare accuracy by conditions, for all participants

Display	Estimate	P-value
Adj-N word order – Pronominal gender	0.39	<0.05
Adj-N word order – Past	-0.03	0.990
Adj-N word order – Subject-verb agreement	0.32	<0.05
Pronominal gender – Past	-0.42	<0.05
Pronominal gender – Subject-verb agreement	-0.07	0.863
Past – Subject-verb agreement	0.35	<0.05

The pairwise comparison (Tukey’s test) reveals that there is a statistically significant difference in accuracy between Past tense and Subject-verb agreement ($p < 0.05$). This indicated that the participants are more accurate in judging Past tense compared to Subject-verb agreement. Therefore, these two conditions are not equally difficult, and learning Subject-verb agreement is challenging for Persian learners of English.

Moreover, the pairwise comparison (Tukey’s test) shows that there is a statistically significant difference in accuracy between Adj-N word order and Pronominal gender ($p < 0.05$), i.e. the participants are more accurate in judging Adj-N word order than on Pronominal gender. Thus, these two conditions seem to be not equally difficult and learning Pronominal gender is more problematic for Persian learners of English.

Furthermore, there is a statistically significant difference in accuracy between Adj-N word order and Subject-verb agreement ($p < 0.05$), while there is not a statistically significant difference between Adj-N word order and Past tense ($p = 0.99$).

Additionally, there is a statistically significant difference in accuracy between Past and Pronominal gender ($p = 0.0001$), while there is not a statistically significant difference in accuracy between Pronominal gender and Subject-verb agreement ($p = 0.86$).

4.2.2 Interaction between conditions and age

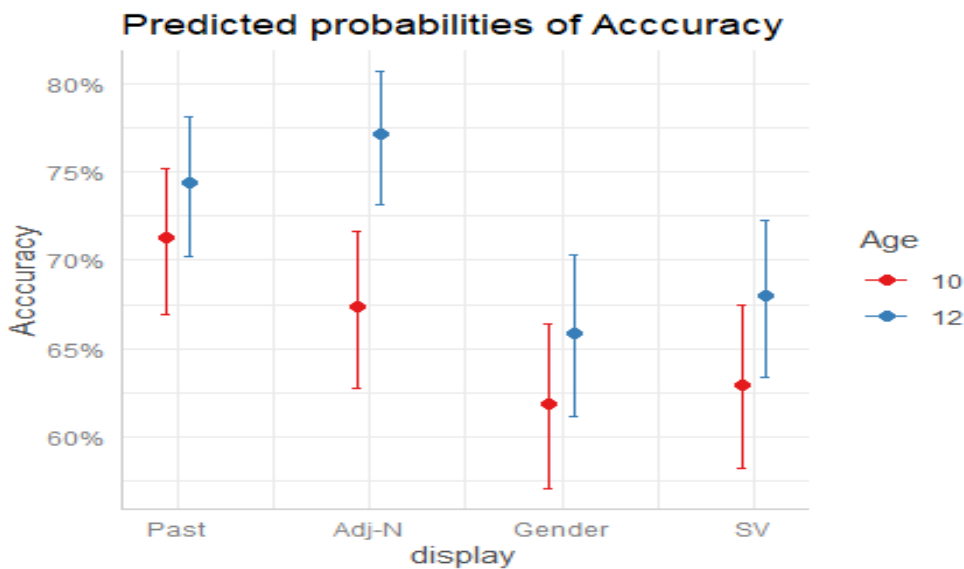
Although there is no age difference when it comes to proficiency, there is an age difference in how the participants judged acceptability in different conditions.

Table 15 shows the comparison of accuracy by conditions between two groups of participants (10 and 12 years old) (see appendix 13); figure 4 shows the same results. It is clear that there is a statistically significant difference in the Adj-N word order ($p < 0.05$), which means that the 12-year-old students had higher accuracy in Adj-N word order compared to 10-year-old students. Therefore, there is a strong effect of age in the Adj-N condition, and there is also a marginal effect in Subject-verb agreement ($p = 0.089$).

Table 15. Compare accuracy by conditions between groups

Contrast (10 – 12)	Estimate	SE	Df	z.ratio	p.value
Past	-0.157	0.134	Inf	-1.169	0.242
Adj-N word order	0.490	0.136	Inf	-3.605	<0.05
Pronominal gender	-0.175	0.131	Inf	-1.335	0.181
Subject-verb agreement	-0.222	0.131	Inf	-1.701	0.089

Figure 2. Predicted accuracy values by condition and age



According to Figure 2, the accuracy of 12 years old students is higher than 10 years old students in all conditions. However, there is a statistically significant difference only in the accuracy of Adj-N word order between the two groups ($p < 0.05$). This means that 12 year-old students have higher accuracy in the Adj-N condition compared to 10 year-old students.

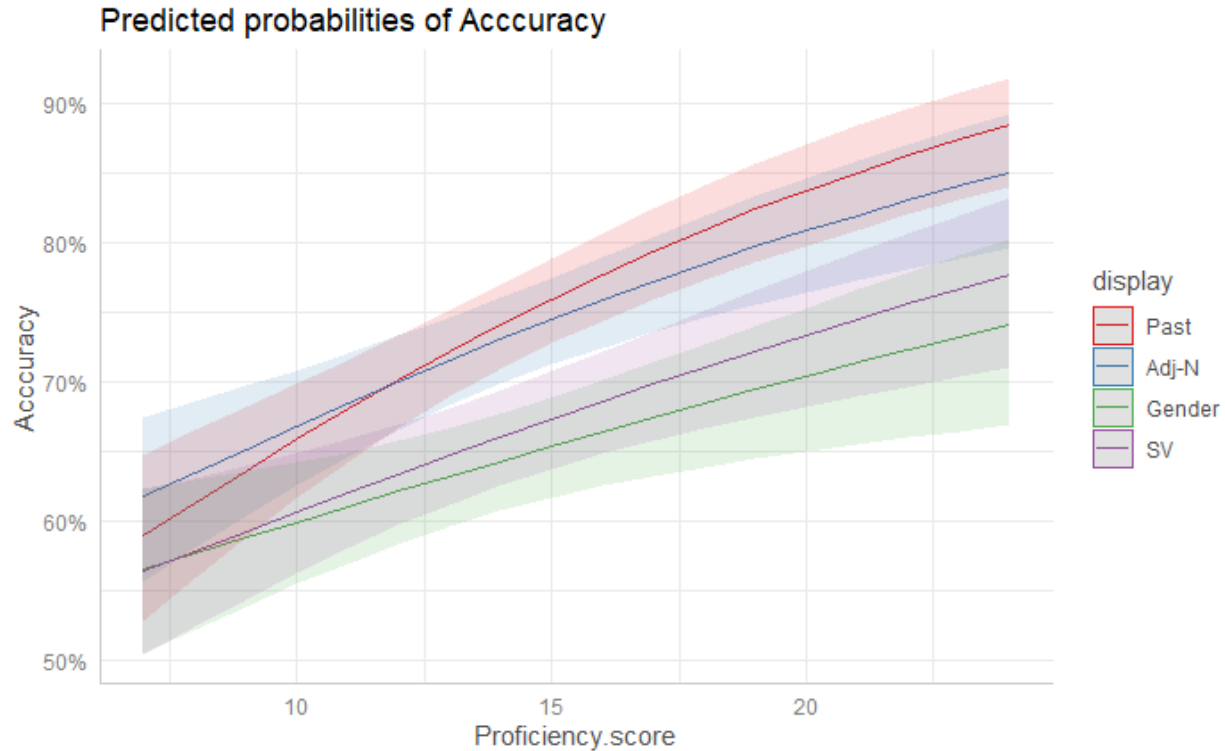
4.2.3 Interaction between conditions and proficiency scores

With regard to the results in table 16, the second column (Proficiency score trend) is the estimate for the effect of proficiency for each condition (appendix 15). None of the confidence intervals here include 0, which indicates that Proficiency is significant for each of the conditions (see figure 5, all the lines are clearly sloping).

Table 16. Estimated marginal means of linear trends

Display	Proficiency score trend	SE	Df	Asymp.LCL	Asymp.UCL
Past	0.098	0.016	Inf	0.066	0.13
Adj-N	0.074	0.016	Inf	0.042	0.10
Pronominal gender	0.046	0.015	Inf	0.016	0.07
Agreement	0.058	0.015	Inf	0.028	0.08

Figure 3. Predicted probabilities of accuracy



As seen in Figure 3, at the beginning, the accuracy of Past tense is lower than Adj-N word order. Moreover, when the participants get a higher general proficiency their accuracy of Past tense increases faster than Adj-N word order because it has a steeper slope. That is, at the higher accuracy the participants are more accurate at identifying Past tense. However, at the lower accuracy, the participants are better with Adj-N word order. It can be indicated that Adj-N word order is early acquired at least by some of the participants but when they realize Past tense, its acquisition goes very fast and falls in place.

As Figure 3 reveals, the slope for Past tense *-ed* and Adj-N word order is significantly steeper than the slope for Subject-verb agreement and Pronominal gender. This indicates that the L2 learners improve their accuracy in Past tense and Adj-N word order conditions faster than Subject-verb agreement and Pronominal gender. Furthermore, at the lower accuracy, the participants perform similarly in both Subject-verb agreement and Pronominal gender. Nevertheless, as the participants get a higher general proficiency, their accuracy of Subject-verb agreement increases faster than Pronominal gender.

According to table 16, and figure 3, there is an effect of proficiency and also interaction between proficiency and conditions. The significant interaction between conditions and proficiency suggests that accuracy on one property, Past tense, develops faster than the other conditions. This can be seen from the different slopes of the lines in Figure 3.

In sum, both age and proficiency have predictive power, but proficiency does to a greater extent. This is because it has an effect in all conditions, while age has an effect in one condition (Adj-N).

5 Discussion

In this chapter, I discuss the questions of the study and the results which are presented in chapter 4.

Research Questions:

RQ1: Do Persian learners of English have more difficulty acquiring functional morphology compared to syntax and semantics?

RQ 2: Is English functional morphology a more persistent problem than its syntax and semantics for L1 Persian speakers?

RQ 3: Are the two morphological conditions equally difficult in L2 acquisition for L1 Persian speakers?

RQ 4: Are the two syntax-semantics conditions in English equally difficult in L2 acquisition by L1 Persian?

Predictions:

Prediction 1: Persian learners of English have more difficulty acquiring functional morphology compared to syntax and semantics.

Prediction 2: Functional morphology is a more persistent problem than syntax and semantics.

Prediction 3: The two morphological conditions are not equally difficult for L1 Persian speakers.

Prediction 4: The two syntax-semantics conditions in English are not equally difficult in L2 acquisition by L1 Persian.

As explained in section 3.1, the predictions are based on the Bottleneck Hypothesis and drawn from the findings of the previous studies in the L2 acquisition of functional morphology, narrow syntax and semantics. To recap, the key point in the previous chapters is that based on the claims by the BH, acquisition of functional morphology is challenging, as it is not transferable and it must be lexically learned, while acquisition of syntax and semantics is easier as they are transferable and are processed by means of universal operations. In the current study, Subject-verb agreement and Past tense *-ed* are used to test knowledge of functional morphology in Persian speakers

learning English as an L2, and Adj-N word order and Pronominal gender are used to test their knowledge of syntax and semantics respectively. Accordingly, the BH predicts that learning Subject-verb agreement and Past tense *-ed* is more problematic than Adj-N word order and Pronominal gender, as stated in prediction 1 and 2.

Regarding prediction 3, based on the previous research, Dehghani et al. (2016) examined twelve English grammatical features (as discussed in section 2.3.2) to see which grammatical features are more difficult for Persian learners of English. The results of this study revealed that Persian learners of English do not have challenges in the acquisition of tenses. Moreover, M. Jensen (2017) found that Past tense *-ed* is easier than both Subject-verb agreement and verb movement across an adverb in subject-initial clauses for Norwegian learners. Therefore, it is predicted that the two morphological conditions are not equally difficult to acquire and the L1 Persian speakers may have less difficulty acquiring Past tense *-ed* compared to Subject-verb agreement.

Regarding prediction 4, due to the differences between the two conditions of Adj-N word order and Pronominal gender, as discussed in sections 2.5.4 and 2.5.5, they may be not be equally difficult. Moreover, Felzien (2011) examined the use of Pronominal gender by Mandarin learners of L2 English. The results of Felzien (2011) demonstrated that Mandarin learners have problems in acquiring Pronominal gender in L2 English. Like Mandarin spoken form, Persian has no Pronominal gender, therefore it is predicted that L1 Persian speakers may have difficulty in the acquisition of Pronominal gender. Thus, conditions of Adj-N word order and Pronominal gender may not be equally difficult to acquire. Nevertheless, according to the BH, both conditions within syntax and semantics should be easier to acquire than the two morphological conditions.

5.1 Do Persian learners of English have more difficulty acquiring functional morphology compared to syntax and semantics?

Regarding research question 1, it is predicted that Persian learners of English have more difficulty acquiring functional morphology compared to syntax and semantics. This means that acquisition of Subject-verb agreement and Past tense *-ed* should be more difficult than Adj-N word order and Pronominal gender. The results reveal that the participants' accuracy was lower in judging sentences within Pronominal gender than in Subject-verb agreement, Adj-N word order and Past tense *-ed*.

Regarding the Subject-verb agreement condition within functional morphology, it was found that the accuracy of Subject-verb agreement is significantly lower than the accuracy of Adj-N word order. Although Persian has a rich inflected verbal system, the participants made frequent errors when judging sentences within Subject-verb agreement. This is in line with the findings of Jensen et al. (2020), which indicated that Subject-verb agreement is more challenging to acquire than narrow syntax by L2 English speakers of L1 Norwegian speakers. This may be due to the mismatch in the agreement system between English and Norwegian, as Norwegian does not have an overt agreement system. The finding is further supported by M. Jensen (2017), who found that Norwegian learners of English have more difficulty in judging sentences with Subject-verb agreement compared to narrow syntax. It is worthy to note that in addition to some support for the BH, M. Jensen (2017) found some problems with this hypothesis, which is further discussed in section 5.3.

Based on the findings discussed above (e.g. M. Jensen, 2017; Jensen et al, 2020), it can be expected that L2 learners have problems in acquiring Subject-verb agreement, regardless of the knowledge of previously acquired languages. In this respect, according to Slabakova (2013), the difficulty level of functional morphology is associated with the formal features that cannot be transferred from the previously acquired languages, but should be learned lexically (p. 14).

Moreover, the results confirm previous studies, such as Haznedar (2001), Ionin and Wexler (2001) and Lardiere (1998a,b), who reported that English L2 speakers are more accurate with syntactic phenomena in obligatory contexts, than in morpho-syntax related to the same functional category, like Subject-verb agreement. Slabakova (2013) declared that the results of these studies reveal that although L2 learners have not acquired the target functional morphology, they are able to engaged knowledge of syntactic operations. This supports the view of *syntax-before-morphology* and argues against the *morphology-before-syntax* view (White, 2003). According to Slabakova (2013), the former view argues that that knowledge of narrow syntax comes before the accurate knowledge of functional morphology, and the latter view argues that acquisition of functional morphology drives acquisition of functional categories.

In sum, when considering Subject-verb agreement and word order only, it may seem that the BH is supported, since the former is much more difficult than the latter. However, in the current study

I tested the Past tense feature and Pronominal gender as well, which resulted in somehow conflicting results. I chose Past tense to test another condition within functional morphology, and also I chose Pronominal gender as it does not exist in Persian.

Regarding Past tense *-ed* within functional morphology, the results indicate that the participants' accuracy is higher in Past tense compared to Adj-N word order, Pronominal gender and Subject-verb agreement. In other words, the participants made few errors with Past tense sentences than they did with Adj-N, Pronominal gender and Subject-verb agreement sentences. Based on the BH, Past tense *-ed* should be more difficult than narrow syntax and semantics. However, the results indicate that Past tense *-ed* is in fact easier than the two syntax-semantics conditions and also easier than Subject-verb agreement, which is opposed to the BH. This is in line with M. Jensen's (2017) study, which found that Past tense *-ed* was easier to acquire than both Subject-verb agreement and verb movement in subject-initial clauses. In section 5.3, I discuss the reason based on the interpretability.

Additionally, it was found that the accuracy of Pronominal gender is lower than the accuracy of Past tense, Adj-N word order and Subject-verb agreement. In other words, the participants had frequent errors judging the sentences with pronominal gender and showed weak performance in the acquisition of this property. Thus, this study indicates that acquisition of Pronominal gender is more difficult than other conditions by Persian L1 speakers acquiring English as their L2. This outcome does not support the BH.

Difficulties in the acquisition of gender have been widely attested in L1 and L2 acquisition research. According to some accounts (e.g. Corbett 1991), English has a pronominal gender system which is hard to acquire even by L1 English-speaking children. Moreover, the acquisition of gender is very challenging especially for L2 learners. This also becomes clear when we consider cross-linguistic effects in the acquisition of gender. Cross Linguistic Influence (CLI) seems to take place only when there is sufficient overlap between the gender systems in the two languages, e.g. Italian vs. Spanish (cf. Dussias et al. 2013). Since Persian lacks Pronominal gender, the participants should learn this property as a new feature. In this study, acquisition of Pronominal gender was found to be the most challenging task for Persian L1 learners of L2 English. Therefore, the findings correspond to the findings of Felzien (2011), who found that native Mandarin speakers had

difficulty using Pronominal gender, as in the spoken form, Mandarin has a basic pronoun *ta* that is mapped onto *he*, *she* and *it*. Thus, Felzien (2011) argued that the reason could be due to one-to-many mapping. As noted earlier, Persian does not have Pronominal gender and the pronoun *U* is mapped onto *he* and *she*. Thus, the reason can be due to one-to-many mapping as well.

Furthermore, according to the Contrastive Analysis Hypothesis (Lado, 1957), similarities between the L1 and the L2 should make the acquisition of L2 easier. Accordingly, Pronominal gender does not exist in Persian, therefore, L1 and L2 are not similar in this respect. According to both FT/FA and CA, acquisition of Pronominal gender in English is hard for Persian learners of English due to the differences between L1 and L2 concerning this property.

In sum, the results indicate that semantics seems to be the bottleneck in L2 acquisition by Persian speakers. Moreover, the results reveal that Past tense *-ed* in L2 English is the easiest condition, as the participants performed well in Past tense. This outcome is opposed to the prediction of the BH that claims that functional morphology is more difficult to acquire than narrow syntax and semantics. Thus, the findings do not support the prediction 1.

5.2 Is English functional morphology a more persistent problem than its syntax and semantics for L1 Persian speakers?

In order to answer this research question, I consider the way the acquisition of these four conditions develops. As there was no correlation between age and proficiency scores (see section 4.1), I use both age and proficiency as proxies for development.

Regarding age, 12-year-old students outperformed 10-year-old students in all four conditions. Moreover, the analysis shows that there is a significant interaction between age and Adj-N word order. The 12-year-old participants performed well in Adj-N word order compared to 10-year-old students. It can be indicated that at first the participants transferred their L1 word order (N + Adj), while at the age of 12 this condition was in place and they performed better than 10-year-old students. Following Slabakova (2013), I would argue that syntax is easy to acquire as it is processed by the means of universal operations and is thus transferable. In other words, the reason why it is easy for 12-year-old students to learn English word order is that they have full access to UG. This is consistent with the FT/FA hypothesis which argued that the initial state of the L2

system will have to change in light of L2 input that cannot be generated by the L1 grammar. In this respect, the failure of L1 grammar to assign a representation to the “L2 input data will force some sort of restructuring of the system (‘grammar’), this restructuring drawing from options of UG (and hence the term ‘Full Access’)” (p. 41), therefore making universal features and constraints accessible to the L2 learner. In contrast, there is no correlation between age and other conditions. This means that both 10- and 12-year-old students judged the sentences similarly, regardless of their age. In addition, both groups performed worst in Pronominal gender, i.e. this condition is not fully acquired by either of the groups.

Regarding proficiency, at the beginning, the participants’ accuracy in Past tense is lower than Adj-N word order. Then, as the participants get a higher general proficiency, their accuracy in Past tense increases faster than Adj-N word order. In other words, the participants become more accurate in recognizing Past tense at the higher accuracy. In sum, at first, the participants acquired Adj-N word order, but when they realized Past tense, its acquisition goes very fast and falls in place.

Moreover, the accuracy of Pronominal gender and Subject-verb agreement is the same at the beginning. Then as the participants get a higher general proficiency, their accuracy in Subject-verb agreement increases faster than Pronominal gender, which shows weak performance of the participants in Pronominal gender.

In sum, the interaction between conditions and age and the interaction between conditions and proficiency scores reveal that Pronominal gender is a more persistent problem. Thus prediction 2, that English functional morphology is a more persistent problem, is not supported. Although Pronominal gender is explicitly taught at Persian schools, learners struggle with this condition. It seems why Pronominal gender is a more persistent problem could be due to the lack of Pronominal gender in L1 which makes its acquisition problematic not only for bilingual learners (Felzien, 2011), but also for monolingual children (Corbett 1991).

5.3 Are the two morphological conditions equally difficult in L2 acquisition for L1 Persian speakers?

Regarding the research question 3, it is predicted that the acquisition of Subject-verb agreement is more challenging than Past tense –*ed*. According to the results, there is a significant difference in

the accuracy of Subject-verb agreement and Past tense *-ed*, i.e., the participants had lower accuracy in Subject-verb agreement than in Past tense and made frequent errors when judging sentences testing Subject-verb agreement.

Based on the discussion in section 5.1, in Persian, verb inflection in present tense is richer than English, while acquisition of Subject-verb agreement is hard for Persian learners of English. Furthermore, the result corresponds to what M. Jensen (2017) found in Norwegian-English bilingual students. In her findings, M. Jensen (2017) found that acquisition of Subject-verb agreement is more difficult than Past tense. Additionally, the results of the current study are in line with the findings of Dehghani et al. (2016) whose results indicated that tense is in the classification of less difficult features for Persian learners of English. I would argue that the reason is due to interpretability vs uninterpretability features (see section 2.1.2). Tense is an interpretable feature and the Past tense marker *-ed* is needed to keep the meaning of the sentence, while Subject-verb agreement is an uninterpretable feature and it does not change the meaning of a sentence. This means that if we eliminate the agreement marker *-s* from the verb, it only makes the sentence ungrammatical. Therefore, as the past tense marker contributes to the meaning of the sentence, it is expected to be easier to acquire, while the agreement marker regulate core syntactic behavior, and it is expected to be more difficult to acquire (see section 2.1.2 and section 2.5.2). As it was mentioned in section 5.1, acquisition of Subject-verb agreement is problematic for all L2 learners of English, regardless of the knowledge of previously acquired languages (Slabakova, 2013).

Furthermore, another reason why Past tense *-ed* is easier than Subject-verb agreement is that Past tense is much more local than Subject-verb agreement. In other words, tense is only marked on one constituent, whereas Subject-verb agreement involves two constituents: subject and verb. Therefore, the Past tense marker could be easier to acquire. Based on the reasons for the differences discussed above, prediction 3, that the two morphological conditions are not equally difficult, is supported.

5.4 Are the two syntax-semantics conditions in English equally difficult in L2 acquisition by L1 Persian?

In relation to the research question 4, it is predicted that Adj-N word order and Pronominal gender are not equally difficult to acquire for Persian L1 speakers. Regarding the prediction, the results

reveal that the accuracy of the participants was considerably higher in judging sentences within Adj-N word order than in Pronominal gender.

I argue that the reason why acquisition of Adj-N word order is easier for Persian L1 learners is due to full access to UG. As mentioned in section 2.1.1 and section 5.2, based on the “*Full Transfer/Full access Hypothesis*”, 10-year-old students transferred their L1 word order as they thought the English linguistic system is the same as the Persian system. Then by being exposed to L2 input they restructured their L2 grammar by accessing to UG. Accordingly, Slabakova (2013) stated that universal properties are transferable from L1. As syntax is a transferable feature, it is easier to acquire even though mismatches exist between Persian and English. Therefore, the acquisition of Adj-N word order is easier for Persian L1 learners.

In contrast, the results demonstrate that the acquisition of Pronominal gender is more difficult for Persian L1 learners compared to Adj-N word order. The results correspond to the findings of Felzien (2011) who found that acquisition of Pronominal gender in L2 English is difficult for Mandarin L1 learners whose L1 lacks Pronominal gender in the oral form. Felzien (2011) argued that the reason could be due to one-to-many mapping, as Mandarin has one third person singular *ta* which maps onto *he*, *she* and *it*. Moreover, I would suggest that the reason why Persian L1 learners have problems with Pronominal gender is the lack of knowledge of the gender system of English. Persian has no Pronominal gender, while in English Pronominal gender is expressed by the pronouns *he* and *she*. Thus, there is a one-to-many correspondence and the participants have to learn Pronominal gender from scratch. This is more discussed in section 5.1.

In sum, prediction 4, that the two conditions within syntax and semantics are not equally difficult is supported. However, the results are not in line with the claim of the BH, that the two conditions within syntax and semantics should be easier than the two conditions within functional morphology, as the results show that Pronominal gender is difficult than Subject-verb agreement and more difficult than Adj-N word order and Past tense *-ed*. Moreover, the students made more errors judging the sentences with Adj-N word order compared to Past tense *-ed*. Nevertheless, still much more research is needed in order to better understand the complex phenomenon of acquisition of Pronominal gender especially in languages that lack this feature.

5.5 Does the current thesis support the BH?

In summary, the participants struggled more with pronominal gender than they did with other conditions. This is surprising because according to the BH, the morphological conditions should be more challenging than syntax-semantics conditions. I therefore argue that the Full Transfer/Full Access hypothesis (FT/FA), transfer from the L1 (see section 2.1.1) and interpretability vs uninterpretability (see section 2.1.2) cause the difference in the results. According to the BH, Subject-verb agreement and Past tense *-ed* should be more difficult to acquire. Nevertheless, the findings of the current study indicated that Persian speakers struggled more with Adj-N word order than with the Past tense *-ed*, which is opposed to the prediction of the BH.

If I had just examined Subject-verb agreement against syntax, I could have said that the findings of the current study fully support the BH. Nevertheless, in the current study I tested Past tense *-ed* and another condition within semantics and the results were different. Thus, I cannot conclude that the BH is supported. According to the findings of this study, more research should be done on the BH and it needs to be refined in such a way that it predicts which condition is more problematic to acquire in L2 English.

6 Conclusion

This chapter presents a summary of the findings obtained from the quantitative analysis of the data. Moreover, implications and recommendations for future research are presented and discussed.

In this study, the Bottleneck Hypothesis (Slabakova 2006, 2008, 2013) has been tested in L2 acquisition of English by Persian L1 speakers. The BH is one of the prominent hypothesis in the field of second language acquisition as it contributes to current knowledge of the cognitive process when a learner acquires an L2. This hypothesis claims that functional morphology is the bottleneck of L2 acquisition, and that narrow syntax and semantics, for instance, are easier to acquire. Accordingly, it is predicted that functional morphology is more difficult for Persian speakers to acquire compared to syntax and semantics. As the previous chapters have shown, the experiment presented in the current study does not support the Bottleneck Hypothesis. More specifically, the results demonstrated that the learners' performance with semantics was weaker than their performance with functional morphology and syntax, and also, semantics was a more persistent problem although the students' age and their proficiency in English increased. Moreover, the results indicated that one of the morphological conditions was easier than the two conditions within syntax and semantics.

In order to test the BH, four conditions were included: Subject-verb agreement, Past tense *-ed*, Adjective-N word order, and Pronominal gender. Subject-verb agreement and Past tense *-ed* tested knowledge about functional morphology, while Adjective –N word order and Pronominal gender tested knowledge about syntax and semantics respectively. As noted earlier, English and Persian are two different languages with distinct linguistic systems. To exemplify, although English and Persian have overt agreement system, they are different in the use of inflections. With regard to Past tense, in English, Past tense is marked by adding the suffix *-ed* or *-d* to regular verbs, while in Persian Past tense is made by deletion of the infinitive suffix /æɪn/, and adding personal endings to the past stem of the verb. The only exception is the 3rd person singular, which has no personal ending and is the Past tense stem alone. Moreover, Persian has a rich inflectional system and is more complicated than English, which caused mismatches between the two languages. Regarding Adjective-noun word order, in English, adjectives precede the noun they modify, whereas in

Persian adjectives follow the noun they modify. Furthermore, English has Pronominal gender, while Persian has no gender distinction.

The four conditions were tested on 252 students in two age groups (10- and 12-years-old), see section 3.5. The participants were L1 Persian speakers of L2 English. The experiment was based on *Gorilla* (an online survey method), which included a timed acceptability judgement task, a background questionnaire and a proficiency test, as discussed in section 3.7.

If I had only examined Subject-verb agreement against syntax, I could have said that the findings of the current study fully supported the BH. Nevertheless, in the current study I tested Past tense *-ed* within functional morphology and another condition within semantics and the results were different. Like Felzien (2011), the current thesis found that Pronominal gender appeared to be difficult to acquire for L2 English learners whose L1 lacks gender. In addition, Pronominal gender was found to be a more persistent problem for all the students. The reason could be in selecting and mapping features onto a specific morphological form. Since Persian lacks Pronominal gender, the participants should learn Pronominal gender as a new feature. Thus, the acquisition of Pronominal gender is the most challenging task for Persian L1 speakers of L2 English. Furthermore, like M. Jensen (2017), the current study found that Past tense *-ed* is not only easier to acquire than Subject-verb agreement, but also it is easier than syntax and semantics. In addition, the result corresponds to the findings of Dehghani et al. (2016) who found that Persian learners do not struggle with the acquisition of tense. This can be due to interpretability. Past tense marker is an interpretable feature, that is, “it contributes to the meaning of the sentence and it cannot be deleted before Spell-Out, i.e. it survives into the semantic system for interpretation” (Slabakova, 2013, p.8). Therefore, it can be acquired easier. In contrast, the agreement marker is an uninterpretable feature, that is, it can be eliminated before Spell-Out, which means that it is “purely formal in nature, and serve to establish syntactic dependencies” (Slabakova, 2013, p.8). Therefore, it is difficult to acquire it.

Regarding the condition within syntax, 12-year-old students outperformed 10-year-old students in acquiring Adj-N word order. Due to full access to UG (Schwartz & Sprouse, 1994; 1996), the current thesis argues that acquisition of Adj-N word order is easy for 12-year-old students.

In sum, the current study does not support the BH. Regarding the difference in the results between the two morphological conditions, I would suggest that the BH needs to be modified in a way it argues which conditions within functional morphology are more difficult to acquire. Furthermore, although acquisition of Pronominal gender is challenging even for L1 English speaking children (Corbett, 1991), more studies should be done to examine the performance of L2 English learners whose L1 lacks Pronominal gender.

The findings of this study may help teachers as well. Both linguistic and pedagogical knowledge can help teachers to know where they should pay more attention to the in-class instruction. In respect to language instructions, Slabakova (2016) declared that “our main focus is ultimately on classroom instruction” (p. 390). According to Slabakova (2016), when teachers are teaching L2, they need to focus on both form and meaning. As Persian has no gender and the results indicated that Persian learners struggled more in acquiring Pronominal gender, “it should get the lion’s share of attention in language classrooms” (Slabakova, 2016, p. 203) in a way that teachers can present this condition in a form based instruction and help students for better understanding. Finally, the BH needs to be refined in a way it claims the difficult parts of L2 acquisition, so that L2 teachers can be aware of the difficult conditions of the L2

Furthermore, according to the results of the current thesis, it seems that further investigations should be done on what is easy and what is hard to acquire in L2 acquisition by considering other conditions. Since this study involved only 10 and 12 year-old students, it remains an issue whether older students will have problems with the acquisition of Pronominal gender or not. Thus, a similar study can be conducted by considering different age groups, i.e., high-school students or a comparison of elementary and high school students. Furthermore, in order to test the BH, it would be interesting to test the morphological conditions against other domains than narrow syntax like pragmatics and the syntax-discourse interface. In addition, in order to investigate whether the same conditions are the difficult ones, it would also be interesting to test the BH in other languages. Finally, in order to investigate the learners’ implicit knowledge, it would be useful to test the BH in other methods like eye-tracking or a speeded acceptability judgement task.

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8 Appendices

Appendix 1: The pilot participants' mean score of judgements for grammatical and ungrammatical sentences when the Likert scale is treated as an ordinal variable.

	Subject-verb agreement	Past -ed	Adj-N	Pronominal gender
Grammatical	3.29	3.15	2.85	3.00
Ungrammatical	3.12	2.57	3.06	2.57

Appendix 2: Information letter in English

To whom it may concern

This is to confirm that Melika Rajabi is a second-year student enrolled in the English Language Acquisition and Multilingualism Master program at the UiT – The Arctic University of Norway. Melika Rajabi's MA thesis investigates the relative difficulty of morphological, and syntax-semantics properties of English for Persian learners. Two groups of student (10 and 12 years) will be recruited for participation in this study. The younger students attend 4th grade of Persian primary school, and the older students are in their last year of Persian primary school (6th grade).

This study includes an Acceptability Judgement Task (AJT), a background questionnaire, and a proficiency test. In the AJT students will be asked to judge sentences based on a Likert scale from very good, to very bad (thus testing the linguistic intuitions of the students). The background questionnaire asks about the students' age, and in which language they speak to their family and friends. The last test is a proficiency test which is a multiple-choice test. It will take approx. 30 minutes to complete all the tasks. The participation in the study is voluntary, the students' responses will be anonymous and confidential, and at no stage in the project will personal information about the students made public. The tasks will not have any effect on the students' grades at school.

If you have questions about the project, or want to exercise your rights, please send an email to:

mral16@uit.no (student) or marit.westergaard@uit.no (supervisor)

Appendix 2.1: Information letter (Persian translation)

اطلاعات تحقیق

به افراد و مسوولین مربوطه

بدینوسیله گواهی می‌شود که خانم ملیکا رجبی دانشجوی سال دوم مقطع کارشناسی ارشد در رشته یادگیری زبان انگلیسی و چند زبانی است و در دانشگاه ترومسو UIT - دانشگاه آرکتیک نورژ ثبت نام کرده است. پایان نامه مقطع ارشد ملیکا رجبی به بررسی دشواری نسبی ویژگی‌های صرفی و نحوی زبان انگلیسی برای فارسی زبانان که قصد یادگیری زبان انگلیسی را دارند می‌پردازد. دو گروه از دانش آموزان (9الی 10 ساله و 12الی 13 ساله) به منظور شرکت در این مطالعه بکار گرفته می‌شوند. گروه جوانتر دانش آموز کلاس چهارم ابتدایی در ایران و گروه سنی بزرگتر کلاس ششم ابتدایی (سال آخر آموزش دبستان) هستند.

این مطالعه شامل انجام یک آزمون قضاوت درباره قابل قبول بودن (AJT) و یک پرسش نامه زمینه‌ای و یک آزمون مهارت می‌باشد. در آزمون قضاوت درباره قابل قبول بودن، از دانش آموزان خواسته می‌شود که بر مبنای بازه خیلی خوب تا خیلی بد درباره جملات قضاوت کنند (بنابراین شم زبانی دانش آموزان مورد آزمون قرار می‌گیرد). در پرسش نامه زمینه‌ای، درباره سن دانش آموز، مقطع تحصیلی و اینکه با چه زبانی با خانواده و دوستان خود صحبت می‌کنند، پرسش می‌شود. آخرین آزمون، آزمون مهارت است که به صورت چند گزینه‌ای است. برای پاسخ دادن به هر سه آزمون تقریباً 30 دقیقه زمان نیاز است. شرکت در این پژوهش اختیاری است و پاسخ‌های دانش آموزان محرمانه و بدون درج نام حفظ خواهد شد و در هیچ یک از مراحل آزمون اطلاعات شخصی دانش آموزان به صورت عمومی اعلام نمی‌شود. این آزمون تاثیری روی نمرات دانش آموزان در مدرسه نخواهد داشت. در صورت نیاز به اطلاعات بیشتر لطفاً با من تماس بگیرید.

ایمیل : marit.westergaard@uit.no or mra116@uit.no

Appendix 3: Consent letter

Title: L2 Acquisition of English by Persian L1 Speakers. Comparing Morphology, Syntax and Semantics

Researcher: Melika Rajabi

To: Parents

I have read the information sheet and I have been given an explanation of this research project. I have also had an opportunity to ask questions and have them answered.

I understand that I may withdraw my child or any information traceable to my child or me at any time until May 1st, 2022, without giving a reason.

- I agree that, who is my child, will participate in this research.
- I agree that my child can participate in this research and do the three tasks.
- I agree that the information about my child can be published in a way that he/she cannot be identified.
- I agree that my child’s personal data can be processed until the end date of the project, approx. June 2022
- I agree with the abovementioned information and I give consent that my child can participate in the master’s project.

Signed:

Name:

Date:

Appendix 3.1: Consent letter (Persian translation)

رضایت نامه

عنوان تحقیق: فراگیری زبان انگلیسی بعنوان زبان دوم توسط دو زبانه های فارسی-انگلیسی: مقایسه ی ریخت شناسی و نحو

پژوهشگر: ملیکا رجیبی

به: والدین

من اطلاعات این تحقیق را مطالعه کرده ام و محقق این طرح پژوهشی را برای من توضیح داده است و این فرصت به من داده شده است تا سوال بپرسم.

من می دانم که می توانم تا ماه می 2021 بدون ارایه دلیلی از اینکه از اطلاعات مربوط به فرزندم در این

تحقیق استفاده شود، صرف نظر کنم.

من رضایت دارم که فرزندم،.....، در این تحقیق شرکت کند.

من رضایت دارم که فرزندم می تواند در این تحقیق شرکت کند و به سوالات سه پرسشنامه پاسخ دهد.

من رضایت دارم که اطلاعات مربوط به فرزندم به گونه ای منتشر شود که شناسایی او امکان پذیر نباشد.

من رضایت دارم که داده های فرزندم تا پایان پروژه (ژوئن 2022) قابل پردازش باشد.

من با اطلاعات فوق موافقم و رضایت دارم که فرزندم در این پروژه کارشناسی ارشد شرکت کند.

امضا:

نام و نام خانوادگی:

تاریخ:

Appendix 4: The Proficiency test

لطفا جملات را با دقت بخوانید و پاسخ درست را از میان گزینه های موجود انتخاب کنید. توجه: جملات 11 تا 20 مربوط به زندگی "محمد علی کلی" بوکسور معروف می باشد.

1. Water _____ at a temperature of 100° C.

- is _____ to boil
- is _____ boiling
- boils

2. In some countries _____ very hot all the time.

- there _____ is
- is
- it is

3. In cold countries people wear thick clothes _____ warm.

- for _____ keeping
- to _____ keep
- for to keep

4. In England people are always talking about _____.

- a _____ weather
- the _____ weather
- weather

5. In some places _____ almost every day.

- it _____ rains
- there _____ rains
- it raining

6. In deserts there isn't _____ grass.

- the
- some
- any

7. Places near *Brazil* have _____ weather even in the cold season.

- a warm
- the warm
- warm

8. In Iran _____ time of year is usually from December to February.

- coldest
- the coldest
- colder

9. _____ people don't know what it's like in other countries.

- The most
- Most of
- Most

10. Very _____ people can travel abroad.

- less
- little
- few

11. Mohammed Ali _____ his first world title fight in 1960.

- has won
- won
- is winning

12. After he _____ an Olympic gold medal, he became a professional boxer.

- had won
- have won
- was winning

13. His religious beliefs _____ change his name when he became a champion.

- have made him
- made him to
- made him

14. If he _____ lost his first fight with Sonny Liston, no one would have been surprised.

- has
- would have
- had

15. He has traveled a lot _____ as a boxer and as a world-famous personality.

- both
- and
- or

16. He is very well known _____ the world.

- all in
- all over
- in all

17. Many people _____ he was the greatest boxer of all time.

- is believing
- are believing
- believe

18. To be the best _____ the world is not easy.

- from
- in
- of

19. Like any top sportsman, Ali _____ train very hard.

- has to
- must
- should

20. Even though he has now lost his title, people _____ always remember him as a champion.

- would
- will
- did

قسمت زیر در مورد تاریخچه هوانوردی است، متن زیر را بخوانید و بهترین پاسخ را برای هر قسمت خالی انتخاب کنید.
توجه داشته باشید که جملات به صورت داستانی و متوالی (پشت سر هم) هستند.

21. The history of _____ is

- airplane
- the airplane
- an airplane

22. _____ short one.

- quite a
- a quite
- quite

23. For many centuries men _____ to fly,

- are trying
- try
- had tried

24. but with _____ success.

- little
- few
- a little

25. In the 19th century a few people succeeded _____ in balloons.

- to fly
- in flying
- intoflying

26. But it wasn't until the beginning of _____ century that anybody

- last
- next
- that

27. _____ able to fly in a machine

- were
- is
- was

28. _____ was heavier than air,

- who
- which
- what

29. in other words, in _____ we now call a 'plane'. The first people to achieve

- who
- which
- what

خیلی ممنون که در انجام این پروژه به من کمک کردید لطفا روی گزینه ی ارسال کلیک کنید.

Appendix 5: Background questionnaire

لطفا به تمامی سوالات پاسخ دهید

سن

جنسیت

دختر

پسر

مقطع تحصیلی

از چه سنی یادگیری زبان انگلیسی را آغاز کرده اید؟

در کجا یادگیری زبان انگلیسی را آغاز کرده اید؟

مهد کودک

مدرسه

کلاس زبان

معلم خصوصی

در خانه توسط والدین

در خانه به چه زبانی با مادر خود صحبت می کنید؟

در خانه چقدر با مادر خود انگلیسی صحبت می کنید؟

<u>همیشه</u>	<u>اغلب</u>	<u>گاهی اوقات</u>	<u>به ندرت</u>	<u>هرگز</u>
--------------	-------------	-------------------	----------------	-------------

در خانه به چه زبانی با پدر خود صحبت می کنید؟

در خانه چقدر با پدر خود انگلیسی صحبت می کنید؟

هرگز به ندرت گاهی اوقات اغلب همیشه

در خانه به چه زبانی با خواهر یا برادر خود صحبت می کنید؟

در خانه چقدر با خواهر یا برادرتون انگلیسی صحبت می کنید؟

هرگز به ندرت گاهی اوقات اغلب همیشه

در مدرسه چقدر با دوستان خود انگلیسی صحبت می کنید؟

هرگز به ندرت گاهی اوقات اغلب همیشه

آیا در محیط خانه کارتون، فیلم، سریال، و آهنگ به زبان انگلیسی گوش می دهید؟

هرگز به ندرت گاهی اوقات اغلب همیشه

پایان تست دوم. لطفا روی نوار قرمز رنگ پایین کلیک کنید.

Appendix 5.1: Background questionnaire (English translation)

Please answer all the questions.

Age:

Sex:

Girl

Boy

Grade:

When have you started learning English?

Where have you started learning English?

Kindergarten

School

English class

Private teacher

At home with your parents

In which language do you speak to your mother at home?

How often do you speak English with your mother at home?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

In which language do you speak to your father at home?

How often do you speak English with your father at home?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

In which language do you speak to your father at home?

How often do you speak English with your siblings at home?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

How often do you speak English with your friends at school?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

Do you listen to music, or watch cartoons, film, or serial at home?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

Second test is finished. Please click on the red bar below.

Appendix 6: Instruction of the acceptability judgement task

سلام بچه ها، من ملیکا هستم معلم زبان انگلیسی برای انجام پایان نامه ام به کمکتون نیاز دارم. تحقیق من سه تا پرسشنامه دارد و برای تکمیل پرسشنامه ها کلا به 20 تا 30 دقیقه زمان نیاز دارید. تست اول: در هر صفحه یک جمله نمایش داده میشود، لطفا جمله را با دقت بخوانید. باین جمله چند گزینه هست و شما با انتخاب یکی از گزینه ها نظرتون را در مورد اینکه جمله چقدر در زبان انگلیسی درست هست بیان می کنید. دقت کنید که برای پاسخ دادن به هر سوال فقط 15 ثانیه وقت دارید. قبل از شروع تست اصلی با هم تمرین می کنیم تا در انجام تست مشکلی نداشته باشید.

برای انجام تمرین روی این نوار قرمز رنگ کلیک کنید

Play Farid and All football in park the.

15

Very good 😊 Good 😊 Bad 😊 Very bad 😊 I do not know

پس از دیدن تمام ویدیو روی این نوار قرمز رنگ کلیک کنید و یک جمله رو تمرین کنید

Sima and Bahram ate food at home yesterday.



Very good 😊

Good 😊

Bad 😊

Very bad 😊

I do not know

پس از دیدن تمام ویدیو روی این نوار قرمز رنگ کلیک کنید و یک جمله رو تمرین کنید

با کلیک روی نوار قرمز رنگ پایین، شما هم یک جمله رو تمرین کنید

تمرین

پس از دیدن تمام ویدیو روی این نوار قرمز رنگ کلیک کنید و یک جمله رو تمرین کنید

Went Katie to museum the.



Very good 😊	Good 😊	Bad 😞	Very bad 😞
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I do not know

تمرین تمام شد. با کلیک بر روی نوار قرمز رنگ وارد تست اصلی می شوید. آماده اید؟

شروع تست اصلی

Appendix 7: The sentences

Conditions	Grammatical	Ungrammatical
Subject-verb agreement	Lisa wants a present every Sunday.	Lisa want a present every Sunday.
Subject-verb agreement	John takes a taxi to work every day.	John take a taxi to work every day.
Subject-verb agreement	David reads a story book every week.	David read a story book every week.
Subject-verb agreement	Helen talks about toys every Monday.	Helen talk about toys every Monday.
Subject-verb agreement	Jason plays basketball every Tuesday.	Jason play basketball every Tuesday.
Past tense -ed	Anna and Jack played football last Monday.	Anna and Jack play football last Monday.
Past tense -ed	Sarah and Emma fixed a car last month.	Sarah and Emma fix a car last month.
Past tense -ed	Sue and Rose borrowed three books yesterday.	Sue and Rose borrow three books yesterday.
Past tense -ed	Anne and Tom baked a cake two hours ago.	Anne and Tom bake a cake two hours ago.
Past tense -ed	Joe and Max answered two questions last Tuesday.	Joe and Max answer two questions last Tuesday.
Adjective-noun word order	Those books with new covers are expensive.	Those books with covers new are expensive.
Adjective-noun word order	Those students with colorful clothes are sad.	Those students with clothes colorful are sad.
Adjective-noun word order	Those animals with white fur are thirsty.	Those animals with fur white are thirsty.
Adjective-noun word order	Those boys with heavy suitcases are tired.	Those boys with suitcases heavy are tired.

Adjective-noun word order	Those girls with big earrings are beautiful.	Those girls with earrings big are beautiful.
Pronominal gender	Kate saw a doctor because she was sick.	Kate saw a doctor because he was sick.
Pronominal gender	Mina bought a house and she was happy.	Mina bought a house and he was happy.
Pronominal gender	Sam heard a noise outside and he was scared.	Sam heard a noise outside and she was scared.
Pronominal gender	Max made a mistake and he was confused.	Max made a mistake and she was confused.
Pronominal gender	Maral had a car crash and she was shocked.	Maral had a car crash and he was shocked.
Ungrammatical Fillers		<p>At a hotel took Emily a bath.</p> <p>In a concert sang Niloofar a song.</p> <p>At the park found Shima a friend.</p> <p>Yesterday made Bardia a salad.</p> <p>At the restaurant ate Leila kebab.</p> <p>In the museum stole Frank a painting.</p> <p>Last Saturday sent Parmis a message.</p> <p>In the coffeshop drank Nima water.</p> <p>In the evening saw Farhad a cartoon.</p>

		Last Sunday broke Melika a window.
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Appendix 8: Correlation between Proficiency score and age

Residuals:

Min	1Q	Median	3Q	Max
-6.5498	-3.5470	-0.5498	2.4530	10.4530

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	13.546985	0.060618	223.482	<2e-16 ***
Age12	0.002789	0.086456	0.032	0.974

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.204 on 9459 degrees of freedom

Multiple R-squared: 1.1e-07, Adjusted R-squared: -0.0001056

F-statistic: 0.00104 on 1 and 9459 DF, p-value: 0.9743

Appendix 9: A mixed effects logistic regression to Model accuracy by conditions

AIC	BIC	logLik	deviance	df.resid
11426.2	11469.1	-5707.1	11414.2	9455

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.2334	-1.0463	0.4675	0.7431	1.4885

Random effects:

Groups	Name	Variance	Std.Dev.
Private.ID	(Intercept)	0.579604	0.76132
Item	(Intercept)	0.009774	0.09886

Number of obs: 9461, groups: Private.ID, 252; Item, 20

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	0.95798	0.08134	11.777	< 2e-16 ***
displayGender	-0.38784	0.09063	-4.280	1.87e-05 ***
displayPast	0.02775	0.09175	0.302	0.762274
displaySV	-0.31838	0.09049	-3.518	0.000434 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Appendix 10: Estimated marginal means of accuracy by condition

display	emmean	SE	df	asympt.LCL	asympt.UCL
Adj-N	0.958	0.0813	Inf	0.799	1.117
Gender	0.570	0.0794	Inf	0.414	0.726
Past	0.986	0.0809	Inf	0.827	1.144
SV	0.640	0.0793	Inf	0.484	0.795

Results are given on the logit (not the response) scale.
Confidence level used: 0.95

Appendix 11: Pairwise comparison between the conditions

\$contrasts

contrast	estimate	SE	df	z.ratio	p.value
(Adj-N) - Gender	0.3878	0.0906	Inf	4.280	0.0001
(Adj-N) - Past	-0.0278	0.0917	Inf	-0.302	0.9904
(Adj-N) - SV	0.3184	0.0905	Inf	3.518	0.0025
Gender - Past	-0.4156	0.0902	Inf	-4.606	<.0001
Gender - SV	-0.0695	0.0889	Inf	-0.781	0.8630
Past - SV	0.3461	0.0901	Inf	3.843	0.0007

Results are given on the log odds ratio (not the response) scale.
P-value adjustment: tukey method for comparing a family of 4 estimates

Appendix 12: A mixed effects logistic regression to model accuracy by the interaction between conditions and age

AIC	BIC	logLik	deviance	df.resid
11420.6	11492.1	-5700.3	11400.6	9451

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.2022	-1.0393	0.4664	0.7410	1.4724

Random effects:

Groups	Name	Variance	Std.Dev.
Private.ID	(Intercept)	0.564590	0.75139
Item	(Intercept)	0.009784	0.09892

Number of obs: 9461, groups: Private.ID, 252; Item, 20

Fixed effects:

Estimate	Std. Error	z value	Pr(> z)
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(Intercept)	0.90780	0.10326	8.792	< 2e-16 ***
displayAdj-N	-0.18267	0.11124	-1.642	0.100552
displayGender	-0.42355	0.10965	-3.863	0.000112 ***
displaySV	-0.37684	0.10927	-3.449	0.000563 ***
Age12	0.15692	0.13422	1.169	0.242328
displayAdj-N:Age12	0.33298	0.13486	2.469	0.013547 *
displayGender:Age12	0.01782	0.13010	0.137	0.891080
displaySV:Age12	0.06509	0.12972	0.502	0.615853

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Appendix 13: Pairwise comparison between age groups by condition

\$contrasts

display = Past:

contrast	estimate	SE	df	z.ratio	p.value
10 - 12	-0.157	0.134	Inf	-1.169	0.2423

display = Adj-N:

contrast	estimate	SE	df	z.ratio	p.value
10 - 12	-0.490	0.136	Inf	-3.605	0.0003

display = Gender:

contrast	estimate	SE	df	z.ratio	p.value
10 - 12	-0.175	0.131	Inf	-1.335	0.1817

display = SV:

contrast	estimate	SE	df	z.ratio	p.value
10 - 12	-0.222	0.131	Inf	-1.701	0.0890

Results are given on the log odds ratio (not the response) scale.

Appendix 14: A mixed effects logistic regression to model accuracy by the interaction between condition and proficiency scores

AIC	BIC	logLik	deviance	df.resid
11393.5	11465.0	-5686.7	11373.5	9451

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.2533	-1.0401	0.4657	0.7454	1.4371

Random effects:

Groups	Name	Variance	Std.Dev.
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Private.ID (Intercept) 0.492348 0.70168
 Item (Intercept) 0.009776 0.09888
 Number of obs: 9461, groups: Private.ID, 252; Item, 20

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-0.32878	0.22662	-1.451	0.14684
displayAdj-N	0.28749	0.24053	1.195	0.23200
displayGender	0.26240	0.23169	1.133	0.25740
displaySV	0.17838	0.23160	0.770	0.44117
Proficiency.score	0.09839	0.01616	6.087	1.15e-09 ***
displayAdj-N:Proficiency.score	-0.02433	0.01713	-1.420	0.15550
displayGender:Proficiency.score	-0.05178	0.01633	-3.172	0.00152 **
displaySV:Proficiency.score	-0.04024	0.01636	-2.459	0.01392 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Appendix 15: Estimated marginal means of linear trends

display	Proficiency.score.trend	SE	df	asympt.LCL	asympt.UCL
Past	0.0984	0.0162	Inf	0.0667	0.1301
Adj-N	0.0741	0.0161	Inf	0.0424	0.1057
Gender	0.0466	0.0152	Inf	0.0168	0.0764
SV	0.0582	0.0153	Inf	0.0282	0.0881

Confidence level used: 0.95